The Role of Street Furniture in Expanding Mobile Broadband

Wireless
Infrastructure
Association

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The Role of Street Furniture in Expanding Mobile Broadband

Abstract

Demand for mobile broadband is driving the need for small-cell architecture to supplement the macrocellular layer of commercial cellular coverage in today's 4G networks and for eventual 5G deployments. Street furniture – utility poles, bus-stop enclosures or any other street-level infrastructure that can house wireless equipment – offer highly effective tools in the mobile carrier's toolbox to bring their networks closer to their customers, if deployments can be done in an efficient manner. Street furniture can be used to expand the network using small cells, Distributed Antenna Systems (DAS), backhaul and other means to transmit and increase RF coverage to augment macrocellular tower deployments. These infrastructure solutions facilitate network densification under the macrocellular layer in areas where additional capacity is required.

Introduction

The world has gone mobile. A Time Magazine Mobility poll found that 84 percent of smartphone users cannot imagine going more than one day without cellular service. One bellwether of tracking U.S. mobile data consumption has been one of the nation's – and world's – most-watched events: the Super Bowl. Super Bowl 50 in February 2016 obliterated all mobile data consumptions records. Participants used more than 15 terabytes of data from approximately 35,000-plus estimated unique devices, according to eWeek.[1] Meanwhile, bandwidth-heavy mobile video traffic is expected to exceed 50 percent of total mobile data traffic this year.[2]

As such, U.S. carriers are scrambling to bolster their networks to keep up with the insatiable demand for constant mobile data connectivity. Generally, there are three ways to increase wireless coverage in an urban environment: Carriers can purchase new spectrum, which is expensive and not always available; carriers can deploy advanced technology – a continual process designed to increase wireless coverage through incremental changes to the network; and carriers can add more infrastructure sites. Adding macrocellular towers remains the most efficient way to get wireless coverage and capacity to the greatest number of people. Small cell and DAS solutions can augment the macrocellular tower infrastructure to bring the network closer to the end user.

The purpose of this white paper is to educate stakeholders about the role of street furniture applications and highlight some of the existing tools available to streamline their use in commercial cellular networks.

What is Street Furniture?

Street furniture is a term used to define objects in public spaces that – in the context of wireless infrastructure – house small-cell units in boxes and are considered visually commonplace and acceptable to the public. Street furniture must have a power source for the wireless equipment to function. Common examples of street furniture outfitted for small-cell networks include billboards, lamp posts, lit signage, phone booths, mailboxes, park benches, public art, utility poles, athletic field light poles, traffic signals and other structures that have a nearby power source.

In order to make street furniture suitable for small-cell networks, it must be able to accommodate power, antenna and associated fiber and other cabling equipment. In addition, good design and engineering is crucial to successful small-cell deployments on street furniture.

The Wireless Landscape

Mobile carriers have deployed the LTE protocol, also called 4G technology, to build out their communications networks. LTE technology is typically deployed using macrocellular Base Transceiver Stations (BTS) mounted onto telecommunication towers. Another strategically important technology is the small cell – often in combination with DAS, backhaul and fiber – as a way for carriers to densify their networks. Small cells are a significantly smaller version of the traditional macrocell because the attributes of a cell tower – like radios and antennas – are compressed into a low-power, portable and easy-to-deploy radio device. Small cells typically have a range varying from 10 meters to a few hundred meters and are used by carriers either to offload traffic from the macrocellullar network in a high-density, short-range environment or to strengthen the range and efficiency of a mobile network. Small cells can be integrated with DAS, LTE, and Wi-Fi technologies and incorporated into street furniture. In addition, small cells can bring the added advantage of low latency, which enables end users to connect to their content quickly.

As depicted in Figure 1, small cells can provide enhanced coverage and capacity outdoors while umbrella coverage is provided by the macrocell.

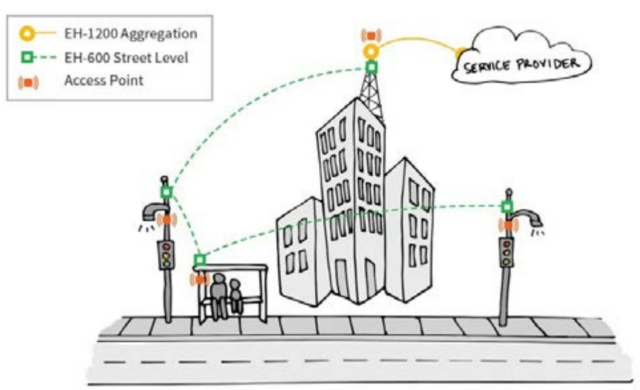

Figure 1: The macrocellular tower connects the RF signal to the street furniture, which then connects to the mobile device, and the device sends the signal back to the macrocellular tower via the street furniture.

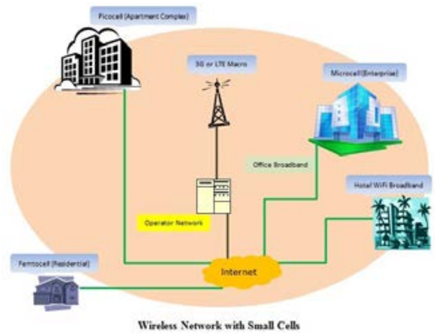

Figure 2: Several types of small-cell technologies can be used as part of a carrier's network strategy.

Microcells and picocells are designed to support hundreds of users and can be used in smaller networks that are not necessarily inside the range of a macrocellular network. Femtocells are tiny radios that can be deployed in residential areas to augment better signal strength indoors. Carriers also are using unlicensed Wi-Fi technology to offload traffic from macro networks. Wi-Fi technology also can be used as a standalone, high-speed short-range network.

Power Considerations for Small Cells on Street Furniture

For street furniture to be part of a carrier's wireless network, it must have power and the ability to backhaul traffic, meaning that it distributes the RF signal from the edge of the network back to the operator's core network. Some carriers also require back-up power sources. Back-up power requirements have largely been set by network providers and vary from small solar-powered solutions to a centralized Direct Current (DC) power hub.

DC Power Requirements

Base Transceiver Stations are the piece of equipment that connects the mobile device to the mobile network and are an integral part of both macrocellular towers and small-cell deployments. Historically, BTS deployments have necessitated the use of high power/high voltage DC power plants. Traditional macrocells have operated on +24 or -48 volt Direct Current (VDC) with power output levels as high as 6 kilowatts (kW) or more. They have been designed to be adaptable for input voltage so that they may be used internationally. While some small cells, particularly lower power examples, are moving to eliminate the need for external power conditioning and distribution, in most cases an AC-to-DC conversion still seems to be a basic power requirement.

DC power providers are producing power systems that can supply small cells using smaller versions of the existing original equipment manufacturer's (OEM) product lines. These miniaturized DC-power systems are modular designs that offer flexible power-distribution options. They can support larger batteries for longer back-up power periods. The controllers that provide remote monitoring of the power system and the back-up batteries are also contiguous with their larger power-system counterparts. However, these back-up power units are not always physically or aesthetically viable in public areas, including light poles and standards or on other structures. Weight and weather exposure can make larger power plants impractical.[3]
A second type of unit has been developed as a response to concerns that the DC power systems

may not be physically or aesthetically viable. The “pole/wall mount” category of power systems are all-in-one systems; however, they usually have less configuration flexibility and more limited back-up battery options. They are smaller and lighter, more aesthetically pleasing, simpler and less expensive to implement. They offer a reasonable power output range for a variety of base-station applications.[4]

Heat Dissipation Considerations

Heat dissipation is also a factor in deployments. Traditional BTS shelters for macrocellular towers are typically climate controlled with air-conditioning systems, but street furniture small-cell power systems often rely on fans or convection cooling and are typically engineered for them. Power conversion efficiency also must be a factor in design of small-cell power systems. The high cost of electricity makes the old standards of 80 to 85 percent conversion efficiency less attractive, particularly in more expensive urban environments, often making efficiency ratings above 95 percent the new benchmark.

Back-up Battery Requirements

Back-up battery requirements are another factor in the location of small-cell power systems on street furniture. Larger DC power system cabinets typically can be used if the time frame for back-up is longer than two hours. Internet connectivity is necessary to remotely monitor and control the back-up system. A wide range of power output options are necessary in both types of DC power supplies due to the wide range of transmitter power levels in different small-cell platforms. Picocells can be 50 watts or less and microcells can be as high as 1 kilowatt.

All of these factors come into consideration when designing power systems for small cells on street furniture. Since it is rare for small-cell deployments to be identical, this can make design and selection more time- and labor-intensive.

Antennas – Directional and Omni-directional

Small-cell antennas are the heart of the densification effort as they carry the RF signal. Street furniture infrastructure can support directional, omni-directional, and external antennas where heat output is not excessive.

RF Pattern Requirements

Several factors must be considered when choosing small cell or DAS antennas for use on street furniture. First is the RF pattern required: directional or omni-directional. A directional antenna, as seen in Figure 3, could be mounted atop or below the top of a street furniture structure, while an omni-directional antenna, Figure 4, would preferably be on the top because omnidirectional antennas require 360-degree radiation patterns in most cases so there is no structural blockage of the RF emission.

Figure 3: Directional antenna
Courtesy of CommScope

Figure 4: Omni-Directional antenna
Courtesy of Crown Castle

Structural Integrity

The next factor for consideration is the structural integrity of the street furniture intended for use. Among other factors, engineers will need to address the safe weight loading capability, how much added wind force the antenna contributes and the weight loading capability for cabling internal and/or external of the structure.

Other Considerations

While there are other mechanical and electrical considerations, the vast majority of questions among wireless infrastructure stakeholders, local jurisdictions and the public regarding street furniture antennas are related to aesthetics and local approval. Each jurisdiction has a set of rules and processes associated with deployments that make each deployment unique. These disparate processes can be costly and often impact reasonable deployment schedules.

To overcome these barriers, antenna manufacturers have developed products that integrate the antenna elements into pole structures to make them virtually indistinguishable from poles that are not supporting small-cell structures. More RF-friendly paint and fabric radom covers and structures are making it easier to match building faces and other surfaces.

Street Furniture Examples

While there are many innovative solutions to integrating antennas into street furniture, a few common examples are provided below. Figure 5 provides small cells attached to an existing light pole. Figure 6 provides a photo of small cells disguised into a bus stop with an electronic bill-board.

Figure 5: Small-cell equipment can be placed on light poles.
Courtesy of Crown Castle

Figure 6: Small-cell equipment can be disguised in bus stop.
iStockPhoto

Rights-of-Way Access Management

The Telecommunications Act of 1996 designated the Federal Communications Commission (FCC) as the primary entity responsible for rules governing telecommunications services, and designated states and local governments as the primary entities responsible for rules governing access to the public's rights-of-way (ROW).[5] Since a number of entities can access the rights-of way, each entity must be a good steward and follow the proper procedures to ensure work is done safely and does not negatively impact other entities collocated on the street furniture. Local jurisdictions can help to ensure that proper processes are followed so potential concerns are mitigated.

Approvals for infrastructure in the ROW can be as simple as consent and/or street work permits for use of the respective governmental ROW or can involve complex local access and regulatory/zoning requirements imposed through municipal legislation and codes. In some cases, these codes delegate authority to an agency, which is often the case in larger cities. In such instances, agencies often have detailed processes and guidelines for reviewing and approving franchises to gain access to ROW for conduit or other above-ground physical infrastructure. In smaller communities, codes or laws of the respective state reserve and/or delegate authority to local elected officials in managing access to the ROW. To date, there is not a uniform method for handling the ROW process across the United States, so industry has to navigate the process project by project.

Depending upon the state, municipalities also may negotiate various licenses, franchises or other use fees as trustees of the public's interests. Typically, state and municipal governments have had experience in the wireless context with ROW use for DAS, but not every municipality has rules in place to address street furniture collocation.

Considerations for Street Furniture Deployments

The following guidelines can support the integration of street furniture into a municipality's infrastructure planning:

1. Talk with municipal economic development officials to explain the opportunities and benefits associated with wireless street furniture and seek support.
2. Coordinate legal franchising and permitting requirements early on to identify timing and other expectations from both municipal and infrastructure provider perspectives.
3. Identify any special local considerations (historic districts, architectural requirements, tribal approvals) that may increase the cost or extend the timeline of the deployment.
4. Realistically discuss costs and fees for access in relation to any published municipal schedule or point of view and nature of the project and seek interpretations as needed for project economic viability.
5. Be prepared to respond to standard construction and safety requirements in the municipality for access to the ROW, such as road and sidewalk work permits and insurance.

Optimizing Network Densification with Available Industry Tools

New tools are available that can help carriers better predict their network needs proactively, rather than using call records to prioritize network densification. These new tools incorporate User Entity (UE) datasets to identify underserved areas and prioritize deployments based on demand for coverage and capacity. The information from these new network planning tools and processes is used in parallel with next-generation Acquisition, Zoning and Planning (AZP) tools to select the best street furniture deployment options in an automated, less expensive and expedited manner. New toolsets allow companies to quickly scale collection and planning without leaving the office, saving time and money for all agencies.

This expedited network planning and AZP points to the potential for governmental bodies to be overloaded with requests for use of street furniture. This potential overload could delay delivering more high-quality 4G and 5G service in congested areas and indicates a need for a streamlined approval process.

For the benefit of end-user customers, as well as public and governmental agencies such as FirstNet, regulatory change and management guidelines for governmental bodies are required to make this overload manageable. These changes should be aimed at lowering costs and expediting these deployments.

Environmental Compliance

The FCC is required to assess the potential effect of federal actions on the environment as specified in the National Environmental Policy Act (NEPA) of 1970. In many cases, carriers must conduct an environmental analysis and submit it to the FCC before they can install wireless infrastructure.

The FCC has recognized nine NEPA categories that must be evaluated:

- Facilities to be located in an officially designated wilderness area;
- Facilities to be located in officially designated wildlife areas;

- Facilities that may affect listed, threatened or endangered species or designated critical habitats, or are likely to jeopardize the continued existence of any proposed endangered or threatened species, or are likely to result in the destruction or adverse modification of proposed critical habitats pursuant to the Endangered Species Act of 1973;
- Facilities that may affect sites or structures significant in American history, architecture, archaeology, engineering, or culture that are listed in the National Register of Historic Places (NRHP);
- Facilities that may affect tribal religious sites;
- Facilities to be located in a floodplain;
- Facilities whose construction will involve significant change in surface features;
- Antenna towers and/or supporting structures that are to be equipped with high-intensity white lights that are to be located in residential neighborhoods as defined by the applicable zoning law;
- RF energy exposure limits that must be verified every time the RF environment at a wireless site is modified.[6]

Many of the above-mentioned issues may not be a concern for urban street-furniture deployments. However, historic properties and tribal religious sites may trigger consultation process (often referred to as Section 106) with both the relevant State Historic Preservation Office (SHPO) and federally recognized tribes if the deployment impacts their lands or if they have identified the land as an area of interest.

The FCC recently created a set of categorical exclusions to streamline the environmental analysis of sites deemed to have a minimal impact based on the nature of their design and their location.[7] Optimal street-furniture deployments would be designed to take advantage of these exclusions. To meet these exclusions, installations generally would consist of collocations on existing non-tower structures and would have to meet the following requirements: non-tower structure is less than 45 years of age, is not located within the boundaries of a historic district, not located within 250 feet of a designated historic district and is not listed in the National Register of Historic Places. Utility structures are excluded from the 45-year age requirement. Meanwhile, the FCC is reviewing non-utility structure exclusions in 2016.

If a proposed street-furniture deployment is a collocation on an existing non-tower structure meeting all of the criteria within a given exemption category, it would be categorically excluded from the Section 106 consultation process. Section 106 review would be required if the proposed deployment does not meet one or more of the exclusion criteria, requires the installation of new street furniture or requires certain instances of ground disturbance.

The strategic advantage of using street-furniture infrastructure to achieve categorical exclusions is that such deployments should have improved speed-to-market timelines. Street-furniture deployments typically are subject to RF energy exposure limit verification in order to comply with NEPA Category 9. Jurisdictions may also have their own RF verification reporting requirements that are separate from those set forth by the FCC. Ideal street-furniture deployments are situated to ensure public exposure to RF energy is minimized consistent with Maximum Permissible Exposure (MPE) limits for the public set forth by the FCC.

Each street-furniture deployment is different, and the above recommendations are intended only as a general guideline for optimizing deployments from a NEPA-compliance perspective. Consultation with a knowledgeable environmental compliance consultant throughout all stages of the street-furniture design and deployment process is recommended to ensure categorical exclusions are evaluated and met when possible, and to ensure all aspects of the compliance process are completed accurately and promptly.

Managing Operations and Maintenance

With the massive demand and subsequent explosion of data usage, more wireless network infrastructure companies are operating inside of the mobile carrier's ecosystem. As a result, workforce collaboration and data-sharing between carriers, neutral-host providers, property owners, service providers and vendors within these heterogeneous networks has become increasingly complex. By establishing secure and efficient communication protocols, it will become easier to implement cost-effective operations and maintenance plans. These plans include procedures and frequency of maintenance tied to environmental and safety compliance, preventative maintenance, work orders and trouble tickets.

Environmental Compliance: Some best practices include annual verification of Material Safety Data Sheets (MSDS) for all hazardous material located onsite, and checking to make sure the "Permit to Operate Generator" is posted, if applicable.

Safety/Compliance: Some best practices include annual verification of battery spill kit safety contents, including first-aid kits and eyewash kits; verifying ear protection kits are present; and checking expiration dates on kits, if applicable.

Preventive Maintenance: Some best practices include semi-annually checking to see what spare equipment is onsite as well as inspecting antenna systems and power equipment.

Work Orders and Trouble Tickets: Some best practices include standardizing Alarm, Alert and Ticket priority terminology and ranking between stakeholders; implementing operations and maintenance support plan; and maintaining 4-hour resolution protocol.

Some best practices include having a centralized communication platform for ticketing and tracking systems that interface with all aspects of the network architecture. The ability to route relative information to each stakeholder will reduce operational expenses and improve operational efficiencies significantly.

Using an electronic interoperability data exchange can lower operational costs, record information and automate communication within these heterogeneous networks.

Conclusion

To optimize the short- and long-term success of network densification, network deployments will be contingent on many factors; some key factors include:

- Availability of backhaul and power;
- Location of sites that improve coverage, can be structurally supported and deployed at the right height;
- Suitable equipment with available frequency bands, power and size;
- Ease of deployment and scalability;

- Cooperation in partnership with localities and other owners of street furniture.
- Ease of maintenance and upkeep.

These factors directly impact the business case to deploy wireless network infrastructure. Using new and existing street furniture can augment the typically more-efficient macrocellular deployments, adding more coverage and capacity to today's mobile broadband networks, which are quickly becoming the backbone of today's connected society.

Author Information

Jim Lockwood, Aero Solutions

Jim Lockwood is CEO and founder of Aero Solutions, a leading provider of structural engineering, A/E services and tower reinforcement products since 2002 to the wireless infrastructure industry. Aero optimizes macro-cell co-locations on tower structures and buildings and small cell applications on buildings, light poles, utility structures and other street furniture. Headquartered in Boulder, CO, the company has completed over 4.000 co-locations across the United States, Caribbean, Asia and Europe, providing professional engineering, construction management and reinforcing materials.

Jim has 15 years of experience in the wireless infrastructure industry and 30 years as an entrepreneur in the engineering, products, and construction industry. He established Comptek in New York in 1998, a provider of structural components and engineered products; and Wind Tower Technologies in 2013.

Prior to 1998, Jim was a Principal of J. Muller International, responsible for the firms Chicago and New York offices and CEO of Egis, Inc. in New York. Jim is a professional engineer, P.E. and holds a BSCE degree from the Univ. of Cincinnati and an MSCE degree from the Univ. of Washington, Seattle.

Don Bach, SAC Wireless

Don Bach is the Vice President of Engineering for SAC Wireless. After graduating from the Electrical Engineering program at DeVry University in 1986, Don went to work as a technician in the Public Safety and LMR two-way radio industry. In 1994, Don was hired as a System Performance Engineer on the iDEN Network by Fleet Call, later to be renamed Nextel. After 22 years in a variety of RF Engineering positions, Don left Sprint in 2007 to start a regional RF Engineering and implementation company focused on DAS networks. In 2012, Don sold this company to SAC Wireless. SAC wireless was purchased in 2014 by Nokia Networks and Systems.

Karen Caldwell, Caldwell Compliance

Karen Caldwell is president of Caldwell Compliance, located in Pleasanton, Calif. Karen has held numerous positions throughout her 21-year wireless career, with her longest tenure being president and CEO of Caldwell Compliance. Her experience includes all aspects of site acquisition and development, where she has built a successful track record of delivering projects on time and on budget. Currently, her

responsibilities include business development, training, recruiting and charting the company's growth.
Karen is an active member of the Wireless Infrastructure Association, Women's Wireless Leadership Forum and the California Wireless Association. She has been a featured speaker on several panels where she discussed the importance of appropriate management of the FCC regulatory process for new development and modification projects. Caldwell consults with nationwide carriers and tower companies alike ensuring their projects avoid unnecessary delays and cost overrun associated with compliance.

Karen holds a Bachelor of Arts in English from the University of Santa Clara, located in Santa Clara, Calif.

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Christopher B. Fisher is a partner at Cuddy & Feder LLP, a New York based law firm where he chairs the firm's Telecommunications Practice Group and is past chairman of the firm's Land Use, Zoning and Development Practice Group. Chris provides wireless operators, tower companies, DAS and small cell providers with real estate, government relations, zoning, environmental litigation and other legal services. He has been recognized as a Super Lawyer in Communications Law for the New York Metropolitan area annually since 2013.

Chris is also a founding board member and has served as President of the New York State Wireless Association since 2012. Under Chris' leadership, NYSWA established its Wireless Forum Conferences in NYC, published a statewide wireless economic impact report, expanded its advocacy with State leaders in Albany and has otherwise provided new and improved opportunities for NYSWA members to do business in New York.

Chris further contributes to the wireless industry nationally as a member of the Wireless Infrastructure Industry's Innovation & Technology Council and HetNet Forum, where he focuses his efforts on mobile infrastructure deployment. For over 20 years, Chris has been a tireless advocate for the wireless industry as an attorney, writer, speaker and in various leadership roles at the national, state and local level. www.cuddyfeder.com; www.nyswa.org

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Ray Preston Hild is an accomplished senior management and business development professional with over 23 years of experience working in the wireless industry. He has consulted on several initiatives including unified communications, interoperability, and wireless broadband solutions for large government, healthcare, hospitality, higher education and enterprise firms.

Ray has held management and leadership positions with several prominent corporations over the years. Those include Sprint-Nextel, Corning, Galtronics and Kaveri Telecom. He has won several awards for service and performance. Some are: President's Council 14 times, The CEO Award, Public Sector Distinguished Service Award, FBI Service Award post 9-11.

Keith Kaczmarek, Public Safety Ventures

Keith is a general partner at Public Safety Ventures, a private equity firm focused on the public safety and critical industry markets. Keith has more than 30 years of wireless telecommunications experience. He has held prominent business, technology and operations leadership roles at inPhase Wireless, Intrado, Powerwave, Cyren Call, FiberTower, inOvate Communications Group, Teligent, Nextel, AirTouch, PrimeCo and GTE. Keith was a co-founder of Cyren Call Communication, focused on supporting public safety in the creation of a nationwide public safety broadband network. He was also a general partner at inOvate Communications Group a venture fund focused on early-stage wireless companies. Keith is a Radio Club of America Fellow, holds an MBA degree, a M.S. in Electrical Engineering and a B.S. in Electrical Engineering from the University of Illinois.

Jeff Pokonoshy, Kaipac

Jeff Pokonosky is CEO and Co-Founder of Kaipac, a leading provider of Network Operations Intelligence and Interoperability Data Exchange software solutions for the wireless industry, enabling workforce collaboration between network operators, tower companies, DAS providers, integrators, vendors, and service providers. Kaipac streamlines the sharing of time-sensitive, proprietary data related to network operations including, site location search, project builds, asset management, state and federal regulatory compliance and operations and maintenance. Jeff has 25+ years of experience in the wireless industry as an entrepreneur, inventor and business marketing executive with Qualcomm, Nokia Mobile Phones and SBC.

Footnotes

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This white paper is meant to be an educational tool and does not reflect Wireless Infrastructure Association policy.

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