



Femtocells Challenges and Opportunities

A GENBAND Whitepaper
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In-home/in-business base stations present FMC challenges and opportunities for mobile operators

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For savvy mobile operators, one key to unlocking the Fixed Mobile Convergence (FMC) puzzle may be the advent of a new class of small, low-powered, highly-affordable and highly-secure base stations called femtocells, designed specifically for in-home and in-business deployments.

By thinking small, the mobile industry hopes to reap big time gains in subscriber satisfaction, network efficiencies and bottom-line business performance.

The Microcell Trend

Driven by the continued worldwide growth in demand for mobile communications, mobile operators are evaluating and deploying technologies that deliver secure, low-cost voice and data services where subscribers make a growing percentage of mobile calls -- at their homes and in their workplace.

Mobile services have gained a reputation for inadequate building penetration, resulting in inferior call quality. This quality issue becomes even more paramount as mobile subscribers begin using advanced services available in 3rd Generation (3G) networks¹, as nearly 70% of all 3G traffic originates from indoor locations². However, research shows that only two percent of buildings are currently equipped with purpose-built indoor coverage solutions.

With the growing demand for these new services, most industry observers see significant potential for the use of new technology in the form of "femtocell" solutions. Femtocells operate in the same wireless spectrum as the macrocell network, enabling high quality voice and multimedia services to be delivered to mobile devices in indoor settings. A femtocell access point creates a small wireless coverage area, and it is attached to a subscriber's broadband Internet service for connection to the mobile operator.

Many femtocell trials and deployments began in 2008, and analysts expect a significant market ramp-up by 2010. ABI Research projects some 103 million femtocell access points by 2011³, indicating strong worldwide support for femtocells -- particularly in regions that have high mobile penetration and where 3G is currently being implemented.

Femtocell Business Case. Beyond the need to provide high quality indoor voice services, the Femto Forum observes that femtocells are an especially attractive alternative for data-intensive services⁴. In order to penetrate into the home or business effectively with a strong, high quality signal, these services would normally require expensive augmentation to the operator's Radio

¹ InStat, May 2008

² VisionGain, 2006, "In-Building Wireless Solutions"

³ ABI Research, 2008, "Fixed Mobile Convergence"

⁴ FemtoForum.com, 2008

Access Network (RAN). Typically, this means adding new, high cost macrocell base stations. Femtocells, however, allow the operator to avoid these build-outs, since coverage is provided by the access point in the home or business.

In addition to avoiding the build-out of more base stations, operators also benefit by using the subscriber's own Internet service for backhaul. If the macrocell network had provided the service, the cost would be borne by the operator directly using expensive (and typically leased) T1/E1 or data links to backhaul traffic from the operator's base stations. However, since the femtocell connects to the subscriber's broadband connection, voice and multimedia traffic traverse the Internet -- and the operator avoids a significant portion of the expense for backhaul.

Femtocells also drive the business case for new revenues and services. Most large, integrated network operators have plans to offer fixed and mobile services in bundles or packages, expecting to use their own fixed line, broadband access networks to backhaul the femtocell traffic. Operators also see promise for revenue growth from new services, with bundles and associated advanced solutions such as home networking integration, family plans and enhanced voice services eventually driving additional subscriptions and increasing Average Revenue per User (ARPU).

Understanding Femtocells

The Femto Forum states that: "Femtocells are low-power wireless access points that operate in licensed spectrum to connect standard mobile devices to a mobile operator's network using residential DSL or cable broadband connections"⁵. Put simply, a femtocell is a small base station that can be deployed in homes, buildings or other locations that offer limited access to the mobile network.



Simple Example of a Femtocell

Femtocell networks are the latest solution to the problem of indoor coverage. A small-sized femtocell access point is usually located in a home or business where it is also linked to a broadband Internet connection. The femtocell creates a small coverage area that uses the same frequency as the macrocellular network. When in range of the femtocell, the mobile device communicates with the mobile core network via the femtocell. All voice and multimedia traffic used by the subscriber is transited to the mobile operator via the Internet connection instead of the macrocell radio access network. Macrocell to femtocell handoffs are also enabled -- for instance, when a commuter on a cell phone arrives at home, a transparent handoff is made.

The femtocell makes it possible for high-quality voice, data, and video sessions to flow efficiently, securely and reliably using the consumer's existing broadband connection. Femtocell access points are easily installed, easily managed and are small enough to fit

⁵ FemtoForum.com, 2008

comfortably on a desk. Additionally, unlike WiFi-based FMC solutions, they do not restrict the subscriber to the use of dual mode phones, which are more limited in number in the subscriber population. These benefits to the consumer can increase loyalty to the mobile operator and reduce churn.

Productivity should also be enhanced in the workplace and home since femtocells can provide users with features such as a single phone number, single contact list, single voicemail and single consolidated bill – all of which are major drivers for consumer attraction to this technology. This attraction should increase revenue for mobile providers, as femtocells can accelerate the rate at which consumers make the leap from fixed line service to mobile – irreversibly altering the landscape of the telecommunications industry forever.

Industry Challenges

Femtocells hold significant promise for mobile and integrated wireline/wireless service providers, but this technology must also overcome a number of challenges. The industry and vendors are now working to address issues related to macrocellular interference, cost of femtocells, simple installation at the femtocell with auto-configuration, support for regulatory services, Quality of Service (QoS) for backbone backhaul, and a plethora of femtocell solution architectures. These and other issues are briefly covered below.

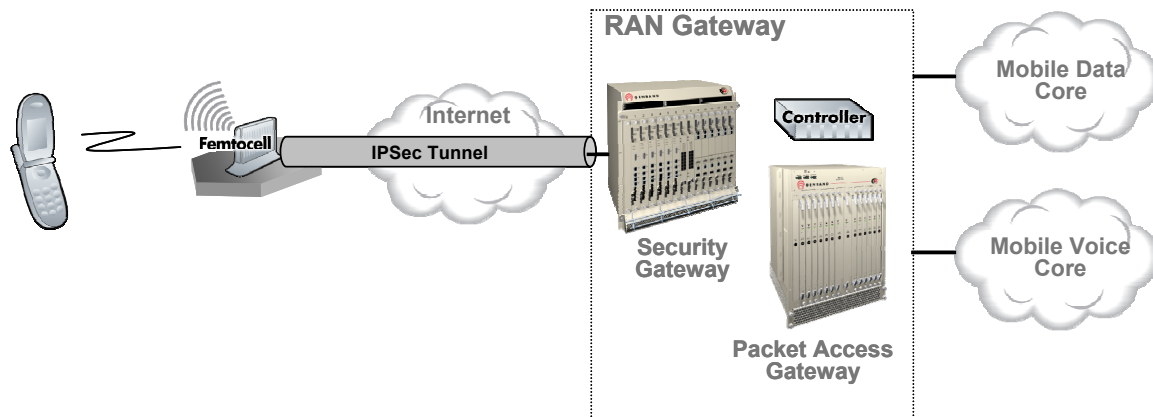
- **Interference Management:** Seen as perhaps the most crucial hurdle, the existence of many small microcells -- in contrast to a few macrocells -- changes the ways in which operators must manage their transmission power; some operators are also expressing uncertainty as to which frequency allocation scheme they would use to support this implementation.
- **Proprietary Interfaces:** The variety of transport mechanisms and a lack of standardization are potential roadblocks, with many operators looking to vendors to provide end-to-end femtocell solutions, complete with full system integration; a number of organizations – including the Femto Forum, 3GPP and 3GPP2 – are currently working to address standards and interoperability issues relating to the deployment of femtocells.
- **Access Model:** Most industry observers say a closed access model -- where only direct subscribers could access service over the femto device -- will likely be the preferred service model in early deployments; later, consumers may be willing to accept a more open access model that would allow calls from various users to transit a femtocell device.
- **Access Point Costs:** Surveys show that operators will pay up to a high-end limit of \$250 for initial deployment of femtocells in the consumer marketplace – an all-in network cost that includes the device, gateway and other requirements. More acceptable price points, however, are at \$200 or less.
- **Core Network Integration:** Femtocells are essentially small base stations in a mobile core network that was designed for fewer, much larger base stations; integrating these many access points into a mobile core poses a considerable operator challenge.

RAN Gateway Solution

Among the various femtocell solution architectures, Radio Access Network Gateway (RAN GW) approaches offer distinct advantages. With RAN GW architectures, Base Station Controller or Radio Network Controller functions are distributed between the femtocells and the RAN GW. The femtocells take on the radio resource management functions and the RAN GW provides the interface to the mobile operator's core network. The RAN GW terminates security tunnels from femtocells, and it hides from the core network the large number of access interfaces (i.e., Access Points) by means of concentration, distribution and other critical functions.

Easily integrating into existing core networks with minimal provisioning impact, RAN GWs provide investment protection by means of future-proof evolution to the all-IP network. The RAN gateway has multiple components with key functions, with the Packet Access Gateway and Security Gateway components described in detail below.

Packet Access Gateway. The Packet Access Gateway component in the RAN Gateway approach provides an interface to packet access networks and a standardized interface to the operator's core network.



RAN Gateway Architecture with Packet Access and Security Gateways

- **Media and Protocol Adaptation.** The Packet Access Gateway connects the IP-based traffic coming from the femtocell (over the Internet) to the TDM, IP, or ATM-based interface into the core network. Only a Packet Access Gateway with true convergence capabilities is capable of supporting transport protocol stack mediation between these protocols.
- **Signaling.** In addition to these protocol and media conversions, the Packet Access Gateway can also simultaneously support signaling gateway capabilities, enabling the efficient translation of packet-to-packet signaling (such as ATM-to-IP), thus reducing CapEx and OpEx through the elimination of additional, separate network elements that would otherwise perform this function.
- **Femtocell Concentration.** Packet Access Gateways also provide substantial benefits by concentrating femtocells. Instead of the mobile core needing to handle thousands to millions of new base stations (in the form of femtocell access points), the Packet Access Gateway in the RAN GW approach provides a singular interface

into the mobile core, enabling overall reductions in management complexity and core network costs

Security Gateway. An array of security risks and related network issues arise when using subscribers' broadband Internet access for femtocell backhaul. These include the risk of exposing the mobile core to security threats, possible compromises of user privacy, and the potential for other network attacks or exploitations.

The Security Gateway component in the RAN GW approach resolves these security issues. Relevant in both 3GPP (GSM/UMTS) and 3GPP2 (CDMA) femtocell architectures, the Security Gateway enables operators to manage, monitor, and secure their femtocell deployments. It is the crucial component that monitors each femtocell connection to protect against network attacks and security threats that could arise when mobile traffic is exposed to public broadband access networks. A high-performance gateway for terminating and managing secure IP tunnels, the Security Gateway should support GSM, UMTS, CDMA or SIP/IMS femtocell deployment models to provide the operator with maximum flexibility in choosing the deployment model that best meets its network needs.

Integration Considerations

Mobile operators must address multiple integration questions when considering the deployment of femtocells over an IP network. These integration challenges include:

- *Interoperability.* Operators should ensure that a femtocell solution provides compatibility and operability between the Femtocell, network gateways and the mobile core network; in the RAN GW approach, these standard interworking functions are provided by the elements within the RAN GW.
- *Security.* Access security is vital when femtocells connect to the mobile core over the Internet. The security gateway performs the critical function of keeping unauthorized users and traffic from penetrating the network, as well as maintaining the integrity and confidentiality of data entering the mobile core. These next-generation gateways provide a range of security and enforcement functions, including:
 - o user authentication, registration, and authorization
 - o establishment of a secure IP interface for each femtocell using an IPSec tunnel for traffic encryption
 - o policy and QoS enforcement
- *DoS Protection.* Gateways can also be used to implement a comprehensive Denial of Service (DoS) protection scheme, including security association limits, IKE DoS Protection, anti-spoofing checks, session flooring and subscriber-specific filter and firewall rules.
- *Mobility.* Operators must also ensure seamless voice and data session continuity when subscribers move between the cellular networks and their home- or office-based femtocell service. Gateways provide crucial handoff capabilities to ensure

reliable, high-quality performance as femtocells are introduced to the mobile environment.

- *Service Delivery.* Operators must also consider questions of bandwidth distribution, availability, and other service delivery issues. As operators move towards converged fixed/mobile networks, next-generation gateways provide the functionality needed to meet service delivery guarantees.
- *Scalability.* To accommodate the rapid growth of mobile devices in the network, operators should use gateways that support an unlimited number of femtocell tunnels. Gateways should provide linear scalability of capacity, efficient load distribution, and carrier-grade redundancy.
- *Femtocell Management.* Gateways also provide important femtocell management by serving as the first point of contact between the device and the network. As the femtocell “controller”, the gateway performs polling and data collection functions, which allows operators to monitor the security and performance of a femtocell network.
- *IMS Evolution.* Operators will need SIP-aware capabilities as they deploy IMS, SIP-based and pre-SIP services. Gateways can deliver robust application awareness, while opening an economic pathway to IMS evolution.

Summary

Femtocells promise a number of measurable benefits to consumers, including the ability to receive high quality voice and data services in indoor locations. Femtocells can advance the use of the mobile device as an always-on, always-present communications device, irrespective of the subscriber's location. Subscribers should also see improved mobile data speed and performance, which translates directly into faster access to mobile services and multimedia content -- and they can do this without the need to make changes to their existing mobile handsets.

Femtocells also deliver significant advantages to operators. They reduce the CapEx and OpEx needed in 3G build-outs as well as reduce backhaul costs, making operators more competitive. Femtocells enable operators to quickly reduce mobile network congestion, while extending indoor coverage and enhancing macro-cellular coverage. Operators can also use femtocells to offer attractive service bundles and drive 3G service uptake by delivering low-cost, high-performance mobile data capabilities.

Security Gateways and Packet Access Gateways are components that are used in the RAN Gateway and other femtocell network approaches. Because femtocells typically use the public Internet for backhaul of the femtocell's voice and data traffic, the operator's mobile core is opened to risk. The Security Gateway manages these communications on secure tunnels over IP, providing user authentication, registration, and authorization, as well as mobility management and QoS/policy enforcement. Packet Access Gateways effectively concentrate femtocells into the mobile core and provide media and signaling conversions to ensure high quality communications between the various network borders in 2G and 3G networks.

When employing Security Gateways and Packet Access Gateways into their networks, mobile operators should be sure that they have these capabilities in order to flexibly meet the growth and quality requirements anticipated for femtocell networks:

- Scalability: to enable large scale, high volume femtocell deployments
- Multifunctional Platforms: to limit the number of network elements
- Carrier Class Gateways: with full redundancy and high availability
- Open Standards and IMS compliance: to ensure that these new elements are long-lived in the network
- Deployment Flexibility for Centralized or Distributed topologies

About GENBAND

GENBAND is a market leader and pioneer in connecting, securing, and enabling efficient communications between network borders. The company's carrier class line of gateway and security products provide interconnection and migration solutions at the borders of circuit and IP networks, as well as advanced security and session management at the borders where IP networks meet.

GENBAND's G9 Converged Gateway is an integrated part of numerous 3GPP, standards-based femtocell solutions, enabling the secure transport of femtocell calls over broadband access networks and into the mobile core. The G9 platform lowers operating and capital costs of femtocell solutions by uniquely combining the media adaptation and signaling gateway functionality into one system.

A pioneer in security products for network operators, GENBAND offers its S-Series security platforms, including the S2 and S9 Integrated Border Gateways. These platforms provide industry-leading Security Gateway capabilities for the most scalable femtocell deployments, supporting up to 1.2 million femtocell tunnels in a single system.

About the Author

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