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FEMTOCELL TECHNOLOGY

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ABSTRACT : *This is a survey paper on the recently developed and rapidly evolving field of femtocells. Quite often, it is noticed that cell-phone signals are strongly attenuated, when indoors, leading to call dropping or poor call quality. Femtocells are mini base stations that are deployed in users' homes so that the user can directly connect to the cellular network through the femtocell instead of the outdoor macrocell, thereby increasing call quality. In the later stages of the paper, we also discuss the integration of the femtocell into the 3Garchitecture, as well as the various interference issues that the femtocell faces. This paper presents the installation and use of femtocells, as well as the problems one may encounter during this process. It also offers a technical solution, with its basic characteristics and the possibility of realization at a particular location, illustrated by the example of a telecomunications provider.*

1. INTRODUCTION

1.1 Introduction

"Can you hear me now?" was a popular phrase for a while amongst people who were mocking the poor sound and coverage of their mobile phones. Although it turned into something of a joke, it's no laughing matter when your cell phone suddenly loses its ability to allow you to enjoy clear communication. Unfortunately, this is often the case in homes and buildings where coverage decreases considerably as soon as you go indoors. Since more and more people are ditching their landlines in favor of mobile phones, as well as because of the simple fact that people want to be able to talk on their cell phones wherever they are, it has become necessary to work on new technology that will facilitate calling coverage both indoor and outdoor. Femtocell technology could be the answer. In addition to facilitating better indoor call coverage, this emerging technology reduces the drain that advanced mobile services (such as mobile broadband) are placing on the capacity offered by phone companies.

One of the solutions that people have started to use is femtocell technology. This technology may be better known to the user as an Access Point Base Station, a small device which is installed in the home or office in order to offer better support to mobile phones there. These base stations can accommodate up to five cell phones which means that you can get increased coverage for your whole household. Essentially, you set up the femtocell technology in your home and it serves to enhance the cell phone signal that you receive indoors so that your call quality isn't decreased when you're talking indoors. Now many operators such as AT&T, Sprint and Verizon in USA, Vodafone in UK are providing Femtocell service.

Definition of femto cell: "Femtocell" is a wireless access point that improves cellular reception inside a home or office building.''

A femtocell is a miniature cell tower for homes or small businesses that extends a carrier's traditional network's range. Femtocells connect to a carrier's network over the customer's broadband internet connection and provide a strong local signal that cell phones in the building can use for any of the typical voice or data applications. Femtocells require carrier support in order to be of any use. The Samsung Ubicell1 (Sprint Airave) is an example of a commercially available femtocell.

Femtocells were originally called access point base stations. The term was derived from cell and "femto," a metric prefix that stands for 10^-15th, or one-quadrillionth, six orders of magnitude smaller than nano. The development of femtocells is credited, in part, to the work of a skunk works team at Motorola in the UK, where they created the world's smallest full power UMTS base station.

In telecommunications, a femtocell is a small cellular base station, typically designed for use in a home or small business. It connects to the service provider's network via broadband (such as DSL or cable); current designs typically support 2 to 4 active mobile phones in a residential setting, and 8 to 16 active mobile phones in enterprise settings. A femtocell allows service providers to extend service coverage indoors, especially where access would otherwise be limited or unavailable. Although much attention is focused on WCDMA, the concept is applicable to all standards, including GSM, CDMA 2000,TD-SCDMA,WiMAX and LTE solutions.

1.2 Need of FEMTOCELLS

Third-generation cellular technology suffers from inadequate indoor-signal penetration, leading to poor coverage in the environment where consumers spend two-thirds of their time. Poor coverage diminishes the quality of voice and video applications, and slows down high-speed data services. To keep customers satisfied, 3G carriers have increased capacity by building additional microcell sites. This strategy is becoming much less attractive. Site acquisition costs are exorbitant and continue to mount as space on viable towers and buildings fills up, landlords exact high rents and regulators impose onerous permit requirements. Public opposition to the building of large-scale base stations is increasingly common.

The idea of small cells has been around for nearly 3 decades. Initially, "small cells" was a term used to describe the cell size in a metropolitan area, where a macrocell (on the order of kilometers in diameter) would be cell split into a number of smaller cells with reduced transmit power, known today as metropolitan macrocells or microcells, and having a radius of perhaps several hundred meters. Simultaneously, cellular repeaters or "boosters" were being investigated , as an alternative to small base stations. These re-radiating devices were intended to help improve the signal quality in poor coverage regions, while reducing costs by not requiring a wireline backhaul. However, their reuse of the licensed spectrum for backhaul limited the achievable throughput, and hence these repeaters were neither helpful to the system capacity nor simple to deploy.

In the 1990s, a precursor to cellular picocells began to appear with cell sizes ranging from tens to about one hundred meters. These "traditional" small cells were used for capacity and coverage infill, i.e. where macro penetration was insufficient to provide a reliable connection or where the macrocell was overloaded. These types of small cells were essentially a smaller version of the macro base station, and required comparable planning, management and network interfaces. More similar to the current femtocell concept was a little known industry project in the early 1990s led by Southwest Bell and Panasonic to develop an indoor femtocell like solution that re-used the same spectrum as the macrocells and used wired backhaul (T1 or PSTN). However, there was a lack at this time of ubiquitous IP backhaul, and the level of integration had not yet achieved the critical point where a base station could be truly miniaturized. Like the other small cell technologies just mentioned, they were technically a step forward but economically unsuccessful, because the cost of deploying and operating a large number of small cells outweighed the advantage they provided.

Acquiring a site is only half the battle: Sophisticated base station equipment must then be purchased, installed, insured, operated and maintained. The net present value of a cell site in the U.K. is estimated to be $500,000. Carriers thus face a serious dilemma Well it's clear more and more consumers want to use mobile phones in the home, even when there's a fixed line available. Friends and family usually call a mobile number first, and it's where messages and contact lists are stored.

However, it is often the case that providing full or even adequate mobile residential coverage is a significant challenge for operators. From a competitive perspective, femtocells are important because mobile operators need to seize residential minutes from fixed providers, and respond to emerging VoIP and WiFi offerings.

Improving user experience in the home is also essential for reducing churn and gaining market share and new revenues. However, high deployment costs ensure that 3G networks rarely extend beyond the regulatory minimum. Using femtocells solves these problems with a device that employs power and backhaul via the user's existing resources. It also enables capacity equivalent to a full 3G network sector at very low transmit powers, dramatically increasing battery life of existing phones, without needing to introduce WiFi enabled handsets.

1.3 The Birth of Modern Femtocells :

New thinking on the deployment and configuration of cellular systems began to address the operational and cost aspects of small cell deployment. These ideas have been applied successfully to residential femtocells where cost issues are amplified. A femtocell is fundamentally different from the traditional small cells in their need to be more autonomous and self-adaptive. Additionally, the backhaul interface back to the cellular network – which is IP-based and likely supports a lower rate and higher latency than the standard X2 interface connecting macro and picocells – mandates the use of femtocell gateways and other new network infrastructure to appropriately route and serve the traffic to and from what will soon be millions of new base stations.

Perhaps more important than the need to provide cellular coverage infill for residential use, the mobile data explosion. The most viable way to meet this demand is to reduce the cell size and thereby the spatial frequency reuse, unless the plentiful (and inexpensive) frequencies in the tens of GHz can be harnessed for mobile broadband, which is extremely challenging. In parallel to the escalating data demands, several technological and societal trends have made low-cost femtocells viable. These include the wide availability and low cost of wired broadband internet connections; the development of 4G cellular standards that are OFDMA and IP-based and provide a better platform for femtocell overlays than 3G CDMA (near-far problem) networks that are circuit switched (the femtocell backhaul is inherently IP); and relentless hardware and software integration has made it foreseeable to have a fully functional low power base station in the $100 price point range.

Small cells have recently become a hot topic for research as evidenced by a significant increase in publications in this area, and small cell technology has advanced a great deal from the simple cell splitting ideas presented in. For example, the number of publications including femtocell or femtocells in the topic registered in the IEEE data base have increased from 3 in 2007 to 10 (2008), 51 (2009), 116 (2010), and continues to accelerate. In addition, the European Union has started funding research on femtocells, for example the ICT-4-248523 Be FEMTO project, which focuses on the analysis and development of LTE/LTE-A compliant femtocell technologies. Today, advanced auto-configuration and self-optimization capability has enabled small cells to be deployed by the end-user in a plug-and-play manner, and they are able to automatically integrate themselves into existing macrocellular networks. This was a key step to enable large scale deployments of small cells.

As a result we have now seen successful commercial femtocell deployments. In the US, Sprint Nextel started their nationwide femtocell offering in 2008, with Verizon and AT&T following suit in 2009 and 2010, respectively. In Europe, Vodafone started their first femto deployment in 2009 in the UK, and subsequently other countries. In Asia, Softbank mobile, China Unicom, and NTT DoCoMo launched their femtocell services in 2009. According to the Femto Forum, operator deployments grew by 60% in the second quarter of 2011 to 31, including eight of the top 10 global mobile operator groups.

2.OVERVIEW OF FEMTOCELL

2.1 Concept of Femtocell

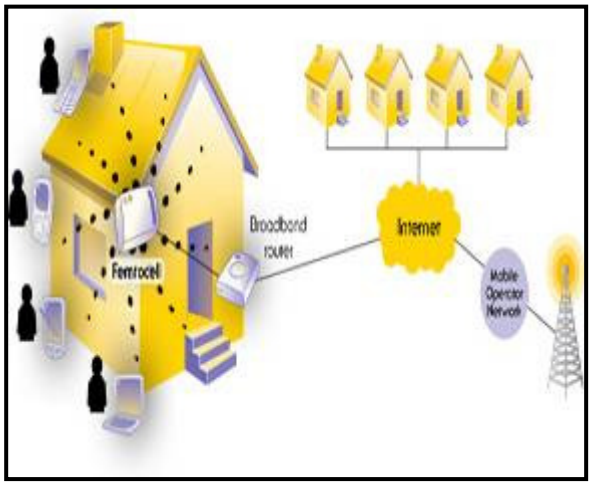

Fig. 2.1 Femtocell Concept

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. A femtocell is a very small base station. So small, infect that can be placed in a customer's residence as shown in fig. 2.1. The femtocell unit generates a personal mobile phone signal in the home and connects this to the operator's network using standard broadband DSL on Cable service and typically supports 2 to 5 mobile phones in a residential setting. This will allow improved coverage and capacity for each user within their home.

2.2 Network Architecture

Connecting femtocells to existing operator networks requires a network architecture that addresses the security needs of operators and mobile users as shown in fig.2.2, while supporting the scalable deployment of millions of femtocells. In addition, it must allow ordinary consumers to install them with plug-and-play simplicity and ensure that critical services such as emergency calling are also supported with the same reliability and accuracy as fixed-line emergency calling. The femtocell network architecture describes the major nodes and connections in a femtocell network, and how they

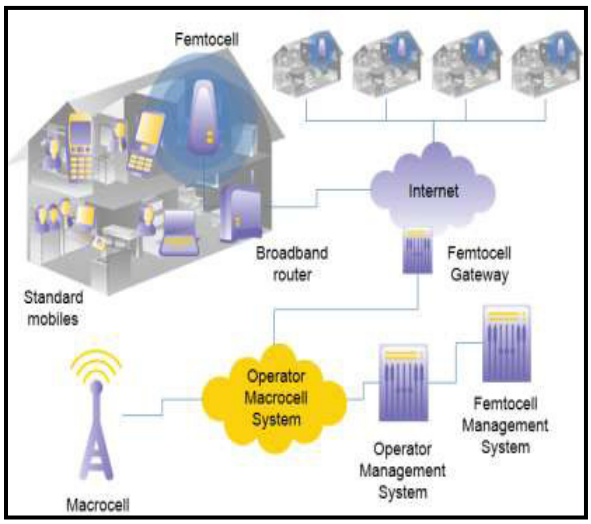

Fig.2.2FemtocellArchitecture

achieve the objectives of mobile subscribers and operators. The femtocell network architecture supports the following key requirements:

- **Service Parity:** Femtocells support the same voice and broadband data services that mobile users are currently receiving on the macrocell network. This includes circuit-switched services such as text messaging and various voice features, such as call forwarding, caller ID, voicemail and emergency calling.
- **Call Continuity:** Femtocell networks are well-integrated with the macrocell network so that calls originating on either macrocell or femtocell networks can continue when the user moves into or out of femtocell coverage. Femtocell network architecture needs to include the necessary connectivity between the femtocell and macrocell networks to support such call continuity.
- **Security:** Femtocells use the same over-the-air security mechanisms that are used in macrocell radio networks. But additional security capabilities need to

be supported to protect against threats that originate from the Internet or through tampering with the femtocell itself. Femtocell network architecture provides network access security, and includes subscriber and femtocell authentication and authorization procedures to protect against fraud.

- **Self-Installation & Simple Operational Management:** Femtocells are installed by end-users. Therefore, the femtocell network architecture must support an extremely simple installation procedure with automatic configuration of the femtocell and automated operational management with "zero-touch" by the end-user.
- **Scalability:** Femtocell networks can have millions of access points. Therefore the femtocell network architecture must be scalable to grow into such large networks, while at the same time maintaining reliability and manageability

2.3 Working of femtocell

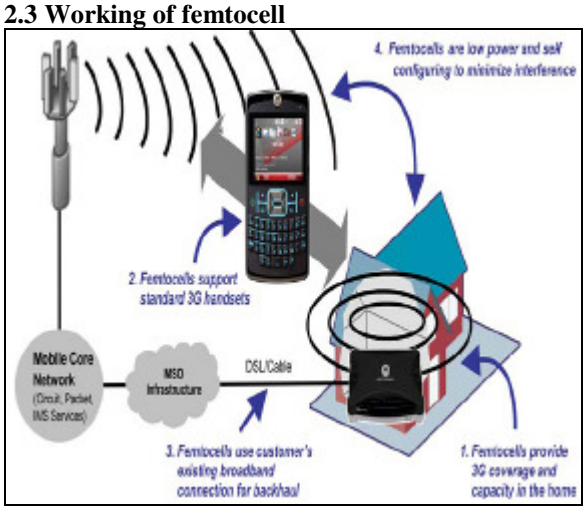

Fig.2.3 Working of Femtocell

Femtocells are sold by a Mobile Network Operator (MNO) to its residential end-users or enterprise customers. A femtocell is typically the size of a residential gateway or smaller, and connects into the end-user's broadband line. Integrated femtocells (which include both a DSL router and femtocell) also exist. Once plugged in, the femtocell connects to the MNO's mobile network, and provides extra coverage in a range of typically 30 to 50 meters for residential and output power — usually 20 mW which is five times femtocells (depending on the existing coverage less than a Wi-Fi router). From an end-users' perspective it is plug and play, there is no specific installation or technical knowledge required anyone can install a femtocell at home.

Femtocell device consists of a radio receiver and transmitter for the connection between the mobile phone and Femtocell device as shown in fig.2.3. It also have an Application Specific Integrated Circuit or Digital Signal Processor to handle the physical connectivity between handsets and Femtocell and between the femtocell and the mobile network. Chip makers design the ASIC or DSP to work with the specific carrier's network. The Femtocell consists a host processor which supports software based task such as security, encryption, and connectivity to the broadband network via Internet Protocol, or technologies such as the Dynamic Host Configuration Protocol as shown in fig.2.4.

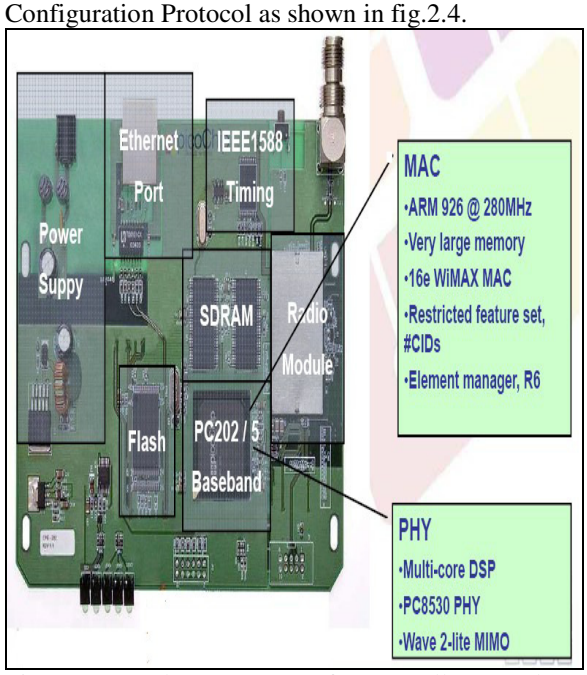

Fig.2.4 Internal components of Femtocell Network

The end-user must then declare which mobile phone numbers are allowed to connect to his/her femtocell, usually via a web interface provided by the MNO. This only needs to be done once. When these mobile phones arrive under coverage of the femtocell, they switch over from the macrocell (outdoor) to the femtocell automatically. Most MNOs provide means for the end-user to know this has happened, for example by having a different network name appear on the mobile phone. All communications will then automatically go through the femtocell. When the end-user leaves the femtocell coverage (whether in a call or not), his phone hands over seamlessly to the macro network. Femtocells require specific hardware, so existing WiFi or DSL routers cannot be upgraded to a femtocell.

Once installed in a specific location, most femtocells have protection mechanisms so that a location change will be reported to the MNO. Whether the MNO allows femtocells to operate in a different location depends on the MNO's policy. International location change of a femtocell is not permitted because the femtocell transmits licensed frequencies which belong to different network operators in different countries.One of the key elements of the femtocell configuration occurs at the first start up when the femtocell equipment is being installed. It is essential that this operates smoothly for the concept to gain acceptance by the user. After acquiring a femtocell the customer should only need to plug the femtocell into the power and connect it to the Internet connection to provide the backhaul connection.

With power applied, the first element of the registration is for the femtocell to register within the

network. When a user makes a call inside the range of Femtocell, the mobile phone uses its radio to connect to the Femtocell. The Femtocell will attempt to gain access to the core network via the gateway. Femtocell is connected to the Security gateway via wired connection to the users broadband, typically DSL or cable. To achieve this it will utilize the femtocell ID - a unique identifier given to the each femtocell. Additionally the operator is likely to have obtained the address where the user will base the femtocell.

The connection between the femtocell and the femtocell host processor uses secure IP encryption (IPsec), which avoids interception. Additional functions are also included such as some of the RNC (Radio Network Controller) processing, which would normally reside at the mobile switching centre. Some femtocells also include core network element so that data sessions can be managed locally without needing to flow back through the operators switching centre (local break out).

The extra capabilities of a femtocell demand it to be self-installing and self-configuring. This requires considerable extra software which scans the environment to determine the available frequencies, power level and/or scrambling codes to be used. This is a continuous process to adapt to changing radio conditions, for example if the French windows are opened in a room containing the femtocell.

Within the operator's network, femtocell gateways aggregate large numbers of femtocell connections (typically 100,000 to 300,000) which are first securely connected through high capacity IP security firewalls.

3. BENEFITS AND INSTALLATION

3.1 Features

1) Operates in the licensed spectrum
2) Uses fixed broadband connection for backhaul
3) Principally intended for home and SOHO
4) Lower cost
5) Smaller coverage
6) Smaller number of subscriber

3.2 Benefits

Due to the substantial benefits, femtocell technology is causing quite a "buzz" in the industry.

Research has forecasted that by 2011 there will be 102 million users of femtocell products on 32 million access points worldwide.

1. Better coverage and capacity:

– Due to short transmit-receive distance

- Lower transmit power
- Prolong handset life
- Higher SINR
- Higher spectral efficiency

2. Improved macro reliability:

– BS can provide better reception for mobile users Traffic originating indoors can be absorbed into femtocell networks over Ip backbone.

3. Cost Benefit:

– $60,000/year/macrocell vs. $200/year/femtocell

4. Reduced subscriber turnover:

– Enhanced home coverage will reduce motivation for users to switch carriers.

5. Capacity benefits of femtocell:

– Reduced distance between sender and receiver leads to higher signal strength[capacity improvement]

– Lowered transmit power decrease the Interference for neighboring cells[capacity improvement]

– Femto-AP can devote a larger portion of resource for fewer users.[frequency efficiency]

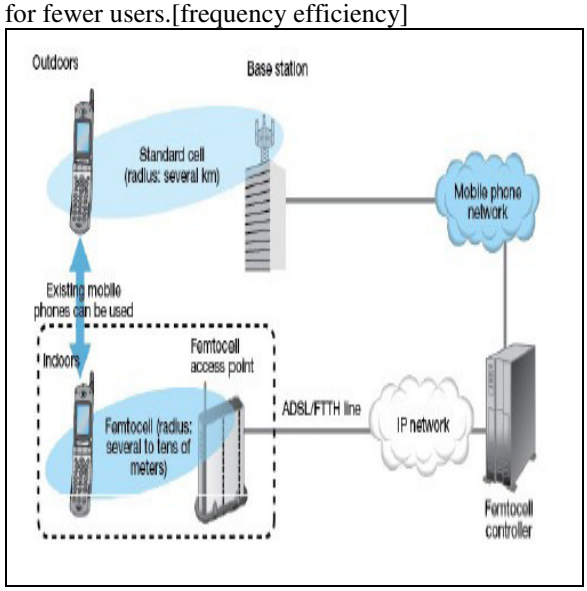

Fig.3.1 Benefits of Femtocell

6. Benefits for end-users:

- Excellent network coverage when there is no existing signal or poor coverage.
- Higher capacity, which is important if the end-user uses data services on his/her mobile phone.
- Depending on the pricing policy of the MNO, special tariffs at home can be applied for calls placed under femtocell coverage.
- For enterprise users, having femtos instead of DECT or Wi-Fi dual
- mode phones enables them to have a single phone, so a single contact list etc.

7. Femtocell Benefits to End Users

- Reduced "in home" call charges
- Improved indoor coverage
- Continued use of current handset
- Reduced battery drain
- One consolidated bill
- Multiple users/lines
- Landline support

8. Femtocell Benefits to Mobile Operators

- Improves coverage
- Reduces backhaul traffic
- Provides capacity enhancements
- Reduces churn

- Enables triple play
- Addresses the VoIP threat
- Stimulates 3G usage
- Captures termination fees
- Allows for multiple users/lines
- Addresses the fixed mobile convergence market with a highly
- attractive and efficient solution.

3.3 Comparison with macrocell

Macrocell is a cell in a mobile phone network that provides radio coverage served by a powerful cellular base station (tower).The antennas for macrocells are mounted on ground-based masts, rooftops and other existing structures, at a height that provides a clear view over the surrounding buildings and terrain. Macrocell base stations have power outputs of typically tens of watts.

To be broadly successful, Femtocells need to perform the same function measured in capacity per square meter—as a macro cell. So, to be successful as a replacement technology, our femtocell would need to deliver the same capacity (voice calls or data bits) per square mile for the same cost. Using a simple example where we only look at basic costs (ignoring other lifecycle costs, such as operation and maintenance), it found that a femtocell could be slightly more cost efficient than a macrocellular network, if it delivered.

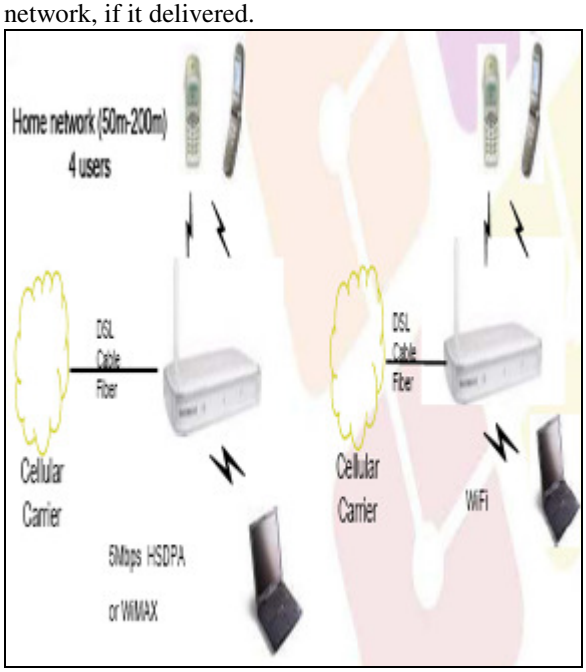

Fig 3.2: Femtocell vs. WiFi

The advanced femtocells do already provide a cell size of 100m radius about the same coverage as modern Wi-Fi. Super femtocells are being designed to provide the higher capacity solution that was needed to serve more than just the Home market.

Femtocell Compared with Wi-Fi Access Point

Since femtocell access point (FAP) is similar to WiFi Access point that provide indoor wireless coverage to mobile phones using existing broadband Internet connections, it is useful to be introduced some points regarding to each device that clarify both of them independently as shown in Fig.3.2

Femtocell access point (FAP):

1. Enables cellular carriers to compete with VoIP, WiFi and UMA (eg Fusion)
2. No need for expensive dual-mode handsets
3. Improves 3G coverage indoors and encourages use of data services
4. Improves capacity
5. Reduces Customer Churn

WiFi:

1. VoIP pricing on calls within the home
2. Single phone for indoor/outdoor calls
3. Provides indoor coverage via WiFi or bluetooth
4. Use dual mode phones in Wi-Fi hot spots.

3.4 Installation

Installation will be simple. In some cases the femtocell will come pre-installed in a home gateway device with other features (for example a DSL modem and WiFi), and you'll simply activate it via a web page. Alternatively, if you already have a home network you will be able to plug in a standalone femtocell. If your operator needs to upgrade the software or settings in your femtocell, this will normally happen automatically without you even needing to be aware.

- **Need of new mobile phone**:

If it's a 3G femtocell, you will need a 3G mobile phone, but any 3G handset will work.

- **Facility of emergency calls**:

In addition, other people in your home could use your femtocell to make an emergency call without needing your permission. But note that femtocells need power and a working broadband connection. If either of these is not working at the time, then you won't be able to make emergency calls through your femtocell. You may still be able to make an emergency call from your mobile phone if you have coverage from a mobile network.

- **Migration:**

Femtocells will normally require authorization from the network operator if they are moved. This is to ensure that the operator has a license to operate in the new location (typically this will not be the case if you go abroad, for example), and to enable emergency calls to be routed correctly.

- **Benefits:**

One other benefit of femtocells is that they help your phone battery last longer indoors. This is because your mobile phone works at a lower power when using a signal from a nearby femtocell.

- **How to Install:**

Femtocells are sold by a Mobile Network Operator (MNO) to its residential or enterprise customers. A femtocell is typically the size of a residential gateway or smaller, and connects to the user's broadband line. Integrated femtocells (which include both a DSL

router and femtocell) also exist. Once plugged in, the femtocell connects to the MNO's.

In most cases the user must then declare which mobile phone numbers are allowed to connect to his/her femtocell, usually via a web interface provided by the MNO. This only needs to be done once. When these mobile phones arrive under coverage of the femtocell, they switch over from the macrocell (outdoor) to the femtocell automatically. Most MNOs provide a way for the user to know this has happened, for example by having a different network name appear on the mobile phone. All communications will then automatically go through the femtocell. When the user leaves the femtocell coverage (whether in a call or not) area, his phone hands over seamlessly to the macro network. Femtocells require specific hardware, so existing WiFi or DSL routers cannot be upgraded to a femtocell.

Once installed in a specific location, most femtocells have protection mechanisms so that a location change will be reported to the MNO. Whether the MNO allows femtocells to operate in a different location depends on the MNO's policy. International location change of a femtocell is not permitted because the femtocell transmits licensed frequencies which belong to different network operators in different countries.

4.APPLICATIONS

4.1 Advantages:

1. Standalone or integrated femtocells

Early femtocell products look very much like Wi-Fi broadband modems, needing only two cables - one for power and one internet connection. Several vendors such as Thomson, Netgear, Pirelli, Cisco and others have integrated the femtocell with other features such as DSL modem, Wi-Fi and even IPTV into a single box. It is expected that in the longer term, most femtocells will be sold in this form.

2. Low power but high quality

Femtocells operate at very low radio power levels - less than cordless phones, Wi-Fi or many other household equipment. This substantially increases the battery life, both on standby and talk time. Since they are so much closer to the handset or mobile device, call quality is excellent and data devices can operate at full speed. Standard units can handle up to 3 or 4 simultaneous calls from different users depending on the model. Larger femtocell designs intended for business (enterprise) use can handle 8, 16 or even 32 concurrent call.

3. Secure and self-managing

The femtocell encrypts all voice and data sent and received from mobile phones and would normally not allow access to the home computer network, so external users cannot break into your computer. In order to reduce cost, these units are self installing and use a variety of clever tricks to sense which frequency to transmit on and power level to use. Unlike outdoor mobile phone base stations (masts), femtocells don't require specialist RF planning engineers to design, calibrate or configure themselves - minimizing the ongoing cost of maintaining them. They do have remote management from the network operator, who can upgrade the configuration and software as required.

4. Doesn't require special phones

They are compatible with existing standard mobile phones, although in future some minor enhancements would allow clear indication of when the phone is using the local femtocell (and thus using a free call allowance) - currently this can be provided by tones at the start of each call.

5. Local Breakout

Femtocells also support a feature known as local breakout, which allows a femtocell user to connect their mobile devices to the local home or office network without traversing the mobile operator's core network. For traffic destined to the global Internet, local breakout also bypasses the operator core network, thus reducing the network load.

6. A Femtocell is used for compensating poor cellular coverage inside the homes – in some places.

7. A Femtocell can also give lower call charges while the caller calling from home, using the Femtocell as it directly connects to the core network through the internet.

8. Some vendors are also planning to incorporate all the three features –Wi-Fi, cellular and DSL into the same box to achieve maximum functionality.

9. The voice calls/data calls through the Femtocells are encrypted and the cell phones automatically switches over to the Femtocells when they come in their range – eg. in homes, where they are installed.

10. Femtocell units can handle up to three or four simultaneous calls, from the same operator, depending on the model. They can operate with normal cellphones, without any enhancements.

11. Femtocell units can help related cellular services like 3G by offering a better speed and data rate when inside buildings, where the coverage and data rate is generally lesser than outside.

4.2 Disadvantages:

1.High price ($300).
2.Difficult to install.(Cabling, roof access etc)
3.Dependent on signal from nearest cell town.
4.Requires broadband connection.
5.More complex to set up, requires a new/different phone number, more potential for errors.
6.It does not provide good coverage in outdoors.

4.3 Applications:

1.DSL Modem

The step is to integrate the femtocell into an existing DSL broadband modem design. No additional external connections are needed – the modem will already have power and data

connectivity, and usually a list of other standard features too. The femtocell module is hardwired into the modem and can be given priority of voice calls to ensure improved performance.

The overall cost of the combined unit is much less than two separate boxes, it is the ease of installation and remote management which benefits this option. Many mobile operators have started offering DSL broadband as an additional service, particularly in Europe. If the additional cost of a combined modem/femtocell is acceptable, then this could be shipped to customers as part of a package.

2.Cable Modem

More households in the USA receive their broadband internet service from their cable TV supplier than from the phone company (as is more common in Europe and elsewhere). The modem can be separate from the TV Set-top box or a combined unit.

This appears to have been discontinued. Although Cable TV companies do own some spectrum (via the Spectrum Co) business, and so could legally launch and operate a rather than traditional mobile phone.

3.The Domestic applications of FEMTOCELL technology in a condensed residential area.

The same characteristics as a crowded shopping centre or CBD may be applied here. Due to condensed living spaces, the demand for cellular network connections and data transfer (for internet etc) is constantly increasing. One cellular tower may be able to handle the majority of the traffic but during peak times it may lag or slow dramatically. Then you also have problems with connecting in some poor coverage areas. This may be due to objects or structures decreasing the signal strength.

3G networks supply high speed internet connections to those using it. It also improves the quality of voice calls over a mobile phone. With the assistance of a cellular provider or an ISP, a Femtocell router or two can be placed in appropriate spots where the load is significantly more. This connection can be paid for through either the strata or Telco Company providing the connection. These routers could easily take the demand and as the cost to purchase and install one is about the same as a domestic wireless router. Condensed living always present problems for telecommunications but it can be overcome by practically apply domestic level products to areas where it is needed the most. This would save the cost of both your back pocket and health of having a second communications tower installed in an attempt to cover the black spots.

4. Poor coverage areas and the application of FEMTOCELL to take the load.

As it says, applying FEMTOCELL to areas such as behind hills, mountain valleys or gullies and areas where a signal would be less than normal. Mountains, gullies and other poor coverage areas could be taken advantage of and with only one or two FEMTOCELL routers could have the same connection quality as an inner city CBD. Smaller remote towns will benefit from this technology if Telco companies choose not to install cell towers in poor coverage areas. Examples can include small remote town businesses or groups of businesses, cattle stations, truck stops and remote highway outlets. As you can see with a landline internet connection any location can become a small domestic

cell tower. Therefore, the major immediate benefit is improving in-house coverage especially in rural regions, since 2G and 3G coverage and capacity for urban users is usually sufficient for in-house coverage.

5.CONCLUSION

5.1 Conclusion

Femtocell technology is still in the early stages of development. Femtocells are now an integral part of the development strategy for cellular telecommunications operators. Not only do femtocells provide additional advantages for users in terms of improved performance within the home, or business office, but they also provide the possibility for additional services and the promise of lower charges. They also offer the change of convergence where a single phone can be used instead of the landline as well as for roaming. For operators they provide a cost effective manner in which they can improve their coverage and gain extra revenue by the provision of additional services. Accordingly the use of femtocells will become a mainstay in the cellular telecommunications road map for the future. Femtocells are on a road to now here. Femtocells have the potential to provide high-quality network access to indoor users at low cost.

Unsatisfactory coverage and the increasing number of high-data-rate application are two driving forces for femtocell development. Potential to provide high quality network access. Provide huge capacity gain. Not likely to be an immediate and outright success. Number of hardware evolutions will probably be needed before form factor, usability and quality of service are adequate.

– Improve coverage
– Provide huge capacity gain

From technical standpoint, some challenges shall be overcome

– New network architecture
– Interference mitigation
– Synchronization
– End-to-end QoS support
– Seamless handover support

5.2 Future scope

By 2012, there will be 36 million shipments with an installed base of 70 million femtocell serving 150 million users.

The femtocell concept, and the considerable research and development that has resulted in early trials of

femtocell technology offers some exciting glimpses of one version of the mobile operator's future network. There is considerable interest in the industry, but a realization that many obstacles need to be overcome before the technology gains widespread success.

Wi-Fi is indisputably the technology for the in-home wireless network. The majority of homes in developed countries already use a Wi-Fi network for Internet access, and multimedia home entertainment devices using Wi-Fi are in mass-production, even though they are still early in the adoption cycle. A number of FMC architectures use the home Wi-Fi access point to deliver the same benefits as femtocells, although this market, too, is in its early stages. But Wi-Fi is already entrenched, has high production volumes, low prices and good consumer acceptance, and is likely to grow in time into this wider role of communicating photos, music, TV and voice around the home. This is the environment the femtocell must penetrate, and it seems a daunting proposition: Wi-Fi already has a significant network effect, and mobile operators must choose whether to be part of that network, or to maintain their separate technology island

Femtocells will change the mobile industry. Operators will use femtocells to build a new generation of lower cost; flat architecture networks that can utilize the Internet as backhaul land deliver expanded capacity for customers. This hybrid mobile network will yield improved platform for new mobile multimedia services, higher revenue, and technology introduction. Femtocells will also change the mobile broadband experience for customers. Excellent wireless coverage in the home will become the norm and not the exception. Femtocells will raise the bar for high performance broadband wireless and customers will expand the utility of mobile broadband devices.

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