Winning the race for the home with 3G femto

Nokia Siemens Networks

1. Executive summary

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3G and mobile Internet access have become mass-market commodities with the arrival of countless user-friendly handsets, attractive applications, and mobile broadband-enabled networks. And fixed-mobile convergence is heating up the battle for the home as Internet service providers (ISPs) and cable, fixed, and mobile network operators (MNOs) vie for a bigger share of household spending on telecommunications and media content.

MNOs entering the fray already own the high ground. Their position is unique: They provide a ubiquitous and personal service experience based on ownership of licensed spectrum, and they exercise considerable control over the user's most personal device, the mobile phone. To capitalize on this vantage point, MNOs need a way of ensuring excellent 3G radio coverage and capacity where the device is used most, at home and in the office.

In contrast to conventional indoor coverage solutions for large public and office buildings, 3G femtocells are mass-market and consumer-friendly because they afford the kind of plug-and-play access people have come to appreciate with residential broadband. A smart 3G femto solution would site this dedicated low-power radio cell right there in the home, connecting to the network via whatever residential broadband access is available. Users would enjoy excellent 3G service in their homes. The same goes for enterprises: The operator could site cellular capacity close to the user, at spots where it is needed most. Fewer users would share the given macrocell's capacity, reducing potential congestion in macro networks and improving the user experience.

Volume and price points, key considerations for any mass-market proposition, have to be right to make 3G femto home access fit for wide public consumption. This requires a common and open architecture that is inclusive enough to provide a broad base for mass-market 3G Femto customer premises equipment. The good news is that this architecture exists: Based on the 3GPP standard Iuh interface to the core network and featuring a new network element, the Femto Gateway, it provides the underpinning for the Nokia Siemens Networks 3G Femto Solution. Independent of the macro radio access network and very compact yet highly scalable, this solution is easily rolled out with negligible impact on the legacy radio and core network's operations.

Nokia Siemens Networks' commitment to an open market for 3G Femto customer premises equipment (CPE) runs deep. The company's certification program for CPE suppliers aims to ensure hassle-free deployment.

2. A wave of indoor solutions driven by mobile data

Once the cellular technology of choice for business and tech-savvy users, WCDMA has spilled over to the consumer mass market with a splash created by the impact of so many 3G mobile phones hitting the market. In fact, WCDMA/HSPA-powered mobile broadband has become so popular that some MNOs have had trouble coping with the exploding data traffic and demand for signaling capacity sparked by always-on applications.

People use mobile data most often indoors, predominantly at home and then at the office. This has triggered a second, more data-centric wave aimed to improve cellular coverage and capacity in buildings. The first voice-focused wave peaked with efforts to incorporate 3G in large facilities accommodating many mobile phone users, and extend macro coverage. Distributed Antenna Systems (DAS) tailored to the needs of each site now provide coverage at airports, shopping malls, large hotels, and office buildings. But it takes careful planning and painstaking integration into the overall radio access network to ensure demanding business users enjoy service that is always available. Planning, installation, and equipment costs are steep, so distributed antenna systems are infeasible for anything but larger buildings. A customer seeking a solution for a smaller building was left without a viable option. What's more, with macro cell performance demands and costs raising sharply, the smart move would be to lighten macro cells' load by diverting traffic to smaller cells.

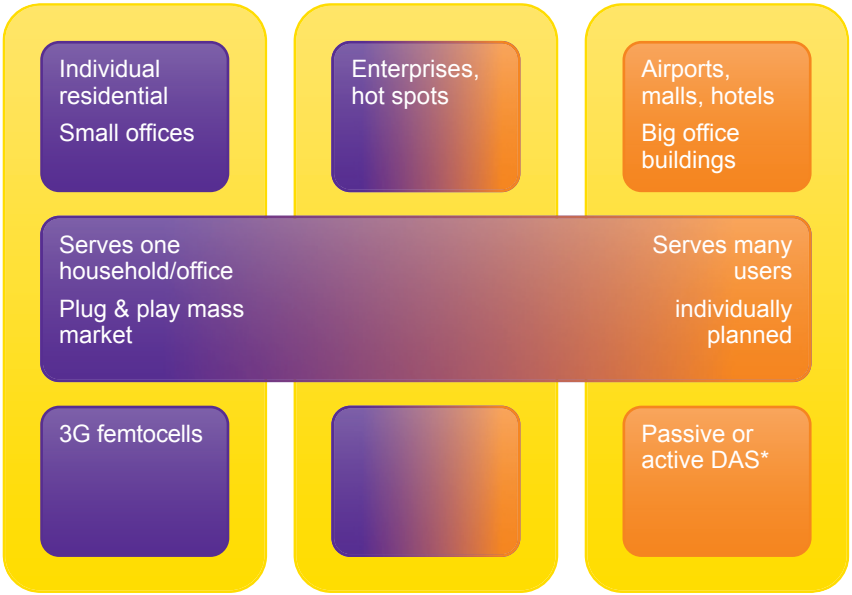

Figure 1: Femtocells. Data driven wave of indoor coverage. * Distributed Antenna System

With 3G making major inroads into the consumer market, MNOs must find a way to treat users to the benefits of a genuine 3G experience wherever they may be, especially at home where they spend so much of their time. Many phones do not support WiFi, so it has to be a 3G air interface to reach all 3G phone users. The success of any bid to transition the consumer segment from a voice-centric 2G business model to a voice-plus-data model hinges on 3G service quality at home. 3G WCDMA spectrum is often allocated at relatively high frequency bands, so in-building environments tend to pose signal propagation challenges. On top of that, 3G WCDMA mobile broadband has grown so popular that many users share the same macro cell and use lots of its capacity. In such instances, the outside macro cell tasked to provide indoor coverage is often unable to deliver the service quality users expect. The straightforward solution to this problem is to place a small, low-output power base station, now commonly called a femto access point or femto CPE, in the residential building. This could take the second wave of indoor coverage improvement to millions of households, if vendors, operators, and suppliers join forces to create a cost-efficient, mass-market focused approach to 3G femtocells.

One of femtocells' greatest benefits is the very low cost of installation and maintenance. To take advantage of this benefit, the operator must entrust the consumer with femto CPE's installation and operation, much in the way of the precedent set with WLAN access points and DSL routers. So setup has to be a plug-and-play drill for this second wave of enhancing indoor coverage with 3G femtocells is to succeed. And in this case, what goes for consumers also applies to businesses: The advantages of femtocells for in-building coverage are undisputed, as is the need to add network capacity closer to where it is going to be consumed. Many smaller business buildings lack conventional DAS systems, so the enterprise segment will also be welcoming the femtocell.

3. Bringing the best value to consumers' homes

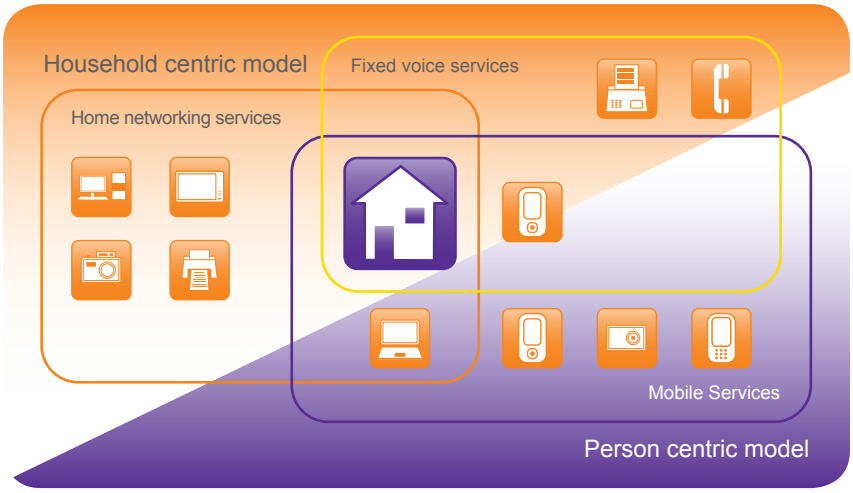

Figure 2: The battle for the home

A fixed line phone, an audio player, a radio, and a TV – for decades, that was pretty much the extent of household telecommunications and media entertainment. Broadband access changed the rules of the game by factoring the Internet, telephony, music, and video into the communication and entertainment equation. The battle for the home was underway. Seeking to increase their share of households' overall telecom and media expenditure and boost subscriber loyalty, operators and ISPs rolled out triple-play offerings. Then mobile subscriptions were added to create the quadruple-play package.

MNOs began offering special home zone rates to edge out conventional voice services. Recently, they rolled out residential, DSL-based broadband packages. Generally, all of a household's members share DSL lines. Stepping away from the mobile subscriptions centered on an individual and moving towards a household-centric approach, this constitutes an engaging new business model. This collective residential broadband subscription includes personal mobile service, which appeals to and could win over all members of a household. Experience teaches that the churn rates for multi-service subscribers are much lower than for people who subscribe to a single service. The Internet is also changing from a relatively static data repository to the dynamic Web 2.0 that invites user participation. User-generated content, social networks, and virtual worlds capture users' imaginations. The dynamic, participatory nature of Web 2.0 is inspiring – users want to be "always on". Mobile broadband and multimedia phones allow users to not only take pictures and record videos, but also post these images immediately on the web. Mobile Internet access takes the web out of cyberspace, puts it into users' hands, and plants it firmly in their real-life experience. More people will track the latest news from their friends; some will stay connected always with their alter-egos in virtual worlds and online games. The mobile phone, the user's most personal device, is always at hand, and when convenience, spontaneity, and speed matter, its small screen will rival the laptop or PC for the Internet access means of choice.

Nokia Siemens Networks has predicted that by 2015, five billion people will be connected to the Internet. For many of these people, the only access option will be a mobile network. If this prediction proves even remotely accurate, the format of Internet applications' content, the user interface, and mobile phones will surely evolve to provide an even more satisfying Internet user experience.

The mobile phone is the perfect personal media player, and more people are reaching for it first when they wish to enjoy music. Why would a user boot a computer, download a tune, and then upload it to a mobile phone when downloading music straight to the handheld device is so much faster and more convenient? The answer is he or she wouldn't, and music downloads will further drive broadband demand.

Statistics on consumer behavior reveal that more people are using their mobile phones at home more often, even if they own a fixed-line phone. The rationale for this behavior is simple convenience. Callers want to get in touch on the first try, so they will dial a person's mobile phone first. And its phonebook is so handy that people will connect straightaway by speed-dialing the number rather than looking it up and dialing it on the home phone. The other reason is privacy: While wireline and cordless phones are usually shared among household members, the mobile phone is a personal device.

If the trend of using mobile phones at home for voice calls and the appeal of Web 2.0 are anything to go by, people at home will surely be dialing up the Internet far more often on their mobile phones. It is unlikely to supplant the laptop or PC, but it will become the preferred device for many applications. SMS is the means of choice for simple and effective messaging, and the same reasoning could make the mobile phone the go-to device whenever the need to input text is reasonable, graphical output is limited, and ubiquitous reach is valued. This affords MNOs an excellent opportunity to differentiate their fixed-mobile convergence offerings.

4. Gearing MNOs up for the race for the home

MNOs have a lot going for them. Their ability to deliver mobile voice services is unrivaled because the licensed spectrum ensures the reliability and quality of service. Also unmatched is the value proposition of providing service that is available, always and everywhere. Their business expertise in maintaining subscriber-centric relationships is unique. And their aptitude for effectively managing users' most personal device, the mobile phone, is a key success factor. Now, with the emergence of mobile broadband for consumers, MNOs have an opportunity to attain a similar vantage point in mobile Internet access. They can make the most of mobile broadband services' always-connected characteristics to cater to the mobile phone's always-on nature. Users get to enjoy a new Internet experience wherever they go, instantaneously, and without having to boot a computer for a peek into the Web 2.0 world.

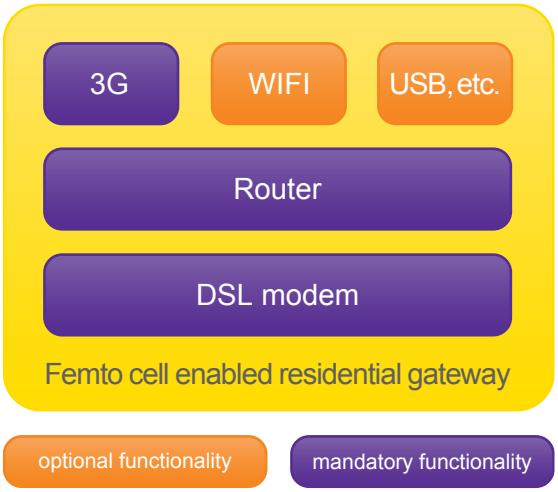

Figure 3: 3G Femto cell CPE / Modular extension of the residential gateway

To capitalize on these strengths and opportunities in the battle for the home, MNOs are compelled to provide excellent voice and broadband service quality everywhere. They must deliver a 3G-quality experience that rivals fixed-line offerings and works seamlessly with legacy 3G and GSM/EDGE networks. With much the same look and footprint as DSL CPE, 3G femtocell CPE connects to the 3G network via existing residential broadband connections. The same device, depending on make, may also feature a DSL or cable modem for Internet connections, an Ethernet router for the home or office network, WiFi radio, USB ports, and so on.

Many different femtocell-specific applications are making their way to the market. They exploit the femtocell's ability to detect the presence of household members – or more accurately, the handsets in their pockets – to enable location-based messaging. For example, so Johnny gets Mom's message when he comes home from school, or Dad gets a text message at work when Julie has made it safely home. Such applications can also facilitate interconnectivity between the handset, the femto CPE, and the rest of the home network, ensuring data flow smoothly between home devices and making the handset a universal home network controller.

The same factors that made conventional residential gateways such as DSL CPE a success on the mass consumer market matter here. For operators to meet the different user segments' needs, the CPE offering has to be varied enough to provide a choice of functions and features such as added LAN and WiFi interfaces, USB interfaces, or printer pool support. And delivery channels and support logistics with mass-market capability must be in place. If an MNO is to base his home access strategy on a 3G femto solution, it must be built on an open architecture that supports a wide range of CPE. The operator will only be able to keep pace with the rapid development in femtocell access point technology and applications if his CPE supply options remain open.

5. Optimizing network architecture for 3G femtocells

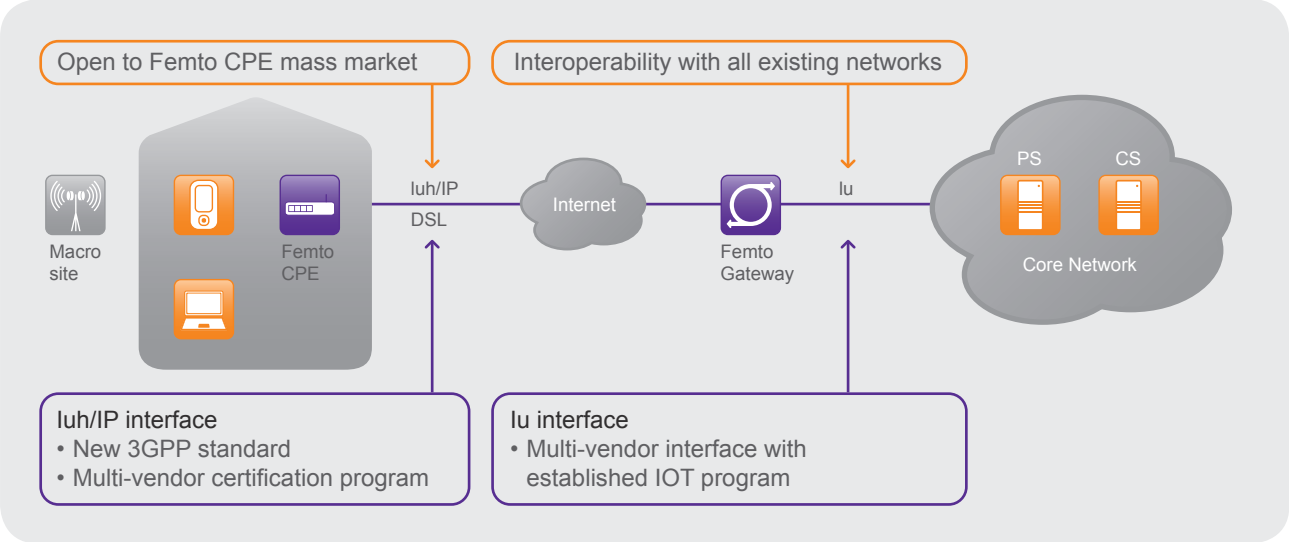

Figure 4: Open and interoperable solution architecture

For the home or small enterprise user, the first encounter – installing the CPE – sets the tone for their 3G femto home access experience. Setting up other residential gateways was an exercise in convenience, and users expect nothing less than plug-and-play installation from the new femtocell equipment. It may be connected to a separate DSL router, but operators would do well to spare the user the added complexity. An integrated CPE that encompasses the 3G femtocell, DSL router, and all other interfaces to the home network is surely more user-friendly. Chances are it would also better support an integrated services strategy – one box and one provider for all the communication services the consumer could want. Of course, each operator's CPE strategy will depend on the target segment and installed base of legacy devices.

Again, operators must be able to use multiple vendors' femto CPE to serve different customer segments, enjoy freedom of choice, or simply benefit from competitive sourcing. This means the interface between the femto gateway and CPE must also be standard. 3GPP settled on a standard for this interface in 2009 with Release 8. Based on the existing 3GPP Iu standard, the new Iuh – the h stands for home – interface has been optimized for femtocell use. The new standard's big technological benefit is that its network architecture is flat. Much of the signaling in conventional 3G macro networks across base stations and RNCs now takes place within the femto access point. The 3GPP standard also defines authentication, security, and management mechanisms to facilitate multivendor CPE interoperability in 3G femtocell networks.

3GPP's next goal is to enhance femtocells' mobility. Residential and small office use cases are largely stationary, so benefits from comprehensive mobility support are marginal. However, larger enterprises with multiple femtocells require standards-based mobility support.

Every household and small enterprise in the network has its own CPE. It takes a highly scalable grooming function between CPE and the core network to handle so many devices. Tens of thousands of CPE units need to be connected via one aggregation point to the core network. The 3G femto solution must ensure the same CPE may be used throughout the network. In other words, it may not be restricted to the macro radio access network regions supplied by a particular vendor. Consequently, the 3GPP standard defines a new femtocell-specific grooming point to be used for this purpose, the femto gateway with 3GPP standard Iu interface to the PS and CS core. The femto gateway must support both ATM- and IP-based Iu interfaces to assure interworking with all core network implementations.

6. The Nokia Siemens Networks 3G Femto Solution

The sharp rise in data traffic has triggered a trend towards flat architecture in mobile broadband networks. The idea here is for user-plane traffic to pass through the fewest possible network nodes. This boosts performance and makes it easier to scale the network to accommodate rising traffic volume. Nokia Siemens Networks has led the way towards flat network architecture in the packet-switched domain of 3G with its I-HSPA (Internet-HSPA) solution, which moves RNC functionality into the Node B. The packet-switched core network's user-plane functions are concentrated in the GGSN. I-HSPA is standardized in 3GPP, Release 7. These two nodes interface via Iu-ps. LTE is built on the same type of architecture.

The 3G femto home access architecture outlined above works well with today's WCDMA networks, and it fits neatly into the simplified network architecture of tomorrow's mobile broadband networks. Improved coverage, lighter network loads, and the potential for outstanding service bundles make 3G femto home access a very attractive proposition. It can underpin a strategy aimed to prevail in the battle for the home or win enterprise customers. And it presents MNOs with a new way of doing business. The CPE is a consumer mass market device, and not part of the operator-owned network infrastructure. Analysts from ABI Research, Infonetics, and Dell'Oro predict that this market could reach forty to sixty million units by 2014.

Nokia Siemens Networks understands that MNOs need a complete solution for 3G femtocells that provides a variety of options for 3G femto CPE and ensures hassle-free end-to-end interworking. Based on the open architecture outlined in this paper, the Nokia Siemens Networks 3G Femto Solution satisfies this need. The company's Femto Gateway is highly integrated and extremely compact, yet scalable enough to deploy the solution in all 3G network environments, from small trials to large scale rollouts.

The provisioning system offers multiple interfaces to operators' customer data systems, making zero-touch femtocell auto-configuration easy.

The Nokia Siemens Networks management system for this solution readily integrates into the macro network management system, thereby driving down operating expenditures. The company has considerable expertise in mobile radio and core networks as well as in residential broadband access networks. The company is in the unique position of being able to delivery network integration and support services to every part of the world. A driving force in femtocell industry standardization, it has a stake in 3G femtocells and LTE's success, as its membership in the Femto Forum Board attests. Its pioneering efforts help set standards in 3GPP and the Broadband Forum, and ensure interoperability through the Network Vendors' Inter-Operability Forum.

Deeply committed to an open 3G femto CPE market, Nokia Siemens Networks runs a certification program for CPE suppliers to ensure interoperability and the compatibility of femtocell CPE and networks. Underpinned by painstaking R&D, close collaboration, and rigorous testing, this program also addresses operation and maintenance concerns. Certified CPE devices from leading femtocell and residential gateway providers are available now. Also, a number of agreements with further companies, and joint efforts to extend the range are underway.

Working closely with these distinguished companies, top network operators, and standardization bodies, Nokia Siemens Networks has turned up a solution that combines innovative features, utmost convenience, and hassle-free operation to the MNOs' best benefit. This 3G Femto Solution empowers MNOs to bring to users' homes and offices a 3G experience without precedent.

Glossary

ADSL	Asymmetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
CPE	Customer Premises Equipment
DAS	Distributed Antenna System
DSL	Digital Subscriber Line
HSPA	High-Speed Packet Access
I-HSPA	Internet HSPA
IOT	Inter-Operability Testing
IP	Internet Protocol
LAN	Local Area Network
LTE	Long Term Evolution
cs	circuit-switched
ps	packet-switched
UMTS	Universal Mobile Telecommunications System
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

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