POSITRON ACCESS

How to Profitably Win Metro Cell Backhaul Business?

A White Paper on Bonded Copper as an Ideal Solution for Metro Cell Backhaul

October 2012

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Executive Summary

Backhaul Service Providers are in the middle of a perfect mobile storm. Wireless Service Providers (WSPs) are looking for low-cost backhaul solutions as they struggle to simultaneously increase capacity in heavy traffic urban areas and increase coverage in rural areas quickly and cost effectively.

WSPs can meet the exponential growth in mobile demand by either macro cell expansion or macro cell offload strategies. Macro cell expansion is usually much more time consuming, requires costly equipment and has complex site acquisition and approval process. Using small cells as a network offloading offers an alternative to macro cell expansion (See figure 1). Small cells are quicker to deploy, more economical and have a much less complex site acquisition and approval process.

Using small metro cells to offload macro cells provide a new multi-billion dollar backhaul opportunity for wire line and competitive carriers. Infonetics Research predicts that there will be nearly three million new metro cells deployed in the next three to five years. Field trials have already started in North America and some carriers are ready to implement the “Macro cell-offload” strategy in 2012. All of these small cell sites present both a new backhaul challenge and an opportunity for an explosive new revenue stream.

For service providers, there are several options to provide backhaul for small cells of which bonded copper is emerging as the most optimal, cost effective and immediately available solution relative to fiber, microwave and cable.

This paper explores how backhaul service providers can provide unique service benefits to WSP’s and profit from the perfect mobile storm using existing copper assets. Providers can respond to wireless carrier needs to enable quick and vast deployment of metro cells and enterprise cells in either urban or rural markets with significant increase in carrier capacity and coverage.

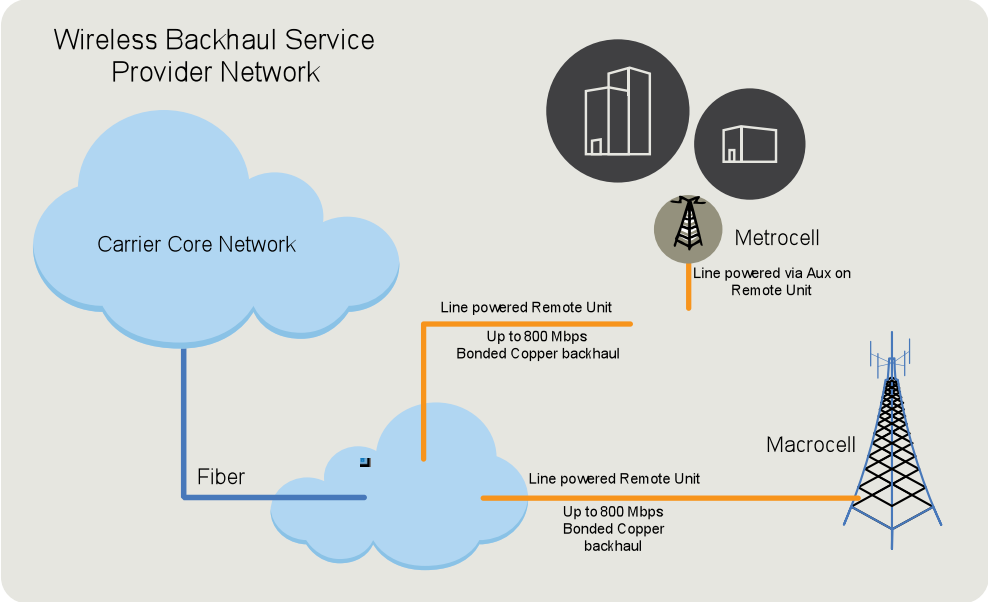
This paper also presents several sample data points to demonstrate the wide range of services at both short and long distances over bonded copper.

Why Use Bonded Copper for Backhaul?

Copper has been a valuable asset that is widely available and has evolved to deliver up to 800 Mbps on bonded copper pairs with technological advancements such as vectoring and MIMO on DMT for alien cross talk cancellation.

The technological advancements and ubiquitous deployment makes copper the optimal backhaul solution for quick and effective deployment of small cells.

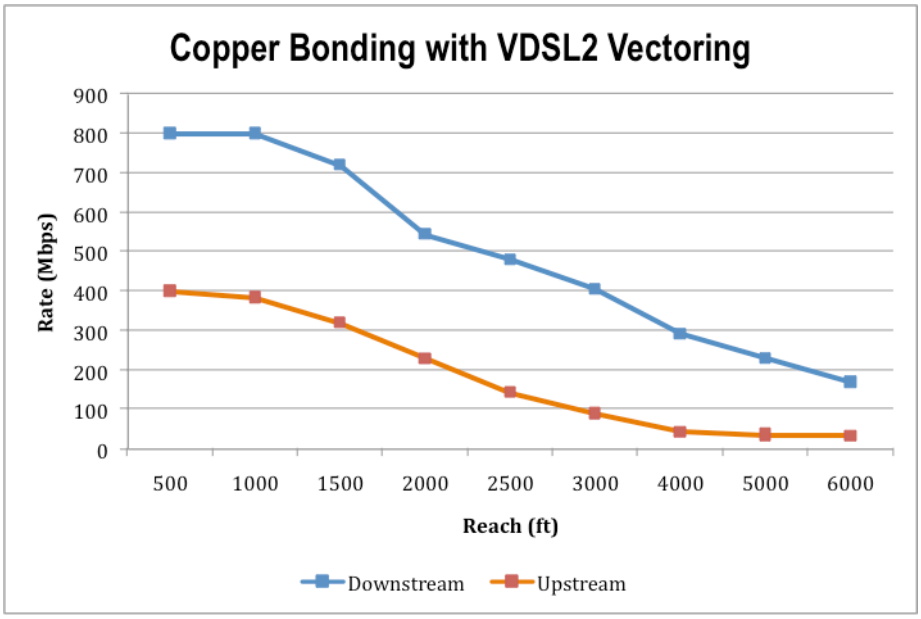
Figure 1: Macro cell and metro cell backhaul over copper for outdoor deployments



Deliver Up to 800 Mbps on Bonded Copper

With network and time tested technological innovations, such as VDSL2 vectoring and MIMO on DMT technologies, service providers can deliver up to 800 Mbps on copper pairs, making it the ideal backhaul solution for now and into the foreseeable future. Figure 2 below shows the rate and reach performance of eight bonded pairs with VDSL2 vectoring as measured on copper in ongoing small cell trials.

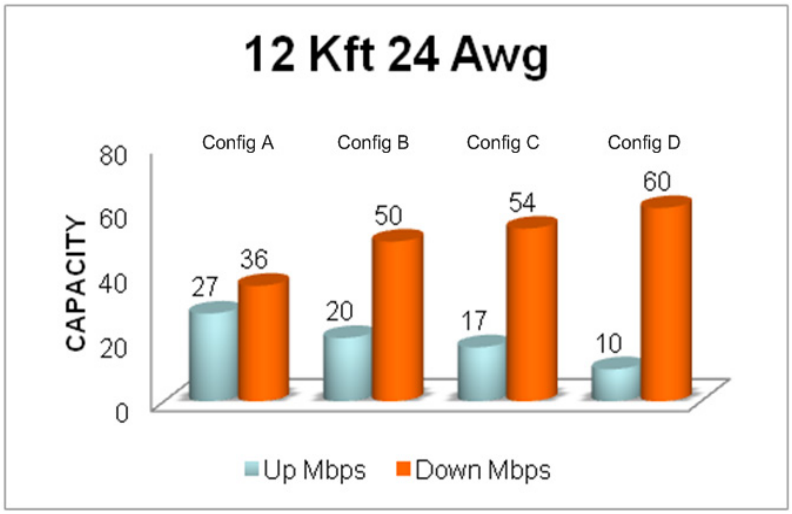
Figure 2: Rate and Reach chart for 8 pairs VDSL2 vectoring bonded copper solution



Provide a Wide Range of Symmetric and Asymmetric Service

An ADSL2/VDSL2 based bonded copper solution also has a key advantage to support both high bandwidth symmetric as well as asymmetric services. By nature an ADSL2/VDSL2 based solution uses frequency division multiplexing giving the flexibility to distribute bandwidth between upstream and downstream band. A technology such as FlexStream takes advantage of Frequency Division Multiplexing (FDM) to unlock the possibility to provide a wide range of services from the same platform. Figure 3 shows a sample of different configurations of upstream and downstream bandwidth at 12 Kft 24 awg. ADSL2/VDSL2 with FDM technology is the only solution with this inherit flexibility.

Figure 3: Flexible configuration to enable wide range of symmetric and asymmetric services



Copper is Lowest Cost Medium for Metro Cell Backhaul

Copper is already widely deployed and can reach 100% of businesses therefore using copper bonding for backhaul would only require the equipment cost, which ranges from $2k to $3K per link. Alternatively, using fiber may need trenching in addition to the equipment cost, which could range from $50K to $200K. Microwave equipment cost ranges from $15K to $40K in addition to Non Line-of-sight (NLOS) wireless costs of about $10K per link.

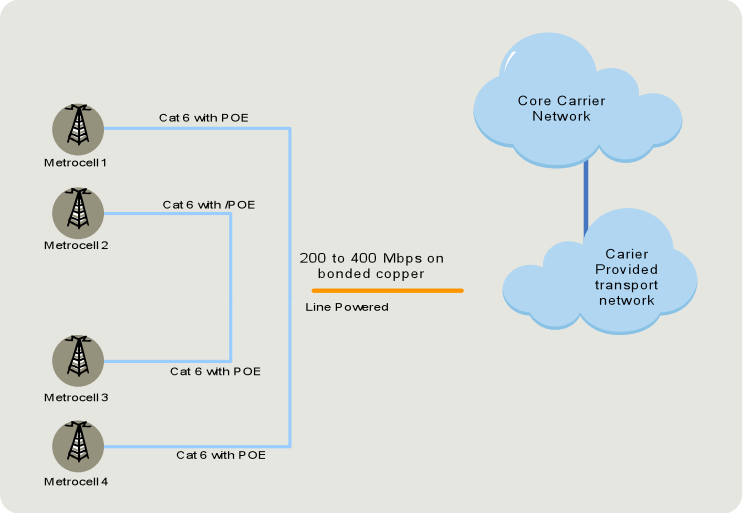
Consequently, it is clear that with respect to cost, copper bonding is the most optimal solution to deliver the required bandwidth at a fraction of the cost relative to other options.

Copper is Readily Available in Densely Populated and Rural Areas

Ubiquitous availability of copper does not require new trenching, which is difficult in densely populated urban regions and not economically justifiable in rural areas. Availability is a key factor for enabling WSP's to quickly and economically deploy small metro cells to significantly increase their capacity and coverage.

Metro cells will also be deployed indoors (in stadiums, buildings, subways, etc) where copper is readily available. Additionally, copper bonded CPEs can provide up to 200 Mbps and support multiple metro cells. Figure 4 shows this deployment scenario.

Figure 4: Indoor deployment of multiple metro cells on a single remote unit



Remote Powering of Small Cell is Only Available Via Copper

Bonded copper can also be used to remotely power the metro cell being backhauled, eliminating the cost and complications of local power and battery backup, simplifying installation and giving the RF engineer a lot more flexibility in the small cell location. Copper equipment can deliver 60 to 100 watts to the small cell directly or via POE, which is more than enough to power 2G, 3G, 4G and multi-standard metro cells.

Bonded Copper vs. Other Mediums

Fiber

Fiber based backhaul require costly equipment, long deployment timelines and complex permitting and might not be deployable at all in certain areas. In addition fiber provides multi gigabits of bandwidth, which is overkill for metro cell backhaul. Most current metro cells require 50 to 60 Mbps and could reach a few hundred megabits for multiple metro cells in the same location.

Metro cells need to be placed at precise locations to efficiently offload traffic from macro cells. Fiber may not be available at all required locations and bringing fiber may be cost and time prohibitive.

The high cost, sparse availability and over capacity make fiber the least optimal solution for metro cell backhaul.

Point-to-Point and Point-to-Multipoint Microwave (Line-of-sight)

Microwave backhaul typically operates at frequencies above 6 GHz (typically 11-42 GHz), is considered a mature and technologically advanced option and requires Line-of-sight (LOS) between the two backhaul nodes. This technology is primarily developed for macro cell backhaul and is not suitable for metro cell backhaul locations. Metro cells may be mounted in Non Line-of-sight (NLOS) conditions with obstacles between the two backhaul nodes (e.g. buildings, trees, etc.). These conditions significant attenuate the power received by the remote node and distort the signal resulting in very low bandwidth throughput.

Traditional microwave is not an option in backhauling small cell sites where clearance of the first Fresnel zone is not possible. In addition, microwave faces very complex regulatory approval processes and is dependent on availability of the spectrum in certain areas. In North America microwave is not widely deployed and will require green field network build out to be able to support the small cell backhaul.

Point-to-Multipoint nLOS/NLOS Radio

Sub-6 GHz Non Line-of-sight (NLOS) solutions using a point-to-multipoint architecture are better suited for dense underlay, but when using licensed spectrum, narrow bandwidth channels put strict limits on backhaul capacity. Additionally, the overall throughput depends on the Fresnel zone encroachment. Dynamic obstructions such as trees and construction sites add to multipath and increase attenuation to the overall path of the microwave link.

Near Line-of-sight (nLOS) microwave radios require proper power budget, fade mitigation, adaptive link characteristics and proper demodulation to dispersion to be successfully deployed.

All of the above has limited the appeal of point-to-multipoint nLOS/NLOS backhaul for cellular backhaul applications.

CableCO Solutions and DOCSIS

CableCOs can deliver backhaul over fiber and microwave but these are not economical or timely options for small cells. In general cable services are asymmetric in nature and can deliver up to 300 Mbps. DOCSIS 3.0 could be a relatively viable solution for metro cell backhaul and provide the necessary asymmetric bandwidth. However the service is delivered over shared infrastructure and best effort service.

ADSL2/VDSL2 based bonded copper solutions can provide up to 800 Mbps of dedicated bandwidth with Quality of Service (QoS). Copper is more readily available to meet the precise location of metro cell deployment. In addition, cable coverage is not extensive enough to match the metro cell deployable location requirements.

ADSL2/VDSL2 bonded copper solutions can enable service providers to leap frog over CableCOs by providing flexible asymmetric services and deliver up to 800 Mbps. Unlike CableCOs, ILECs/CLECs can deliver dedicated high QoS services that meet stringent Service-Level Agreement (SLA) requirements.

Comparison Summary of Backhaul Options

Key Requirements	Fiber (Trenching)	Microwave (Equipment)	NLOS Wireless (Equipment)	Copper Bonding (Equipment)
Cost of Development	$50K to $200K	$15 to $40K	$10K	$2K to $3K
Bandwidth 50 to 60 Mbps	Multi Gbps	100's Mbps	Under 30 Mbps	400 Mbps at 3k feet 200 Mbps at 6k feet 60 Mbps at 12k feet
Speed of Deployment	Months	Weeks	Weeks	Days
Remote Powering	No	No	No	Yes
Footprint	Addresses 15% of businesses in North America	New deployments	New deployments	100% of businesses in North America
Indoor/ Outdoor	Yes	Limitations	Limitations	Yes

Table 1: Metro cell backhaul medium comparison

Ethernet over Copper Rate and Reach in Deployed Wireless Networks

Asymmetric Ethernet for mobile backhaul has been in trials and deployments for several years, and is a proven carrier-grade low-cost solution for the stringent requirements of wireless operators. Small cell deployments are expected to require short reach backhaul where bonded copper can deliver 100's of Mbps. Additionally, bonded copper can effectively deliver for the long reach small cells and macro cells with bandwidths of 50-100 Mbps.

The table below shows typical data rates achieved in deployments of backhaul for macro and metro cell sites in North America and Europe with Positron's bonded copper solution.

Site	Technology	Distance to Metro Cell (ft)	Downstream	Upstream	Number of Pairs
Site A	VDSL Vectoring	3,930	362 Mbps	66 Mbps	8
Site B	VDSL with Vectoring	6,046	228 Mbps	32 Mbps	8
Site C	ADSL2+ with MIMO	7,302	100 Mbps	30 Mbps	8
Site D	ADSL2+ with MIMO	10,780	71 Mbps	10 Mbps	8
Site E	ADSL2+ with MIMO	11,020	58 Mbps	20 Mbps	8
Site F	ADSL2+ with MIMO	13,300	52 Mbps	10 Mbps	8

Table 2: Data rates for two metro cell backhaul sites

Conclusion

Service providers can deliver significant service benefits to WSP's by using bonded copper solutions for small cell backhaul including:

- Asymmetric service offerings that meet current and future requirements with up to 800 Mbps on 8 pairs – not just an interim solution
- Very competitive pricing delivering "dedicated" carrier grade asymmetric bandwidth
- Fast deployments anywhere – copper infrastructure is readily available
- Significant deployment flexibility for wireless carriers with remote line powering – greatly simplifies RF planning and site acquisition for the wireless carrier

ROI for the small cell backhaul service is superior when using bonded copper technology given:

- Use of existing copper infrastructure for fast, low-cost and simplified service bring up
- Significantly lower CAPEX than fiber or other alternatives
- Can be remotely powered, eliminating local power / backup equipment
- Can be delivered on very few pairs to meet metro cell requirements – not all sites need 8 pairs to hit 60 Mbps

Copper is the key enabler of metro cell deployment. Service providers using bonded copper allow wireless carriers to profitably and significantly increase their capacity and coverage for the near and foreseeable future.