Small cell deployments: you don’t have to learn the hard way
The content of this paper is based on a recent series of blogs published by Nokia to discuss the deployment challenges facing operators. The blog series can be found at https://blog.networks.nokia.com/

Contents

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small cell deployments: you don’t have to learn the hard way</td>
<td>3</td>
</tr>
<tr>
<td>Small cell barrier: Nokia brings predictability to site planning</td>
<td>5</td>
</tr>
<tr>
<td>What if small cells become part of the furniture?</td>
<td>6</td>
</tr>
<tr>
<td>3 ways Nokia is solving the small cell backhaul blues</td>
<td>8</td>
</tr>
<tr>
<td>7 ways to pull down costs while putting up small cells</td>
<td>10</td>
</tr>
<tr>
<td>How to deliver 35% higher Quality of Experience with 50% fewer small cell sites</td>
<td>12</td>
</tr>
</tbody>
</table>
Small cell deployments: you don’t have to learn the hard way

Imagine this. You’re a radio network planner for a mobile operator facing growing traffic demand in the center of a city. You need to figure out how to meet that demand by deploying small cells to provide the right capacity, in the right places, at the right cost.

There are more than 20,000 street poles that provide possible deployment locations across the city center. Now you’re probably thinking that’s plenty to choose from. But consider this… Of the 20,000 street poles, the local municipality blocks the use of any that already support police or traffic light cameras. Furthermore, city regulations require that, before a base station can be installed, poles without a ‘mast arm’ type of construction must be replaced, which is too costly. This restriction alone eliminates at least 50 percent of the available poles. Even then, the cost of renting individual poles can vary wildly, anything from US$ 50 to US$ 1,000 per month.

You also have to factor in the availability of both power and backhaul to the sites. Only 20% of countries have decent fiber penetration in cities and of those, the fiber rarely runs to street furniture. So perhaps you have to provide backhaul to the site, either fiber or microwave, as well as a power line. The civil works needed to dig a trench and subsequently repair the road surface which can amount to tens of thousands of dollars. Even if backhaul is already available, the rental costs can range from around US$ 500 to US$ 2,000 per month.

A site may not be as good as it looks

Even then you haven’t finished because you need to know which of the sites you’re left with will deliver the performance you need. For example, does a location have direct line of sight to a nearby macro base station? If so, the small cell’s coverage could be restricted by interference. Simply moving the small cell base station a few meters to a non-line of sight location could more than double its coverage.

Now, think that you have to take all this into account for every small cell you want to deploy.

We haven’t just imagined all this. These figures and examples are based on deployment projects all over the world. In a worst case scenario, of 20,000 potential sites identified at the beginning, fewer than 100 could be left after all the radio planning, civil works assessments, and power and backhaul connectivity costings are completed.

This case, as extreme as it is, vividly reveals the many variables and complexities in predicting the costs of deploying small cells.

First come, first serve

There’s another consideration too, one that may encourage you to pick up the pace of your rollout planning. Any urban area will have a finite number of sites available
and if you are late to the party you may find the best ones have gone, leaving you with higher costs to deploy on the remaining, less suitable sites.

Taking everything into account, it’s of little surprise that up to 90% of the total cost of ownership of a small cell is due to its deployment costs. The complexities have been discussed in general for several years, but it’s only recently that the actual costs and difficulties, which vary by country and location, have been pinned down accurately as operators and their vendors get onto the street and start deploying small cells.

**Top 4 small cell concerns**

Analyst research reveals these as the top 4 operator concerns about small cells:
- Finding the best locations for small cells
- Outdoor site acquisition and municipality acceptance
- Backhaul
- Deployment cost

So, what’s to be done?

Using our on-the-street experience, Nokia Networks has developed innovative ways of not just identifying the costs involved, but reducing them substantially – while increasing the performance and return on investment of small cell deployments. We are publishing a series of blogs to tell you about these solutions, beginning with a new and comprehensive way to rate potential locations according to their deployment costs versus their network performance for a quick way to pick the best sites upfront and avoid going down blind alleys.
Small cell barrier: Nokia brings predictability to site planning

No business likes surprises, especially when it comes to cost overruns. Yet the sheer complexity and multitude of factors to take into account when deciding where to put base stations has made it extremely difficult to accurately predict the final costs involved in rolling out a small cell network. Until now that is.

It’s all in the planning

Operator deployment of small cells is being held back by doubts about the true costs and the many unknowns. From dealing with restrictive municipal rules to avoiding the need for costly civil works for backhaul, to uncertainty over whether the selected location will actually achieve the expected capacity boost, operators are rightly wary of encountering runaway costs they can’t control.

The solution is to find a new way to plan deployment – one that takes all the many cost and quality variables into account.

The Nokia HetNet Engine Room service does exactly that. It processes all the complexities to deliver what we call a Site Value Index – a single number between 0 and 100 that quantifies a location's return on investment (ROI) and tells you instantly how good the site really is.

3-D views bring extra clarity

Nokia HetNet Engine Room* uses a database of information about sites, real estate partners and fiber backhaul availability combined with 3-D Geolocation tools and RF design tools to identify valid sites for small cell deployment. 3-D street views provide powerful insight into the suitability of sites based on pole configuration and location, difficulty of any required civil works, and how close they are to anything that could affect deployment such as nearby bridges, tram rails, power cabinets, fiber access points and manhole covers.

*The Nokia HetNet Engine Room service is available initially in the US.
This enables a calculation of costs including pole replacement, power connectivity, getting fiber to the site and so on. The service also shows how the proposed sites improve the spectral efficiency and capacity in the area.

All this data is then analyzed to create the Site Value Index that allows the operator to compare sites and prioritize its deployment budget. The service has been shown to cut deployment costs by around 20% and speed up rollout by up to 30%.

Nokia small cell planning services are enhanced by award winning 3-D Geolocation for accurate identification of traffic hotspots and better understanding of the mobile broadband experience for subscribers inside high rise buildings. Planning and optimization no longer has to rely on assumptions, but is based on real data and automatic cross-checks to determine if traffic patterns are consistent over time, if they are being generated by multiple subscribers, and if the corresponding macro cell is heavily loaded.

The bottom line is that operators can more confidently deploy small cells without any unexpected negative financial impact.

What if small cells become part of the furniture?

“I know we need to populate the city with small cells to increase capacity – but I don’t know exactly where, under what conditions, and at what final cost.”

Identifying the right location for small cells in cities is a common operator concern. Chances are the sites are spread across a multitude of owners – municipalities, utilities, transport companies, shopping centers and a host of others. To get the sites, you probably have to deal with dozens of site owners, each with their own restrictions and expectations.

It all adds up to long delays and high costs. But what if you had a lengthy menu of pre-qualified sites to choose from? What if the small cell infrastructure were already assessed and approved for deployment at the sites? And what if the certified engineers needed for deployment were readily available on the ground to provide the necessary support? Not only would your site acquisition and deployment costs fall, but the roll-out time of your small cell network would be much shorter.

Choose from a menu of pre-qualified sites

To bring a new, simpler way of working to operators, Nokia Networks has addressed these ‘what ifs’ by entering into commercial discussions and agreements with organizations that own a variety of street furniture. These include advertising agencies, a popular fast food chain, a premium beverage retailer, utility companies and more.

The street furniture incorporates panels that act as qualified sites with power available and which are already in the areas where people congregate – transport hubs, shopping malls and entertainment venues.
Through Nokia Networks, these sites can be made available to deploy small cells. Working with these organizations, we ensure our Nokia Flexi Zone small cells can be fitted easily along with site solutions and without major civil works. Besides ease of fitting, these units are also designed with camouflage to blend them in with the surrounding environment and thus remain unobtrusive. The fact that the Nokia Flexi Zone product itself is the smallest form factor small cell unit on the market also makes it the leading contender to take advantage of these site opportunities.

![Camouflage Enclosure](image)

This photo was taken at Barcelona Mobile World Congress 2015, shows an example of a camouflage enclosure that can house the Nokia Flexi Zone access point, microwave backhaul – and if needed, can be expanded to include additional equipment such as a battery backup unit (Nokia Nano BBU). The enclosure itself can be wall or pole mounted, is designed to minimize the attenuation of RF signals, and can be matched to the surrounding environment (a red brickwork pattern is used here).

Going a step further, Nokia Networks has built a huge bank of verified sites through its Nokia HetNet Engine Room service for the US market. The Nokia HetNet Engine Room uses detailed 3-D street level maps and other tools and data to create a Site Value Index that provides an easy comparison of benefits versus costs for each site. This helps operators forecast the costs of a specific site location and its ROI leads to 30% faster small cell deployment and typically 20% lower costs.

While small cell site acquisition presents a challenge because of the large volume of sites required, it is also an opportunity to leverage existing infrastructure and launch a robust network of small cells speedily and efficiently.

In our next blog, to be published on October 16, we’ll be looking at a further piece of the small cell puzzle – backhaul. Mark your calendar!
3 ways Nokia is solving the small cell backhaul blues

“What’s the best way to link up small cell sites to the wider network?”

This is one of the major small cell deployment challenges that many operators have identified, and it’s a complex issue.

The majority of potential small cell sites lacks a conventional and easy backhaul fix. Unless the distance is low, digging up roads and pavements to bring fiber to hundreds, if not thousands, of sites is a non-starter because of the high costs and time involved.

Instead, some forward thinking about how to overcome backhaul barriers is a more logical approach. Nokia is tackling the backhaul challenges through a combination of products, planning and partners.

1. Easier backhaul through proper product design

Firstly, small cell product design plays an important role in easing operators’ backhaul blues. Nokia Flexi Zone small cell base stations have built-in ports, switch and router that enable them to be daisy-chained together, using a building’s shared Ethernet in indoor locations or wireless backhaul to connect nodes in a long avenue for example.

Meanwhile, the Flexi Zone Controller features split baseband processing that permits a relaxing of the latency requirements towards the small cells that it supports. So a fiber or gigabit backhaul connection can be run to the controller, while lower quality connections can be used to connect the access points back to the controller. Not only is this a cost-effective solution, but it also allows the access
points to be sited in more effective locations – as opposed to being dictated by backhaul constraints.

2. Fast and accurate planning with 3-D tools

The second approach is planning. There are many bands in use for wireless backhaul. Most urban areas will have some kind of fiber backhaul to buildings. If no fiber is available, there is the option of using microwave. Most prominent here are E-band, V-band microwave links but also traditional microwave bands may be used. A potential problem here is that there may not be line-of-sight to street level, in which case sub 6 GHz connections can be used for licensed and unlicensed bands.

All this requires careful planning, achieved through Nokia’s Multi-layer Optimization service that uses 3-D mapping combined with 3D RF propagation modeling. The service shows which type of backhaul will or will not work and can lead to coming up with a viable strategy in one third the time consumed by other methods.

3. Extreme flexibility through partnerships

Finally, partnerships: Nokia has substantially widened its family of third party solution providers to offer operators the right backhaul product whatever their small cell deployment needs.

Together with RADWIN, Nokia offers a field-proven sub 6 GHz PtP / PtMP solution, which employs unique beamforming and interference mitigation capabilities to deliver carrier-class and robust performances in challenging non-line-of-sight environments and combines advanced planning tools and specialized engineering practices for simplified operations.

Together with Tarana, Nokia offers an innovative sub 6 solution that exceeds customer expectations for non-line-of-sight wireless transport and delivers deterministic non-line-of-sight performance and full-rate co-channel operation in point-to-multipoint topologies. Unique algorithms for multipath, cancelling
interference and autonomous adaptation ensure easy deployment, efficient scaling and reliable transport, even in the most challenging dense urban networks.

As an example, Nokia partners offer great flexibility in small cell placement in ever-changing urban environments, where double decker busses constantly pass in front of sites, and bushy trees and street decoration pop up at different times of the year creating interference. Small cell backhaul may be a significant challenge, but with competitive products, perfect planning and best-in-class partners, Nokia has the silver bullet to help operators solve it.

7 ways to pull down costs while putting up small cells

All the planning is done. You’ve picked the best sites for your small cells, and all the permits have been secured. Power and backhaul are in place. Now it’s time to get your base stations installed and running, ready to deliver exciting services to your customers and generate revenue for you.

With lots of site locations in busy urban areas that can be difficult to access, the physical deployment of small cells can quickly add up to big bills. So Nokia Networks has come up with seven innovations to bring those costs right down and help ensure that your installation budget stays reasonable:

1) **Smaller and lighter for easier handling:** At just 5 kg in weight and 5 liters in volume, Nokia Flexi Zone outdoor base stations are the smallest and lightest available. This makes them easier to lift and fix in place by a single engineer. And the mechanical fixing is quick, with no docking stations, which reduces the installation time and costs for hiring lifting gear.

2) **Everything in one unit:** Another advantage of Flexi Zone Base Stations is that they are true all-in-one products, with integrated antennas for both omni and directional connectors, a transport module for both electrical and optical connection, an integrated 1 Gbps router and switch, GPS & all other sync options built in, as well as Bluetooth module and dock. This makes installation so much simpler and faster, a bonus when the engineer is at the top of a lamp post: no fiddly cabling, no need for multiple fixings. This can compress several hours of work into 15-20 minutes per site. Fast installation means less time on site, lower costs for hiring access equipment and less disruption to the surrounding areas.

3) **Golden benefits of Bluetooth:** Integrating Bluetooth communications into Flexi Zone Base Stations dramatically cuts deployment time: As soon as one base station is mounted and connected, the
installation engineer (and the bucket truck) can move on to the next site. Meanwhile, the commissioning engineer can remotely connect to the base station from a nearby vehicle to perform initial set up and final verification. There is no more need to keep access equipment in place for several hours at each site to support the commissioning engineer. Once again, less time on site means less money spent for the bucket truck, and expensive rental equipment can be used to its full extent to deploy as many site as possible in a day.

4) **Remote delivery:** Outsourcing the setting up of small cells to Nokia Global Delivery Centers (GDCs) in India and Portugal brings many cost benefits. Experienced and highly skilled engineering teams can remotely configure the network using proven workflow management tools and processes that are tightly governed, adhere to strict quality procedures, and take advantage of best practices learned from the many projects worldwide that the GDCs have run. Common processes and tools ensure the most efficient and fastest configuration and the lowest costs. Our GDCs use a central 'Smart Service Delivery Platform' to connect the work of different teams and output from different tools in order to maximize the usage of automation. Example: The planning department generates a planning file with certain site-specific parameters. This data is merged with an XML Site Configuration File from iSON Manager and used to automatically configure the small cell in the field. The local field engineering team will also receive an automatic work order informing them of all the details necessary for the physical installation.

5) **Standardizing site designs for economies of scale:** While no two macro sites are the same, small cell sites are often similar – for example, using lamp posts or walls. We’ve hooked into these similarities by designing standardized mounting hardware that is simple and fast to install. Using the same fixings and mounting procedure for multiple small cells simplifies the workload for faster installation by less skilled personnel and minimized risk of errors, all of which adds up to substantially lower costs.

6) **Clustering small cells for bulk deployment:** When there are several small cells in close physical proximity, planning and installation for them all can be undertaken simultaneously for much more efficient implementation. In addition, we pre-assemble as much of the hardware as possible before delivering, eliminating the need to build the small cell sites in the field from multiple components. This is again faster and saves costs.

7) **Fast configuration in minutes with automation:** Nokia Flexi Zone Base Stations can use intelligent Self-Organizing Network (iSON) capabilities with clever HetNet enhanced algorithms to handle the higher number of neighboring cells and underlay situation typical in a small cell set up. Configuration is automated, and enhanced plug and play works for all situations to enable fast set up and configuration times of 20-25 minutes so that costly and skilled commissioning engineers aren’t tied up for hours.
How to deliver 35% higher Quality of Experience with 50% fewer small cell sites

Thus far in our blog mini-series, we’ve answered questions and offered proven strategies related to the overall challenges of deploying small cells. Now we’re wrapping up with a view to how operators can use a novel deployment business model to deliver higher Quality of Experience (QoE) using significantly fewer sites.

Operators have a wide variety of deployment options to consider including the straightforward ‘deploy and operate our own sites’, to buying in everything with a complete ‘small cells-as-a-service’ model.

Somewhere in between these two extremes is the ‘neutral host model’, in which operators share small cell sites. The model was used recently by some US operators to support a visit by the Pope.

This approach can have major cost advantages compared to each operator going it alone. A study by Nokia investigated how many small cell sites would be needed to deliver the same QoE using the neutral host model compared to each of three operators deploying its own small cell networks. The investigation first examined the level of QoE delivered by the existing macro network to a specified urban area. The results showed that deploying a small cell network provided a substantial boost of up to 35% in the ‘baseline’ QoE measured in terms of the number of subscribers receiving 1.8 Mbps downlink throughput.

The study also found that only 25 shared sites were needed in the neutral host deployment compared to 57 sites required if the operators used the ‘go-it-alone’ method. That represents a 56% saving in the number of sites, leading to a significant reduction in costs.
These savings derive from the neutral host business model itself and are not related to any specific small cells products. However, if operators choose to adopt a neutral host model, the Nokia Flexi Zone solution can bring additional benefits such as compact form factor and speedy installation, making it easier for several operators to share a single site. Flexi Zone’s remarkable capacity also makes network sharing possibilities such as MORAN and MOCN* viable for operators.

Of course, the viability of the neutral host model ultimately depends on the local market situation and the individual challenges facing each operator. One size does not fit all which is why a flexible approach in response to operator and market needs is essential. Nokia provides consulting, planning, implementation and optimization services to help make small cell deployment easy and effective.

Your handy guide to small cell deployment

Here is our complete small cell blog mini-series based on typical questions we’ve received. Please don’t hesitate to ask questions and share your comments below.

- **Small cell deployments: you don’t have to learn the hard way** – shows how an apparently large number of potential sites in a city may not be so numerous when we take all the cost and restrictions into account
- **Small cell barrier: Nokia brings predictability to site planning** – explains a new way to plan small cell deployment that eliminates uncertainty about costs
- **What if small cells become part of the furniture?** – examined deployment and how we are partnering with site owners to gain access to street furniture in cities across the globe, making it easier to get the sites you need
- **7 ways to pull down costs while putting up small cells** – offers 7 innovative ways to cut the costs of installing small cell hardware and software
- **3 ways Nokia is solving the small cell backhaul blues** – looks at how Nokia’s products, planning and partners can be the secret to tackling the thorny issue of backhaul for small cells

*For an in-depth discussion about Multi-Operator Radio Access Networks (MORANs), also known as Radio Access Network sharing, and Multi-Operator Core Network (MOCN), please read this excellent article by Analysys Mason.