3G meets broadband

Bringing the promise of 3G indoors.
By **Roy Rubenstein**.

Mobile operators may have paid a fortune to secure 3G radio spectrum, but they have been ill served by signal coverage within the home.

"There has been a giant push around 3G that has left coverage holes in the network," says Steve Shaw, director of marketing at US network equipment maker Kineto Wireless. "They [mobile operators] don't want to put up that many more cell towers." Acquiring extra base station sites improves coverage but is costly, weakening further the business case for 3G that has proved long in coming.

However, advances in silicon, coupled with new software protocols, could change all that. Operators can now afford to put a tiny 3G base station – a femtocell – within a home. The target price for the indoor unit is less than $200.

"Such an access point is targeted at mobile operators, as you require licensed spectrum to operate it," says Chris Cox, marketing manager at Cambridge based femtocell maker ip.access. A 3G handset talks to the femtocell unit via the air interface, while the femtocell is linked to the network using the home's broadband connection.

One reason for the femtocell's appeal is that it works with existing 3G handsets – a user doesn't need to exchange their handset for a dual mode device combining cellular with WiFi. Equally, signal quality in the home is guaranteed without having to install macrocell 3G base stations and antenna sites. By carrying the resulting traffic over the fixed line network, it saves cellular network capacity and avoids costly backhaul links.

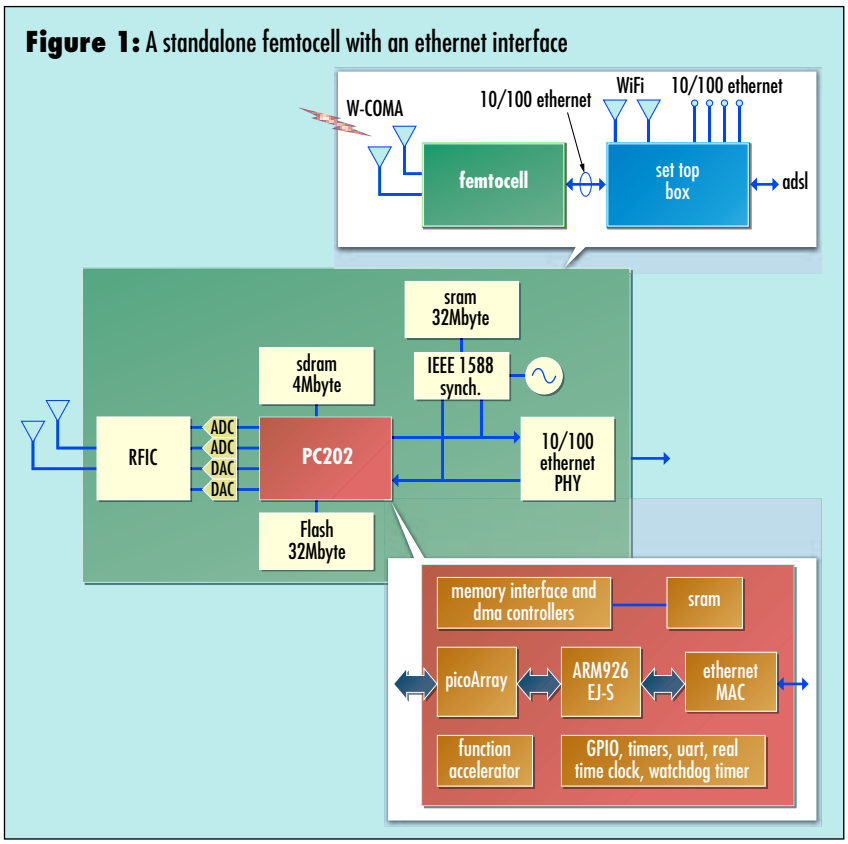
Ultimately femtocells bind customers by improving the performance of the mobile network and bundling other services with voice, such as internet access and tv.

"For the cellular carrier, the central notion [of femtocells] is to capture more of the consumer spend," says Stuart Carlaw, ABI Research's principal analyst, wireless connectivity. ABI forecasts that, by 2011, there will be 32million femtocells deployed supporting 102m users.

But there are hurdles to overcome. 3G base station functions must be crammed into a small femtocell unit and radio interference is another issue. 3G mobile networks are planned carefully in terms of frequencies and scrambling codes. With femtocells, low power base stations will be popping up in homes – and within existing 3G cells – in an ad hoc manner. If a user moves to a window and their handset detects a stronger 3G macrocell signal, will their phone switch to the that cell? In turn, if the femtocell signal is louder than a macro cell, will a passer by's phone try to connect? Operators will only be able to gauge the scale of the problem once trials begin next year.

"No one has done this in anger," says Dean Bubley, founder of Disruptive Analysis. "No one knows what it does to the frequency plans when 1000 of these

Figure 1: A standalone femtocell with an ethernet interface



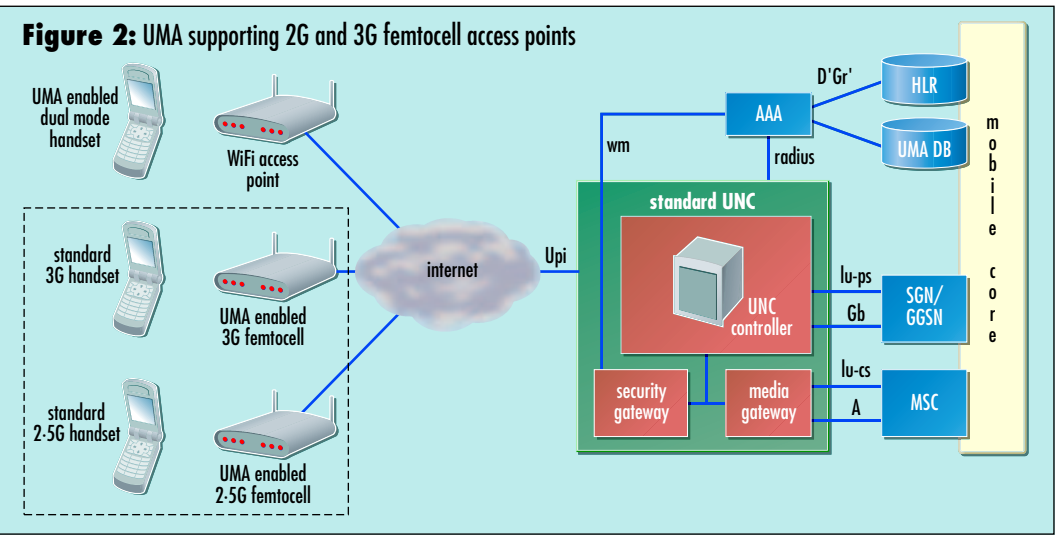


Figure 2: UMA supporting 2G and 3G femtocell access points

"The cost of providing the extra intelligence on each femtocell for a few users is very small."

Chris Cox, **ip. access**

light up in a square kilometre."

Swindon based UbiquiSys is already building trial versions of its ZoneGate femtocell and says mobile operators will start trials involving hundreds of users from spring 2007.

"Our system is made up of the [ZoneGate] access point and the management system, which uses the TR-069 standard," says Will Franks, UbiquiSys' chief technology officer and cofounder. TR-069 allows software running on the management system to communicate with the home gateway to which the femtocell is connected, enabling automated installation, device troubleshooting and remote software upgrades.

What's in the box?

In a 3G network, each base station (a Node B) is connected to a radio network controller (RNC). Typically, 50 to 100 Node Bs are served by an RNC. Node B numbers will rise to thousands – even tens of thousands – once femtocells are used.

"Each one [Node B femtocell] is now simple," says Rupert Baines, vice president of marketing at picoChip, whose multicore dsp chip has been chosen by UbiquiSys and ip.access. "All the RNC 'smarts', such as supporting mobility when a high speed train with 200 users enters a cell, and the handover between one base station and the next, none of this happens with the femtocell." A femtocell serves one household of 3G users only.

UbiquiSys' and ip.access' designs use the picoChip PC202, which has 198 dsps and an ARM9 processor. According to Franks: "The dsp array runs a scaled down version of the basestation modem, but still requires a huge amount of processing power."

In a traditional 3G network, the RNC performs most of the signaling intelligence for the access network, whilst the Node B provides the high speed lower layer functions. To scale to large numbers of femtocells, the processing functions are collapsed within the femtocell.

"The cost of providing the extra intelligence on each femtocell for a few users is very small and the cumulative effect is to cost optimise the overall system," says Cox. "It also improves air interface performance due to the faster turn around of the air interface messaging."

The lower layer functions of the 3G radio are performed by the PC202's dsp array. Tasks include interleaving the real time bits and bytes over the air. The higher layer radio functions are handled by the ARM core. These are what UbiquiSys calls layer two tasks, such as transmitting and receiving blocks of data and performing forward error correction, and the smarter still layer three radio resource controller, which starts and terminates calls.

On top of the three layer UMTS radio sit the software interfaces to the network. There are three main network interface options. Traditional 3G networks' base stations are connected to the RNC via leased lines. Since femtocell traffic is sent over the home's broadband link, the Iub interface is used. This involves the use of the IPsec protocol to transfer packet data over the network.

However, operators are upgrading their networks to converge on Internet Protocol (IP) technology and, as such, are considering two developments. One is the use of unlicensed mobile access (UMA) to interface the femtocells directly to a UMA network controller (UNC), such as that made by Kineto. The UNC then separates and sends voice and data traffic across the circuit switched and IP networks, respectively. The second, and ultimate, goal is to move to the IP Multimedia Subsystem (IMS), an all IP network that makes use of the Session Initiation Protocol (SIP).

Accordingly, a femtocell aimed at all three network classes needs to support Iub, UMA and SIP software clients, which all sit above the UMTS software. UbiquiSys is also adding a Java virtual machine as part of its femtocell software build. "This will create an open services environment," says Franks.

UbiquiSys says the femtocell software design is relatively straightforward. The control plane is separated from the data traffic and with the femtocell supporting data rates of up to 7.2Mbit/s, data must be handled with minimal delay. "The data traffic is point to point, while control plane messaging is switched through," says Richard Byrne, UbiquiSys' software architect.

With the industry continually shrinking radio cells, what comes after femtocells? "More femtocells," says Baines, who points out that wireless capacity can always be added by developing smaller and smaller cells.