Top 10 Challenges Hindering Outdoor Small Cell Deployments

Greg Friesen

Article

September 30, 2015

We are now about 5 years into the small cell discussion and there still have not been any large-scale outdoor deployments. However, this is not due to lack of desire on the operators' side. There is a significant need for outdoor small deployments to deal with LTE density, while still delivering a high capacity, high quality service. This is evidenced by the significant number of announced small cell plans by operators, and the growing participation in steering groups, conferences and events driving industry direction. However, there remains a wide range of challenges that are hindering outdoor small deployments.

Operator	Date	Geography
Sprint	2015	United States
Vodafone	2014	Europe
Verizon	2015	United States
SK Telecom	2014	Korea
T_Mobile USA	2015	United States
Deutsche Telekom	2015	Europe
Ooredoo	2015	Kuwait
Zain	2015	Suadi Rabia
TIM	2014	Brazil
Oi	2014	Brazil
AT&T	2013	United States

Figure 1- Announced Outdoor Small Cell Deployments

Let's take a look at the 10 most common obstacles preventing large-scale, outdoor small cell deployments.

Suitable Small Cell Sites

One of the most commonly faced issues facing small cells is acquiring access to suitable mounting locations. There are many important factors that make a location suitable for a small cell deployment. The most important is location, given that small deployments are done to improve coverage and increase capacity in targeted areas. It is also important that the location is structurally suitable to mount the small cell and backhaul equipment. The site must also have suitable and reliable power to be able to operate the small cell equipment.

One of the most important factors in choosing a site is mounting height. The operators are trying to get down onto the street level in order to deploy the small cells densely and without inter cell interference. At the same time, if the small cell is deployed too low (typically below 10 feet), the regulator may require the small cell to operate at a lower output power, which will be counterproductive to the goal of increasing coverage.

The final major factor is scalability. Mobile operators are trying to deploy anywhere between 1000-10,000 outdoor small cells in a city, so choosing types of structures available in many locations, and ones that do not need to be negotiated for on a per site basis, is very important. This can also allow the operator flexibility to quickly change sites as network plans adjust, or if street level obstructions are discovered. For this reason, operators are commonly targeting locations known as “urban furniture”, such as traffic lights, lamp poles, billboards, and bus stops (although height is a concern).

Figure 2- Small Cell Backhaul Spectrum Overview

Availability of Suitable Small Cell Equipment

Outdoor small cells are still in their infancy, and new equipment is being released at a very high rate. For operators, it is important that their desired frequency bands and technology (LTE, 3G, TDD, FDD) are available. It is also very important to most operators that their small cells have high output power to maximize coverage and to ensure users are operating at maximum modulation to deliver the highest capacities. Powering is also very important for small cells, as traditional telco DC power will not be available at most locations, so that direct AC powering is very desirable.

The most critical factor for small cell equipment is size. The smaller the equipment, the easier zoning and site acquisition becomes. Weight is also critical, as lower weight will broaden the number of suitable sites and also minimize the amount of site engineering required. To address both size and weight, operators are also looking for increased integration, where RAN Access, switching, and backhaul can all be delivered in a single package rather than requiring three or more boxes at each location.

The final important aspect of the equipment is installation simplicity. Operators are demanding equipment that can be installed by non-specialized crews, and at a very high rate of deployment.

Zoning Rights and City Permits

After rights to a site are secured, zoning and city permits must be completed. This can be a very difficult process and is extremely dependent on the specific local regulations. Some municipalities have strict volume, dimension and weight limits, while others may even regulate the color of the equipment. Mounting height will also often be regulated. In addition, all construction permits and safety permits must be completed, which may dictate when installation can take place and by whom. As with site acquisition, the desire is to be able to do permitting on a broad basis, with the ability to adjust rapidly as network topology changes. However, this is very dependent on the flexibility of the municipality.

Fiber Access for Backhaul

The desired mode for backhaul is typically fiber, because it delivers the highest capacity and high availabilities. However, fiber is usually not delivered to the desired urban furniture locations. Although fiber may be very close to the desired location, digging up the street for the last fee meters can be extremely expensive, requiring extensive permitting, traffic stoppage and right of way acquisition, as well as significant labor. Beyond the costs, the administrative work and planning associated with this means that fiber extension will typically take 6-12 months, often making it unsuitable for rapid small cell deployment. If fiber is already at a location, one must weigh the business case to justify the cost of leasing the fiber.

Spectrum for Wireless Backhaul

If fiber backhaul is not available, the next choice is typically wireless backhaul. One of the major challenges with wireless backhaul is finding suitable spectrum. Sub-6 GHz spectrum is desirable, although very scarce, because it can provide non line of sight connectivity. There is about 100MHz of spectrum in 5.8GHz band, but it is unlicensed, which makes it very prone to interference, resulting low capacity and low availability connections. In some countries, 3.5 GHz spectrum can be used for backhaul, although this is typically a small amount of spectrum, resulting in fairly low capacities (~50Mbps). Some operators are considering using their 2 GHz access spectrum for backhaul, although it again is fairly thin spectrum, and the opportunity cost of not using it for access is extremely high.

After sub-6GHz, the 24-42 GHz bands are commonly considered. These bands are desirable, as they support compact antennas suitable for urban furniture. What's more, these bands are often available on an area basis, making co-ordination and deployment simple. The challenges with these bands is that they require line of sight and they are not globally available, but rather available in about half of the world's countries, with specific spectrum varying widely by location.

Many operators are also strongly considering 60 GHz (or V-Band) spectrum, which is also a band that requires line of sight. The 60 GHz band is attractive, as it is a band that is available almost globally. In addition, small form factor antennas are permitted, making it well suited for small cell. There is a very large amount of spectrum available in the 60 GHz band (>5GHz), allowing for high capacity backhaul with little worry of congestion. Lastly, the propagation properties of 60GHz translate to very high attenuation, limiting link length. This is fine for the short links required in small cell, and also means that the signals fade fast, minimizing interference.

The final wireless band under consideration for small cell is E-Band (780/80GHz). This band requires line of sight and is also a fairly globally available band, with small antennas authorized in most regions, the exception being the United States. This band is typically licensed, but at a very low spectrum cost. And with over 10GHz of spectrum in this band, it can offer very high capacities with little worry of interference or congestion.

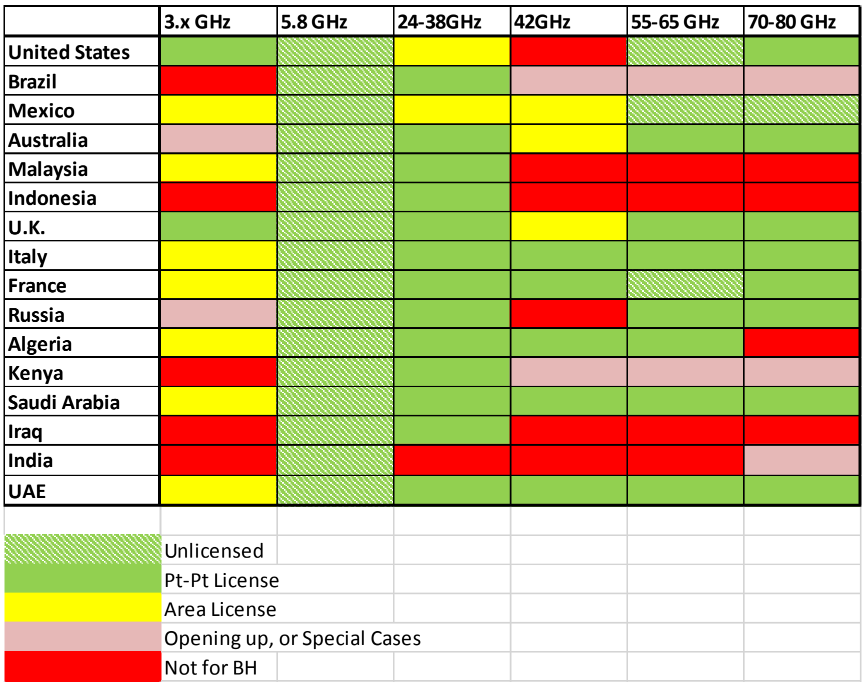

Figure 3 - Small Cell Backhaul Spectrum Overview

Line of Sight Access for Wireless Backhaul

With the exception of the sub-6GHz band, which has capacity, interference and delay concerns, all of the other suitable backhaul bands require line of sight for connectivity. This can be a major challenge, as there are many obstacle at street level, such as trees and buildings. From a desktop analysis, line of sight can be planned, but not with certainty, as the street level is very dynamic environment. This means that either path surveys need to be completed, or a new site may need to be selected during the deployment phase if a line of sight path is not available. An approach some operators are considering is to use a handful of intermediate repeater points often placed on building tops. This allows paths to use this site as an intermediate site, even though there is no base station at the repeater site, in order to get to the desired site. In addition, line of sight drives operators to try and get access to mounting rights as high as possible on a pole or billboard. Many operators are also looking at mounting on the extended arms of light poles to get into the center of the street, and to avoid sidewalk clutter and trees. This will often drive in equipment requirements, as the stability on a light pole arm may be low, and may limit the weight or beamwidth of the backhaul equipment.

Backhaul Capacity

The primary purpose of an outdoor small cell is to increase the user capacity, so, of course, it is important that the backhaul to support it also provides sufficient capacity. Current estimates for this requirement are between 100 and 500 Mbps per small cell site. In the case of 500 Mbps per site, it rules out sub-6Ghz technologies, as they are typically limited to 200 to 300Mbps. In the case of 100 Mbps per site, sub-6Ghz may be used, but perhaps limited to the last mile link, and any aggregation links would require higher capacity systems. The high capacity requirements will also limit the number of sites that can be daisy-chained, or used in a ring, in the 24-38 GHz bands. Lastly, these throughputs will mean that operators must engineer the links to high modulations. If the link is limited to a low modulation because of reach, then the capacity may be limited to 100Mbps or less, even in the V and E-Band.

Installation Time and Processes

As equipment costs and site costs decline, the install costs become one of the major cost drivers of a small cell deployment. Installation time is extremely important, not only for the associated labor costs, but also for the adherence to municipal regulations, which may include lane closures, use of a local unionized workforce, notices and other costs that increase with a longer install. Secondly, the required skill and training of the workforce is very important. Today, it often takes 2 crews of 2 well-trained installers to install a link. Minimizing this to a single crew of untrained workers can reduce the costs by 75%. Install time is also very important for scale. If it takes 2 crews a full day to install a link, it will be difficult to install 10,000 links in a few months, unless 200 crews can be obtained in a single city.

Operators are looking at their own processes to improve install time, with the goal of doing as much configuration as possible remotely. New equipment innovations are coming to help with this problem. Of course size is important, so too is auto-configuration, and wider beamwidth products also help address this problem, while emerging auto-aligning antennas will go a long ways towards reducing install times and the skill levels required.

Scalable Engineering Processes

Most small cell trials and pilot networks that have been deployed to date have use traditional cellular engineering processes. However, these processes do not fit well at street level. In urban small cell deployments, there is no longer a traditional telco environment. Sites that are selected may need to be chosen during the engineering process, if coverage is poor, or backhaul cannot be made available. When these changes are made, the operator needs to adapt within hours instead of the months that could be accommodated for site changes in traditional mobile network. This requires operators to completely redefine their network engineering processes, building in flexibility to quickly change topology and sites, and then reflect that in the design after the fact. The network design needs to be much more fluid than a traditional firm network plan. This will also drive network equipment capabilities that can rapidly adapt to changing architectures requiring significant reconfiguration.

Additionally, the traditional level of likely redundancy is not feasible in an urban environment, where there is limited mounting space and power. Availability may also need to be reduced to accommodate the urban environment, with the understanding that the macro mobile network over-top provides inherent redundancy.

And the Most Critical Issue Is – A Viable Business Case

The business case may be the last item to discuss, but it is also the most important item and has impacts on all 9 of the other challenges. The very goal of deploying small cells is to increase capacity by deploying a significantly higher number of bases stations, typically in the range of 5-10 times more base stations. However, this does not result in a significant revenue increase, and therefore cannot result in a major total cost of ownership (TCO) increase. So, the TCO of a small cell will need to be in the range of 10X lower than that of a traditional cell site. This is a major driver in how the above 9 challenges can be addressed. Almost all of them can be addressed by spending lots of money. However, delivering high capacity, acquiring sites, and deploying rapidly become even larger challenges when there is a major cost constraint. This means as every obstacle is tackled, it must be done so within a budget and with a keen eye to the impact on the total site cost.

The 10 challenges to outdoor small cell deployment are all significant, however each can be addressed if there is the imperative and effort to tackle them. It is important when addressing these challenges to keep in mind that they all interact with one another. For example, you can hit desired capacity, but may have to sacrifice on equipment size or spectrum choice. This makes it critical for operators to optimize the entire small cell deployment challenge rather than focusing on specific areas in isolation. And, some sacrifices may have to be made in each area. This will be a delicate tradeoff that operators have to make. At the same time, every small cell network will be very unique and dependent on city geographies, technologies, spectrum, desired capacity, site availability, and local zoning laws. This will make it very difficult to adapt a cookie cutter approach, but instead operators need to develop very flexible processes that can adapt to specific market nuances.

As Vice President of Product Management at DragonWave, Greg has over a decade of experience in network design, planning, and engineering, at a number of communications firms, and experience in product definition, architecture, and network designs. For more information visit www.dragonwaveinc.com or follow Greg on Twitter: @greg_friesen

View this Article Online

http://online.qmags.com/SCM0915?pg=47&mode=2#pg47&mode2