MOBILE EXPERTS

Streetlight Mounted mmWave Radios Transform Coverage Economics

More than 30% of mobile data is handled by small cells today, and more than 12 million small cells have been deployed by mobile operators in the past ten years. Low power radios are mounted on utility poles, bus stops, and buildings all over the world, and it's clear that adding new radios is now the primary way to add capacity to a network.

This white paper expands on our previous analysis of millimeter wave networks, to examine the practical details related to deployment. In our last white paper, we covered the TCO savings involved with using repeaters in an outdoor mm-wave network. This time, we look at the best way to deploy a low-power radio, to illustrate how a repeater (or any other low-power radio) can be installed very quickly and easily.

Deployment can be messy

The practical issues of mounting a radio in the field can get expensive. Every local jurisdiction seems to have its own rules about size and color and power consumption. Digging trenches for fiber involves a big crew that shuts down the city streets. Electrical power can be a major challenge as well. Let's go through the typical sequence:

Step 1: RAN Planning: Lay out the preferred small cell locations on a map.

Step 2: Site Acquisition: Determine the actual physical locations desired (based on the RAN plan). Contact the owner of the pole/building to discuss a possible lease. Note that this could be a different owner for each site, so this can be difficult to 'scale up'.

Step 3: City Council Meeting: The first visit to the City Council is often unsuccessful. Local city officials get a lot of complaints from citizens about 4G/5G radiation and concerns about appearance, cancer risk, and other issues. So they often force the operators to make changes to the small cell to satisfy a vocal group of citizens.

Step 4: Changes to the Radio: Some changes are as simple as paint colors. Other changes involve redesign of the radio enclosure to fit a unique set of dimensions for each city.

Step 5: City Council Approvals: After making changes, the operator can eventually win approval to mount their radio on a pole.

Step 6: Trenching for fiber: Close down city streets to bring fiber to the site. The cost of the fiber itself is small, but the disruption to traffic makes this a multi-day ordeal for a large crew.

Step 7: Set up prime power: Electrical power can in some cases reach the site in the same trench as the fiber. In other cases it comes in from overhead lines. In either case, a typical mobile radio needs metered power, so the meter and the wiring itself can involve a lot of coordination and extra cost.

> Many deployment steps can be eliminated by choosing an existing pre-approved platform.

Step 8: Power meter: Along with the AC power supply comes a need to monitor the power usage so that the operator can pay for its power every month.

Step 9: Install the radio in the field: We have observed crews taking all day for a single small cell, as they close the street again and fiddle with complex mounting of a radio on a wooden utility pole.

Step 10: Provision a small cell on the network: Registering the new radio on the network and providing the neighbor-relations lists and other necessary settings can require hours of coordination.

A quick alternative

Mounting a small cell or repeater on a streetlight can avoid almost all of the difficulties, delays, and costs associated with the ten-step process described above. We looked at the Ubicquia Streetlight solution, to compare with the typical approach of selecting various utility poles, traffic poles, and walls. We found that the deployment can be significantly streamlined. Ubicquia uses the standard photocell socket on LED streetlights to take advantage of the mounting location and power that's already available.

Step	Typical deployment	Standardized streetlight deployment
1: RAN Planning	Several days to model urban areas in 3D and identify all possible locations for radio mounting	Hours to model RAN performance from each streetlight location
2: Site Acquisition	Weeks to contact building and pole owners. Additional weeks or months to negotiate leases.	A single blanket agreement is set up to govern all radio sites in 2-3 weeks.
3. City Council Meeting:	Weeks to wait for a meeting and present proposed idea. Often unsuccessful.	Most streetlights already approved for electronics in photosensor socket.
4. Changes to product:	Weeks or months to reset the product configuration as required and return for approval	Not necessary; pre-approved.
5. City Council Approval:	Weeks to wait for another opportunity for local approvals.	Not necessary; pre-approved.
6. Trenching for Fiber:	Weeks to months to schedule with approval from city	Not necessary for a repeater
7. Set up power:	Weeks to months for permit approvals and hours for installation	Not necessary; radio can use power from a standard photocell socket
8. Electrical meter:	Weeks to months for permit approvals; hours to install physical meter	Meter is included in some small cell products; no action necessary
9. Radio Installation:	4-8 hour process to physically install each radio; different mounting hardware for walls, poles, etc	15 minutes to position a cherry-picker; one screw to install standard radio module
10. Provision the radio:	Many small cells are pre-provisioned and recognized in minutes; gNodeBs need neighbor relations and other site specific settings	Repeaters can be pre-provisioned for instant turn-on

As you can see, many of the steps involved can be eliminated altogether so that the installation of the radio can be condensed to a 15-minute stop with traffic cones, with less than 30 seconds for the actual installation of the radio itself in the standardized socket. An excellent video of a radio installation in 15 seconds can be viewed on this link.

TCO Impact

Small cells are used to supplement capacity because they're less expensive than erecting new towers and buying more spectrum. Repeaters are used in place of gNodeBs where they can extend coverage at lower cost. The streetlight-based deployment is an extension of this thinking: saving time and energy in the site acquisition, site set-up, and deployment saves money.

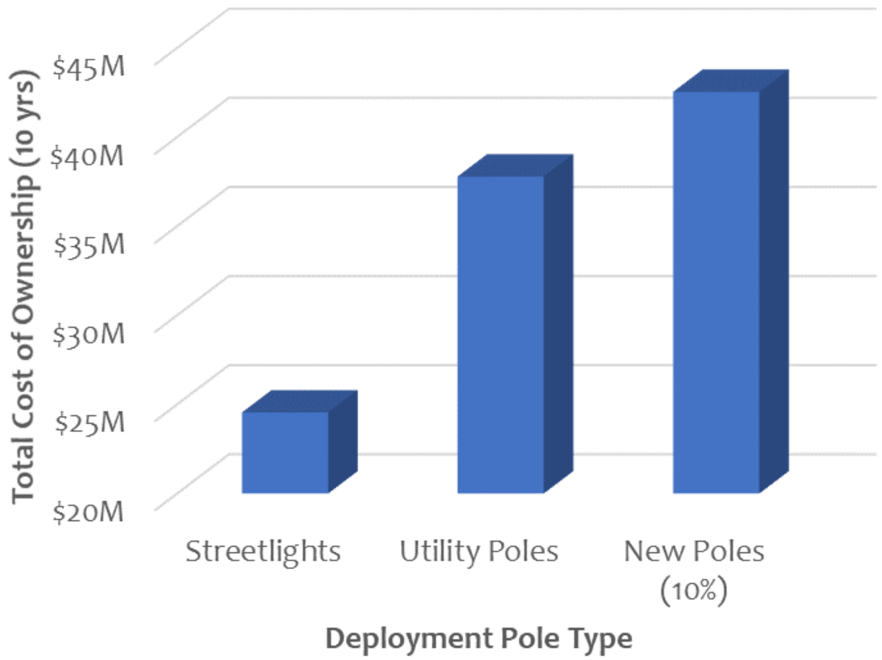
We considered a small city, with 950 mm-wave radio locations. As we have shown in previous analyses, deploying 950 gNodeB units can be very expensive, in the range of $110 million, with excess capacity that cannot be used for years. So, in this scenario, we compare two different deployment models using repeaters: on utility poles and on streetlights. We assumed 100 gNodeB units and 850 repeaters in each case, cutting the total cost dramatically. The table below shows a comparison of two deployment methods for our 950 radio sites, where the radios are similar and we've only changed the deployment approach.

TCO comparison:
$35K per repeater on utility poles
$14K per repeater on streetlights

		Streetlights	Utility Poles	Savings	COMMENT
CAPEX					
	Spectrum				Spectrum cost assumed to be sunk–eliminated this line to avoid skewing results
	Radio Equipment	$ 7,350,000	$ 5,650,000	$ (1,700,000)	Cost of gNodeBs and repeaters in mm-wave network
	Site Acquisition/Setup	$ 935,000	$ 5,355,000	$ 4,420,000	Cost of legal work and pole setup. Assuming 20x less legal work per site in citywide streetlight case
	Fiber	$ 100,000	$ 100,000	$ -	Fiber for supporting gNodeB units only
	Core Network Capacity	$ 916,864	$ 916,864	$ -	Amortized cost of 5GCore at $800 per Gbps
				$ -	
OPEX	*(One-time costs, first year)*			$ -	
	RF Planning	$ 1,350,000	$ 3,050,000	$ 1,700,000	Assume much quicker RF planning for streetlight locations instead of modeling walls/utility pole locations
	Legal/Permitting costs	$ 850,000	$ 1,800,000	$ 950,000	One permit ($50K) instead of 20 permits ($1m) for repeaters. Also includes cost for permitting of gNodeBs.
	Installation, RF equipment	$ 1,225,000	$ 4,200,000	$ 2,975,000	Assume 4 hours/2 person for utility pole, 30min hour/2 person for streetlight repeater
	Installation of fiber	$ 1,600,000	$ 1,600,000	$ -	Assume $80/meter for fiber trench, 200m average distance (for gNodeBs only)
	(Recurring annual costs)				
	Site Rental	$ 315,000	$ 570,000	$ 255,000	Streetlights at $25/month. Utility poles at $50/month
	Meter rental	$ 75,000	$ 228,000	$ 153,000	Meter rental. Typ $20/month physical meter. Streetlight Repeater $5/month using integrated SaaS
	Energy	$ 158,976	$ 239,760	$ 80,784	Streetlight power is often available at 8 cents per kWh, but commercial power is up to 30 cents per kWh.
	Backhaul operation			$ -	Assume owned fiber
	Core Network operation	$ 137,530	$137,530	$ -	Annual cost to maintain and operate core network, amortized over data usage.
	Site Maintenance	$ 335,000	$ 335,000	$ -	Annual cost for failures, electronic maintenance, antenna adjustment, lightning strikes
10 yr TCO		*$24,541,920*	*$37,774,760*	*$13,232,840*	

Looking at these numbers another way, deployment of the repeaters on streetlights can save 35% of the cost of a city-wide network with 8.5 repeaters per gNodeB. The savings would be even higher for a network with heavier use of repeaters, because the costs of fiber/power/etc for the gNodeB sites can be a significant fixed cost in the model.

For the repeater sites, the single most costly item is the legal cost of site acquisition, and the operator should jump on any chance to get a city-wide permit for hundreds (or thousands) of locations in one shot.



The savings can be even bigger if new utility poles must be erected, due to lack of adequate pole infrastructure in a key location. We considered one case in which 10% of repeater sites could not be served by utility poles, and needed a new pole. In our home city of San Jose, we believe that 10% is a conservative figure… the number of new poles could be much higher.

An existing forest of streetlights

> Typical LED streetlight upgrades make 150-300W available on each pole.

The standard photocell socket is not available on every streetlight in every city, but it's pretty widespread. More than 360 million streetlights are already compatible with the standardized photocell socket, with some 65 million in the USA.

Even better, most of these streetlights have already been outfitted with LED lighting, making them much more efficient than the sodium lamps they replaced. Typical LED upgrades save more than 150 Watts for each streetlight, which leaves more than enough power for some radio products such as repeaters and low-power small cells.

What if the streetlights are not in the perfect location for the RF signal? In RAN planning, each operator will have its unique map of preferred sites, that are typically shown as a series of circles on the map.   Streetlights may not always fit within the preferred circles, but streetlights are always positioned *over the street,* and are typically spaced 30-50 meters apart. There's no better platform to find ideal radio locations than to simply identify the streetlight closest to the RAN model.

More than 360 million streetlights are available globally to host radios.

Our conclusion:

For any outdoor radio deployment, streetlight photocell sockets present an incredible opportunity to speed up the process and save money.   This is especially obvious in the case of repeaters, where power consumption is low and no fiber is needed.

Our conclusion: Streetlight deployment is absolutely the way to go.   The cost savings are significant, but more importantly, the radios can be on the air extremely quickly.   Maybe the biggest benefit is avoiding those boring City Council meetings!

In the end, we predict that the CFO will agree with the operations team to use streetlight-based radio deployment.   This may kick off a 'land rush' as operators strive to get access to the best streetlights on the best streetcorners. The operators that move quickest to adopt this concept will benefit most.