Femtocells and Backhaul Issues

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 One of the questions that often gets asked around femtocells is “What about the backhaul issues?” Indeed, some people have suggested that DSL will need to be upgraded to some carrier-grade Ethernet or xPON service to solve this issue.

The quick answer is this: it is transparent, and the requirements of Femto on backhaul are trivial to invisible.

But a more detailed, in depth answer is this. The way the femtocell works is that it uses standard 3G to talk to the handset, exactly as normal. Then the femtocell becomes the end of that call, this then gets processed and converted to VoIP, which tunnels through a secure VPN into the wireless carriers’ core network.

So, in principle, it is no different to any other service. Indeed, easier than most. Skype voice is 40kbps for a call plus a load extra for “chatter” (polling, synch, etc); Vonage is similar – but a cellular call is only 8-12Kbps.

So if the broadband network is OK with other VoIP, then because Femto is easier, with no worries about QoS - in the best IP tradition, QoS gets fixed by more bandwidth…

Of course, the Femto can also carry the 3G data session (there are some interesting complications here, to do with regulation and the comparison to WiFi, but maybe best saved for another time). But in that case it is no different from any other data session: the ISP doesn’t care that the packets originated in a handset instead of an iPOD Touch or a PC.

At present, virtually all carriers are doing Femto as independent from backhaul – it is “invisible”. So, for example, Sprint doesn’t even have broadband, Verizon &

Vodafone are ignoring it – and AT&T offers a choice: it either doesn't care, or if you are a broadband customer, gives you a discount.

That said, there are some fixed line operators who see scope for "enhanced service" – perhaps guaranteed QoS, perhaps a wholesale / white label DSL. So the Femto operator would offer branded DSL, but that is actually delivered by a specialist carrier who doesn't do wireless.

The other wrinkle is net neutrality. In most countries this argument stands because neutrality happens, but there are exceptions. Whether de jure or de facto the carriers either legally cannot, or pragmatically decide not to, block other services – even competitive ones.

But there are situations that are different. Some carriers are deciding to explicitly bundle femtocells with their broadband products. In that case they may want to give some preferential service – or at the very least preferential pricing.

Perhaps the most interesting exception is China. The government recently re-organised the whole industry to create three quite different but very well-balanced competitors – rather as an industry wide rock—scissors—paper. The operators are very integrated and fiercely competitive, so it is likely competitive Femto traffic would be blocked, while integrated offerings become very compelling.

LTE Advanced

In the Red Queen's Race which is technology, it is always true that you must run as fast as you can to keep position, and that the "next big thing" is always there to be chased after.

In wireless, that means that every few years the next generation needs to be developed, engineers work late to design the new products.

For consumers, LTE is nowhere near a concern (even the nerdiest early adopter cannot yet buy anything), for operators it is a current issue - but increasingly for OEMs and development organizations, LTE is "last year's headache" and their attention is moving on to LTE Advanced ("next year's headache"). This is being standardized and managed by 3GPP (e.g. last month's meeting in Shenzhen).

An interesting thing is how with each new generation, the technology problem to be solved changes radically. With 1G to 2G we moved from analog to digital (but the fundamental architecture and logic of cellular had been addressed); then we moved from narrowband to wideband, and enabled fast data services with 3G. As we go from 3G to LTE we move all-IP networks, to OFDM and to MIMO.

But what about LTE Advanced?

One of the interesting things is that this time the changes to the air- interface are relatively minor: we seem to have reached a plateau where Turbo codes, OFMDA and MIMO are "as good as it gets". This reflects the reality that improvements to

efficiency ("bits-per-second-per-Hz") have essentially flatlined: we are now so close to the Shannon limit that opportunities are minimal. Indeed, that perhaps has happened with HSPA+ and Release 8.

So, after 20 years of keeping the architecture but changing the link, where do we go next? Many of the developments come from topology: from the way we design networks (their “shape”) and the way links will be coordinated as a whole, instead of in isolation. Indeed, Paul Jacobs, the CEO of Qualcomm said "the impact of topology will be as significant as the change from analog to digital".

One of the most obvious, but most important, of these changes is the role of small cells. To get high data rates, we need good SNR - and that inevitably implies small cells.

Not only is it true that above a Km or so there is no advantage of LTE over 3G, it soon becomes the case that as range increases there is little advantage over GSM...

Of course, the bigger the cell, the greater the number of users - and the lower the shared (per user) throughput. Then there is the impact of walls: particularly at high-frequencies, walls and metallised windows are excellent at blocking RF. But in a nice piece of technology ju-jitsu, these apparent drawbacks can be turned to good use: by creating a network as a dense mesh of small cells, with short distances and few users, all of whom benefit from excellent data-rates. For those users indoors, which, of course, is where the majority of users will be, then the walls serve to keep that data where you need it and reduce interference from others outside.

These technologies have become viable with 3G (my company supplies most of the HSPA femtocells today) but become essential with LTE and LTE Advanced. Indeed, while femtocell technology was a late addition to the 3GPP standard for WCDMA, it is a fundamental feature of LTE, with the (appallingly named!) Home eNodeB as a standard architecture from Release 8.

With LTE Advanced these ideas become even more sophisticated, with techniques like collaborative MIMO, multi-Node B routing, mesh and multi-hop relay all coming to the fore.

The other areas where there is scope is in "using resources optimally", especially with spectrum. Some of this is "white space" technologies, or the "spectrum sharing" ideas, but there are is a lot research around cognitive radio, assigning different traffic to different streams and optimally using the bandwidth and SNR available.

Finally, there is protocol stack optimization, in particular not treating layers as completely independent, but in using knowledge from one to benefit another layer.

So it is all about 3D improvement: up the stack, across the network in space (topology & small cells), across the network in frequency (cognitive radio), all opimtized. After the transition from analog to digital, from narrow-band, and then from channelized to OFDMA and flattened all-IP architectures – this time the new

technology is far less dramatic with changes to the specific link of the air-interface. While Long Term Evolution is a misnomer (there is nothing evolutionary about it), it is an accurate term to describe the move from LTE to LTE Advanced, with both based on IP, OFDMA and MIMO.

The Business Case for Femtocells

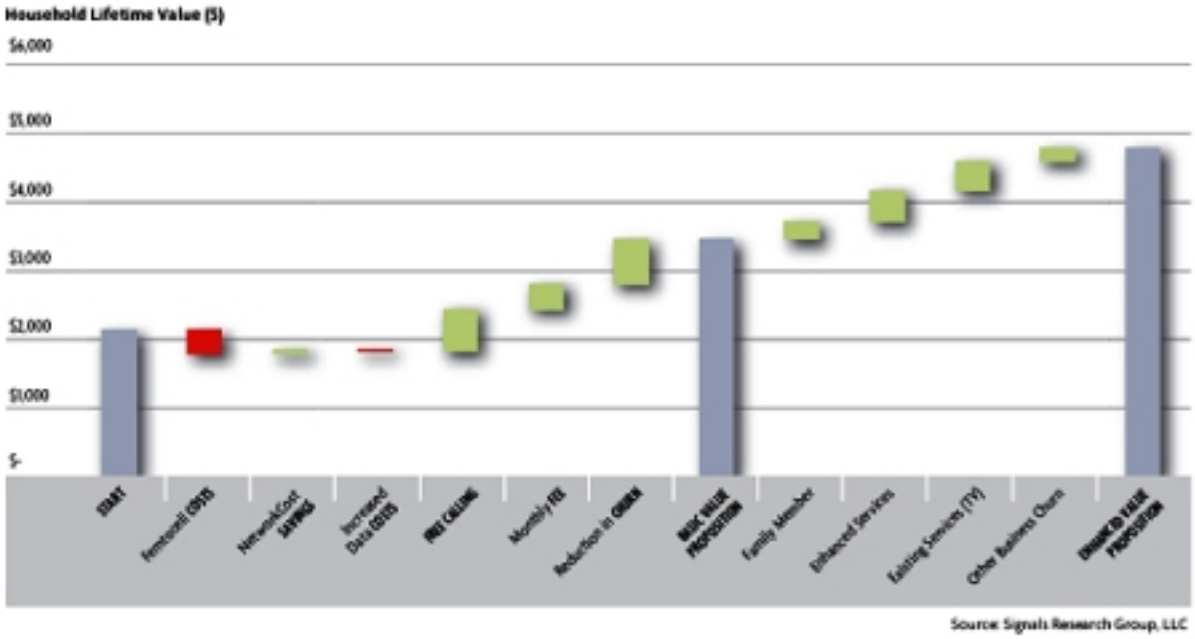
One of the most obvious and important questions when discussing femtocells is “what is the business case?”. In the real-world, while better service and better quality are nice, they are not ends in themselves, but a means by which to increase revenue, gain customers or otherwise profit.

Femtocells can deliver a varied portfolio of benefits: improved cellular coverage, increased capacity for data, new services or applications. But, of course, there are costs: the cost of the access point, the cost of gateways and servers, or provisioning systems and OSS. To decide on the viability of a femtocell deployment all of these factors must be considered.

Signals Research Group is an independent consutancy, expert in wireless economics and deployment. They recently completed a detailed study considering all of these factors, for a variety of different scenarios (different user cases, carriers in different geographies, coverage constrained vs capacity constrained, etc. etc.). The 81-page White Paper is available from the Femto Forum website (http://www.femtoforum.org/femto/).

These benefits combine to deliver significant value – indeed it is the opportunity to share in this value which fuels many of the business models. For example, SRG considered a typical European household with contract customers including ”teenagers who love to talk”. The lifetime value of that household in advance of having a femtocell service is $2,138, including monthly revenues of $54 per individual, $405 in acquisition costs, $620 in retention costs, and costs related to the macro network, customer service, marketing and advertising.

As a simple starting position, a femtocell increases the customer lifetime value to $3,464, an increase in value of 62%, driven by uncontroversial factors such as network cost savings and minor reductions in churn. Even after the initial surge in use the femtocell allowed for increased costs from support and variable cost (e.g. additional traffic through the core). It is this very straightforward service proposition with its 62% increase in customer value which is driving the carriers to deploy. As one CFO said “If I can add $1326 in shareholder value per femto then I can see a very obvious way to increase my market capitalisation by a few billion dollars”.



A second phase of analysis includes more subtle or debatable elements which increases the value further. For example, it is likely that some of the people in the household are with a different carrier: with the femtocell in the home there is a percentage likelihood they will switch to get the benefits, so the value increases accordingly. Or there may be cross-selling opportunities e.g. for an operator who also has a broadband service (examples include AT&T or Softbank who are both using femtocells to sell broadband). Finally, there are the as-yet-undefined services and applications. Taking all of these factors into account, in a more aggressive case, including cross-selling and charging for services, this increases household lifetime value by 162%, equivalent to $4787 an even better for market cap.

To put it slightly differently, the breakeven point for the basic value proposition is 22 months and the ROI is 538%. For the enhanced value proposition the breakeven point is 10 months and the ROI is 1,056% for the aggressive scenario.

Given that kind of opportunity, it is no surprise that many companies see the attraction and are developing business models accordingly.