1.INTRODUCTION

1.1 Femtocell Overview

Mobile operators have been searching for licensed indoor coverage solutions since the beginning of wireless networks. Unfortunately, the bulk of this opportunity (i.e. residential environments) has been beyond the addressable market for cost and operational reasons. These reasons has triggered the design and development of new cellular standards such as WiMax (802.16e),the third generation partnership project's(3GPP's)High speed packet access(HSPA)and LTE standards, and3GPP2's EVDO. In parallel, WiFi mesh networks are also being developed to provide high-rate data services in a more distributed fashion. Although the Wi-Fi networks will not be able to support the same level of mobility and coverage as the cellular standards, to be competitive for home and office use, cellular data systems will need to provide service roughly comparable to that offered by Wi-Fi networks.

The recent technology is femto cell, the main aim of femto cell is to improve coverage and capacity of a mobile network by allowing service providers to extend service coverage indoors, especially where access would otherwise be limited or unavailable. A femto cell is a very small base station. so small, infect that can be placed in a customer's residence. Femto cells are low-power access points that can combine mobile and Internet technologies within the home. The femto cell unit generates a personal mobile phone signal in the home and connects this to the operator's network through the Internet. This will allow improved coverage and capacity for each user within their home.

2.LITERATURE REVIEW

I Early Origins Initially, “small cells” was a term used to describe the cell size in a metropolitan area, where a macro cell (on the order of kilo meters in diameter) would be cell split into a number of smaller cells with reduced transmit power, known today as metropolitan microcells or microcells, and having a radius of perhaps several hundred meters. Simultaneously, cellular repeaters or “boosters” were being in vest gated as an alternative to small base stations. These reradiating devices were intended to help improve the signal quality in poor coverage regions, while reducing costs by not requiring a wire line 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.

II 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 pico cells – 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 discussed in the Section I has mandated the need for a new cellular architecture with at least an order of magnitude more capacity.

III Modern Femtocell Research There is a growing body of research on femtocells, of which we briefly summarize some notable early results here. ANDREWSet al.: FEMTOCELLS: PAST, PRESENT, AND FUTURE 499 Early simulation results for femtocells were presented by H.Claussen and co-authors at Bell Labs (UK) which were extended to self-optimization strategies and multiple antennas shortly afterward. On the academic side, early work included new mathematical models and analysis by

Chandrasekhar and Andrews, specifically looking at the uplink interference problem in CDMAbased networks with closed access. This model and approach was adapted to the downlink and with multiple antennas. Other early work from UCLA suggested adaptive access control to mitigate the cross-tier interference problem, which was given further attention in Das and Ramaswamy in investigated the reverse link (RL) capacity of femtocells, modeling inter-cell interference as a Gaussian random variable. ISRJournals and Publications Page 118 ISRJournals and Publications Page 118 International Journal of Advanced Research in Computer Networking,Wireless and Mobile Communications Volume: 2 Issue: 3 22-Mar-2015,ISSN_NO: 2320-7248 International Journal of Advanced Research in Computer Networking,Wireless and Mobile Communications Volume: 5 Issue: 3 25-Mar-2015,ISSN_NO: 2320-7248 This work was extended in which developed new analytical techniques to improve the optimization for WCDMA femtocell systems. Several papers have also considered interference coordination in OFDMA based networks, including co-channel interference management.

3.DESIGN

3.1 Femtocell Concept

Defenation

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.

Concept of Femtocell

A femtocell is a very small base station. So small, infect that can be placed in a customer's residence as shown in figure 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.

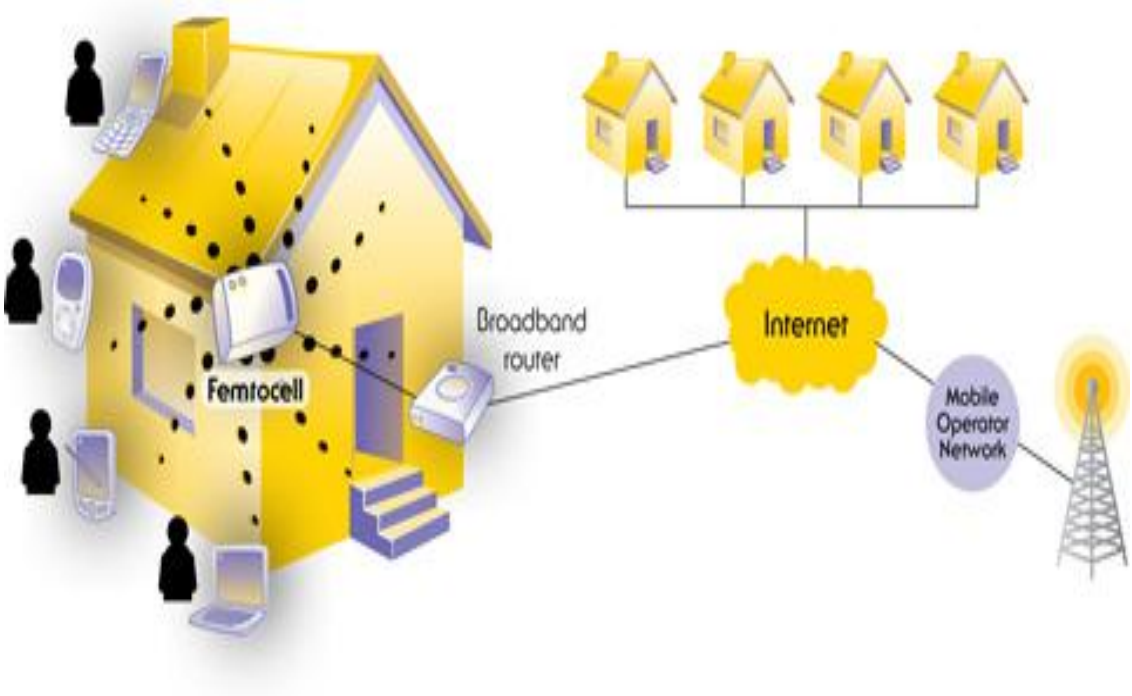


Fig:3.1 Femtocell concept

Motivation

Before the development of femtocells there was existence of other cells such as distributed antenna, microcells.

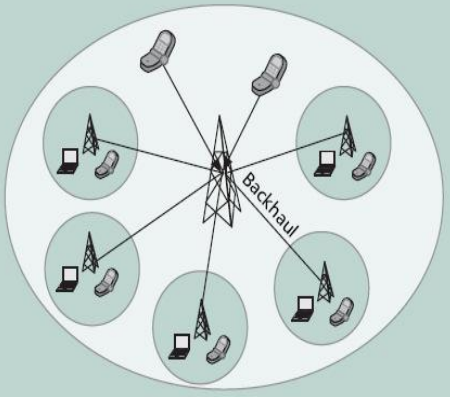
Infrastructure	Expenses	Features
Distributed antennas: Operator installed spatially separated antenna elements (AEs) connected to a macro BS via a dedicated fiber/microwave backhaul link. 	**Capital expenditure.** AE and backhaul installation. **Operating expenditure.** AE maintenance and backhaul connection.	**Benefits.** a) Better coverage since user talks to nearby AE; b) capacity gain by exploiting both macro- and micro-diversity (using multiple AEs per macrocell user). **Shortcomings.** a) Does not solve the indoor coverage problem; b) RF interference in the same bandwidth from nearby AEs will diminish capacity; c) backhaul deployment costs may be considerable.
Microcells: Operator installed cell towers, which improve coverage in urban areas with poor reception. 	**Capital expenditure.** Installing new cell towers. **Operating expenditure.** Electricity, site lease, and backhaul.	**Benefits.** a) System capacity gain from smaller cell size; b) complete operator control. **Shortcomings.** a) Installation and maintenance of cell towers is prohibitively expensive; b) does not completely solve indoor coverage problem.

Table:3.1 Distributed antenna and Microcells

But due to their unsatisfactory coverage and capacity, operators are forced to develop femtocell.

Femtocell Solution

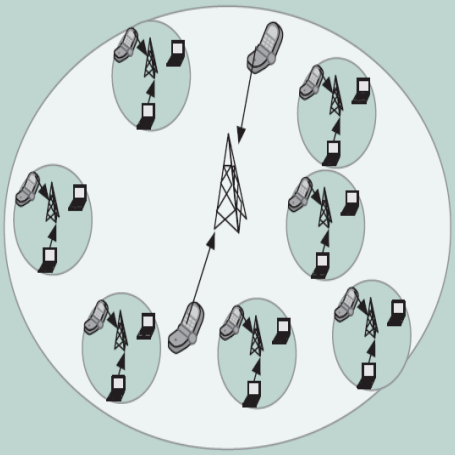
Infrastructure	Expenses	Features
Femtocell: Consumer installed wireless data access point inside homes, which backhauls data through a broadband gateway (DSL/cable/Ethernet/WiMAX) over the Internet to the cellular operator network. 	**Capital expenditure.** Subsidized femtocell hardware. **Operating expenditure.** a) Providing a scalable architecture to transport data over IP; b) upgrading femtocells to newer standards.	**Benefits.** a) Lower cost, better coverage and prolonged handset battery life from shrinking cell-size; b) capacity gain from higher SINR and dedicated BS to home subscribers ; c) reduced subscriber churn **Shortcomings.** a) Interference from nearby macrocell and femtocell transmissions limits capacity; b) increased strain on backhaul from data traffic may affect throughput.

Table :3.2 Femtocell Solution

Need Of Femtocell

Mobile cellular and 3G networks normally often suffer from poor penetration and reception in certain areas, like indoors. This decreases the quality of voice and video communication. It slows down high-speed services.

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.

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 marketshare 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.

Problem-3G Coverage Issues:

- 3G cells are smaller by virtue of supporting higher data rates
- 3G infrastructure needs to Proliferate
- Femtocells are a vehicle for expanding 3G coverage and improving

indoor coverage

- Infrastructure must evolve to support millions of small cells

What is a Femtocell?

Mobile cellular and 3G networks normally often suffer from poor penetration and reception in certain areas, like indoors. This decreases the quality of voice and video communication and slows down high-speed services. A femtocell is a small device that is used to improve wireless coverage over a small area, mostly indoor. It is a small cellular base station, also called a wireless access point that connects to a broadband Internet connection and broadcasts it into radio waves in its area of coverage. As a result, mobile handsets can handle phone calls through the femtocell, via the broadband Internet connection. The name femtocell has the prefix 'femto', meaning a very small cell (area of network coverage). Small is rather a big word here, because femto denotes adivision that is mathematically represented by 10 raised to the power of -15. In plain English, it is one divided by a figure with fifteen zeros. Well, close to infinitely small.

Why Femtocell?

- The 3Cs--coverage, churn and capacity--are stifling 3G adoption. Femtocells , produce cost savings as well for the carriers. Consumer's home in essence becomes a cell site and there is no site acquisition costs involved.Electricity bills can be minimized.Unlimited mobile minutes for a fixed monthly fee.The call charges can also be reduced based on which subscriber we are using.Provides better coverage and also prolonged battery life compared to others.Portable and easy to install and use.Speed:

- **2.5 G**

The femtocell will be 2G GSM technology, supporting data services through GPRS and EDGE which typically offer up to 384kbit/s.

- **3G UMTS**

Femtocells add network capacity and make it possible to deliver 7.2 Mbps and 14.4 Mbps data rates to consumers in indoor environments.

Features of Femtocell

- Operates in the licensed spectrum
- Uses fixed broadband connection for backhaul
- Principally intended for home and SOHO
- Lower cost
- Smaller coverage
- Smaller number of subscriber
- Higher density

3.2 Key Features

The following are the key features that are to be considered as the characteristics of femtocell in the design of femtocell.

Low-impact: Space may be limited for some households. As a result femtocells must be physically small, ideally aesthetically pleasing and easy to position. Furthermore, they should also be silent in operation, generate low levels of heat output and inexpensive to run in terms of on-going [electricity] cost.

Low RF power: The transmit RF power output of femtocells is low; between 10 and 100 milli-watts. Put in perspective, this is a lower power level than many Wi-Fi access points, which can be specified up to 1 Watt of output power. Additionally, by being close to the femtocell the 3G handset is itself able to transmit at lower power levels than it might otherwise have to when on the macro network.

Capacity: Femtocells are aimed at delivering dedicated 3G coverage to a household and in doing so can provide a very good end-user experience within the home environment. As a result, femtocells have a design “capacity” of up to 6 end-user.

Low-cost: There is significant competition for access solutions in the home space. Wi-Fi is commonplace, easy to install/configure, provide a very good benchmark in

terms of performance, and are highly cost effective. Femtocells will be offered for purchase via their Operators. This may be direct or through resellers.

Energy offset: Low-power consumption – Clearly if the end-user is to foot the bill for the electrical energy consumed by the femtocell base-station then this figure must be low enough not to raise concerns as to its impact on the fuel bill. That said, from an Operator's perspective, this OPEX is effectively offloaded, which makes the business case for femtocells even more attractive.

Easy end-user installation: Like cable modems and DSL routers, femtocells will be installed by consumers and activated through service providers. This means that the Operator no longer has to employ installation teams or have a truck-roll every time a new femtocell is "deployed". From the end-user perspective the unit must be a simple "plug and play" installation with a minimal amount of intervention required.

Backhaul via broadband: Femtocells utilize Internet protocol (IP)and flat base-station architectures. Backhaul connection to Operator networks will be through wired broadband Internet service existing in the home such as DSL, cable, or fiber optics as available. There are no connections required to the wider cellular network other than through the IP core. This will benefit Operators by effectively offloading traffic that would otherwise be on the macro-layer directly onto the internet from the femtocell; this not only reduces the load on the core network but also lowers the cost of delivering wireless traffic when compared to the macro network.

Interference: The use of femtocells in spectrum also currently used by the macro layer may, if not managed correctly, give rise to issues with interference between cells; macro with femtocell and in the instance of close proximity of two or more units, femtocell with femtocell. Operators will likely want to launch femtocells on the same channel as their macro cell network for capacity reasons.

Handovers: Current macro RF planning techniques are inappropriate for femtocells. Not least because of the sheer potential numbers of femtocells and managing the neighbor lists that would be necessary. Also the potential to "ping-pong" between layers, especially as an end-user moves around the home and enters into areas where the signal strength from the macro-cell is greater than that of the femtocell, must be

considered very carefully to ensure that the networks provide the best overall coverage without issue. To illustrate, in macro based 3G networks the overhead associated with soft-handovers accounts for a significant proportion of RNC processing capability. Understandably then and in order not to exacerbate the issue, great care and sophisticated algorithms are necessary to overcome these potential issues and ensure that the over-all network quality is not impacted by inefficient handovers and wasted capacity.

Security: Given the requirements for low-cost and easy installation, the use of the broadband internet as the network interface becomes very easy to understand. However this raises security risks in that broadband internet has open access. There are various approaches to address this issue including the embedding of the Iub interface within the IP signaling itself while network security is managed by the IP security (IPSec) protocol.

Worldwide cellular network standards support: Understandably femtocell products are likely to appeal to many end-users around the world. As a result differing models will be developed and offered to satisfy the various needs from the different regions. Products will offer support for their respective and existing (3GPP) UMTS and (3GPP2) CDMA standards, as well as emerging standards such as WiMAX, UMB and LTE.

Support for existing 3G handsets and devices: Support for existing handsets and devices is a very important consideration for the end-user and Operator alike, not least because of the cost of changing devices if that were necessary. In each technology market, femtocells will support existing handsets and devices further helping to drive uptake of 3G services and femtocells in particular.

Operation (transmit/receive) in Operator-owned spectrum: Femtocells operate in licensed spectrum owned by Operators and may share the same spectrum (currently the 2100MHz frequency band) with the macro network.

Operator controlled: Femtocells operate in licensed spectrum and as such Operators must ensure that they comply with the conditions of that license and any other controls

enforced by a regulator. To these ends femtocells feature client software that enables remote configuration and monitoring via an Operations, Administration, Maintenance and Provisioning (OAM&P) system in a similar manner to that used by the macro network.

New services and applications: Femtocells are likely to become an integral part of managing all communications in and out of the home environment. Femtocells enable Operators to cost-effectively offer in-home pricing and integrate mobile services into triple-play / quad-play service offerings. Femtocell architectures include provision for a services environment on which applications may be added, thereby facilitating new revenue opportunities.

Service Assurance: Remote Management to enable an operator to provide the end-user quality of service at the edge of the network.

3.3System Architecture

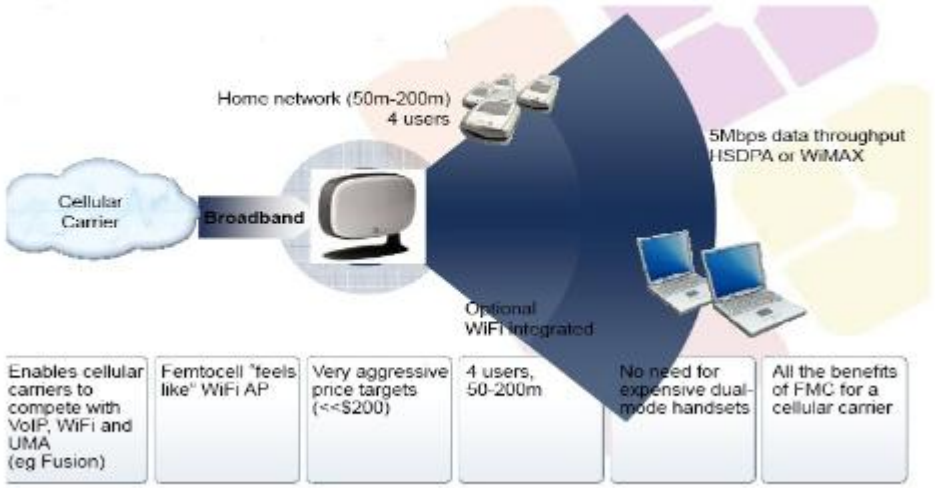


Fig:3.2 System architecture

Kineto Wireless announced today its full support for the 3GPP agreement reached last week on the Home NodeB (HNB) architecture for femtocell-to-core network connectivity. Recognizing that a standard is needed for the mass-market success of

femtocells, Kineto took a lead role in developing consensus among the contributing companies. Having an agreed architecture marks a major milestone towards the completion of a global 3G femtocell standard.

"Developing an industry-wide standard requires a tremendous amount of cooperation between vendors and operators, with all parties contributing their knowledge and experience to develop the best possible solution," said Patrick Tao, Kineto's vice president of technology. "The femtocell standardization effort within 3GPP provides a great example of such cooperation, with the agreed architecture merging key attributes of the 3GPP UMA/GAN-based approach proposed by Kineto with other companies' proposals to create an optimized architecture capable of supporting mass-market femtocell deployments."

The agreed 3GPP HNB architecture follows an access network-based approach, leveraging the existing Iu-cs and Iu-ps interfaces into the core service network. The architecture defines two new network elements, the HNB (a.k.a. Femtocell) and the HNB Gateway (a.k.a. Femto Gateway). Between these elements is the new Iu-h interface.

- Home NodeB (HNB) – Connected to an existing residential broadbandservice, an HNB provides radio coverage for standard 3G handsets within a home. HNBs incorporate the capabilities of a standard NodeB as well as the radio resource management functions of a standard Radio Network Controller (RNC).
- HNB Gateway (HNB-GW): Installed within an operator's network, the HNB Gateway aggregates traffic from a large number of HNBs back into an existing core service network through the standard Iu-cs and Iu-ps interfaces.
- Iu-h Interface: Residing between an HNB and an HNB-GW, the Iu-h interface includes a new HNB application protocol (HNBAP) for enabling highly-scalable, ad-hoc HNB deployment. The interface also introduces an efficient, scalable method for transporting Iu control signaling over the Internet.

Handover Operation

Handover (called handoff in the US) is the process by which a mobile phone switches between different call sites during a phone call, continuing with seamless

audio in both directions. One of the most complex aspects of mobile phone systems. Femtocell users need this capability when entering or leaving their home – perhaps a rare use case, but essential nonetheless.

Handover in Mobile Phone systems

As a person move around when on a call, your mobile phone continuously measures the signal level and quality from nearby cell sites. These measurement reports are streamed to the current active base station, which determines when and where to initiate a handover sequence. Complex algorithms are used when making these judgments, in order to ensure that best use is made of all available capacity while reducing the likelihood of dropping a call during (or by postponing) a handover.

In the case where connection to the current active cell site is dropped, the system is smart enough to allow the mobile phone to request a new connection on a different cell site and reconnect the call. This typically causes a short break of up to a few seconds in the conversation. If the call cannot be reconnected, then it drops out.

3G systems are slightly more complex because it is possible for a mobile to be actively connected to more than one cell site at the same time. This feature, called soft handover, allows the same signal transmitted by a mobile phone to be picked up by multiple cell sites and the best quality reception selected on a continuous basis.

Femtocell Handover

Femtocells do not implement soft handover, regardless of the radio technology used. Instead, all calls are switching instantly to or from the femtocell and the external outdoor cellular network. This is known as “hard handover” and would typically not be audible or noticeable to the caller.

The 2G and 3G systems from the same mobile network co-exist, as is very common with GSM and UMTS, and then handover between 2G and 3G can also occur. Operators prefer to use 3G systems because of the higher traffic capacity and lower costs. Their systems are therefore configured to automatically select 3G where good reception is available, reverting to 2G when out of coverage – typically either in a rural area or inside building where 3G signals can’t so easily penetrate (due to operating at higher frequencies and having fewer 3G call sites thus being further away).

Many 3G femtocells are also capable of 2G GSM reception. 2G typically penetrates buildings better than 3G, it allows the femtocell to determine where it is (by reading the cell site identification on its broadcast channel), derive some timing/clocking reference (as one input to its timing algorithm), and work out which 2G cell sites might be most appropriate to handover to when a mobile phone leaves the femtocell zone. Presumably, these 2G cell site identifies can then be transmitted to the mobile phone as potential handover candidates (known as the neighbor list), and be measured during any active call in case a handover is requied.

Optimizing Handover into a Femtocell

There are potentially three approaches to optimizing handover into a femtocell:

1. Adding femtocells to the neighbor lists of the outdoor macro cells

This is unlikely to be as scalable or workable solution. Although neighbor lists can be quite large, the time taken to scan round many different settings increases proportionally. In dense urban areas, there may potentially be some 100's of femtocells colleocated with an outdoor macro cell. The mobile phone would not be searching for the most likely cell site to switch over to, and dropped calls would increase. Additionally, the complex management to download and maintain vast numbers of femtocell candidates add an overhead to the network operator.

2. Adding some smarts into the mobile phone

One of the key benefits of femtocells is that they work with any standard 3G phone – this is a clear competitive advantage compared with WiFi dual-mode solutions that are restricted to specific (and sometimes more expensive) dual mode devices. However, it could be argued that with some additional functionality in the phone itself, then improved handover into the femtocell zone is enabled. For example, the phone could learn about its femtocell zone and the matching external cell site used outside. When on a call in the external cell site it could additionally monitor for the femtocell and switch across to it when in range

3. Making the femtocell as clever as possible

Ensuring that any calls about to dropout when entering the femtocell zone are quickly restored as soon as the mobile can detect and lock-on to the femtocell. Parameter selected by the femtocell, such as the cell-ld and paging zone, can encourage more rapid identification. Some optimization may be required in the mobile network too, but the idea would be to avoid any changes to the mobile phone itself. This is one area where femtocell vendors will be able to differentiate themselves.

4. ANALAYSIS

4.1 Working of Femtocell

Femtocells from part of the mobile operation's network, although they are located at home or in the business.Most of the functionality of a completer 3G cell site has been miniaturized onto a chip, which look and operates like a WiFi access point, and is connected via broadband DSL back to the mobile operator's network. A femtocell is installed at home and connected to mains power and a standard broadband IP connection (typically DSL) through to the mobile operator's core network. Voice calls, text massages and data services are provided by the same systems.

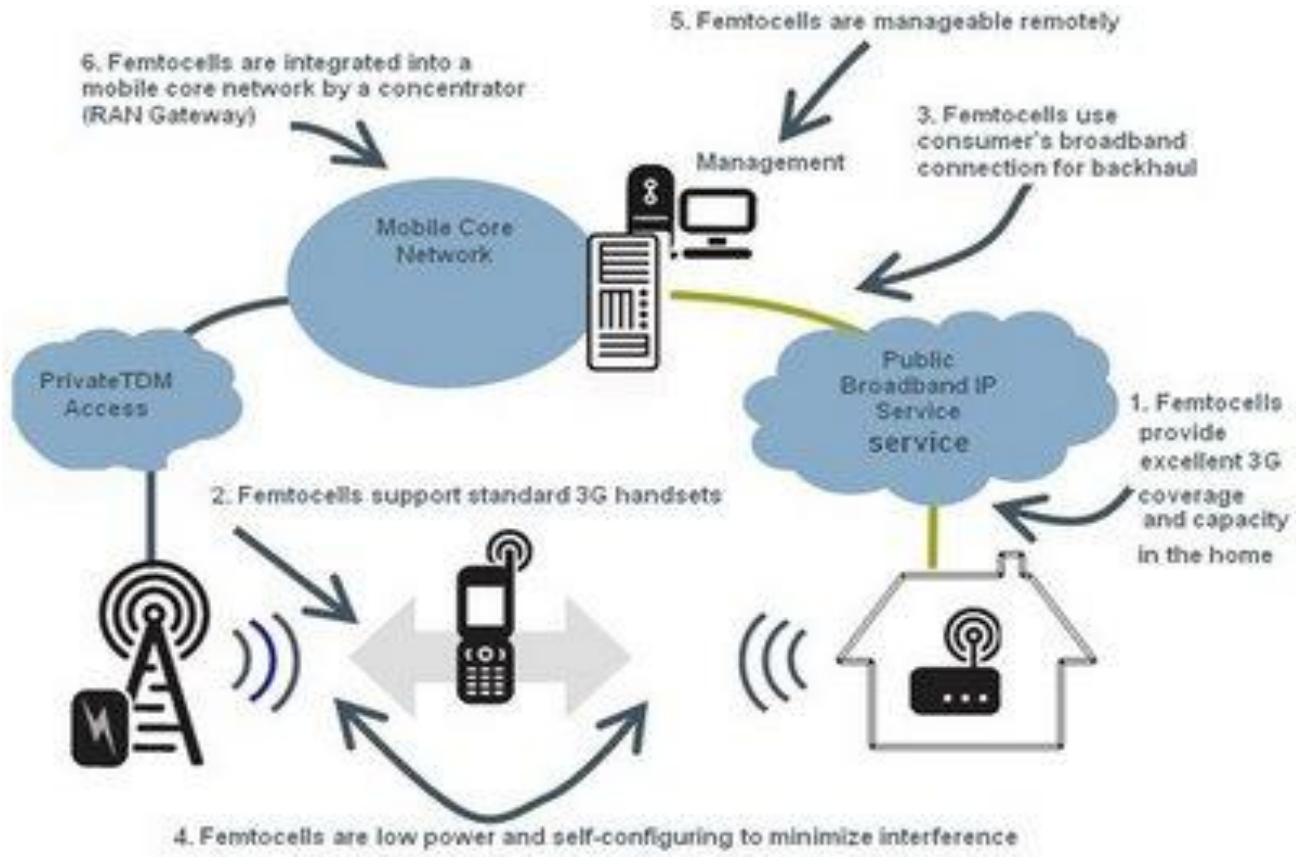


Fig:4.1 Femtocell working

Femtocells operate at very low radiation power levels (50 milliwatts peak output during a call, much lower when idle), and typically have a range of 200 meters. The signals do not travel through walls particularly well, but this is a benefit because it allows the frequency to be reused for other calls in nearby building. Where users walk

outside or out of range, calls are automatically handed over to the external mobile network. Any standard 3G phone can be used on the femtocell if permitted by the mobile operator. Unlike WiFi access points, 3G Femotcells operate using licensed spectrum and thus must be supplied and operated in conjunction with the mobile operator.

The battle is most likely to be between the modified 3G RAN (which some RAN Network vendors are keen to promote because it reuses their existing RNC products) versus UMA, which has new, custom designed systems architected to handle the much larger number of cells and IP connectivity.

4.2 Classification Of Femtocells

Since a large number of femtocells can be installed by subscribers, in certain scenarios femtocell access shall be restricted to certain subscribers who are authenticated and authorized for exclusive access and related network service.

Additionally, femto BS can provide a mechanism delivering initial access information (e.g. BS ID, frequency, closed group information, NSP, roaming capability) of it's own and neighboring femto BSs to any MSs in order to facilitate their network discovery/selection and entry procedure to femtocells.

Femto BS can be classified into 4 types:

Based on bearer connection capability

- Open femto BS : Provides bearer connectivity (full network services) to any MS
- Closed femto BS : Only provides bearer connectivity to allowed (identifiable) MSs

Based on initial access information capability

- Initial access able femto BS : Provides initial access information for any MSs

- Initial access unable femto BS : Not allow to provide initial access information

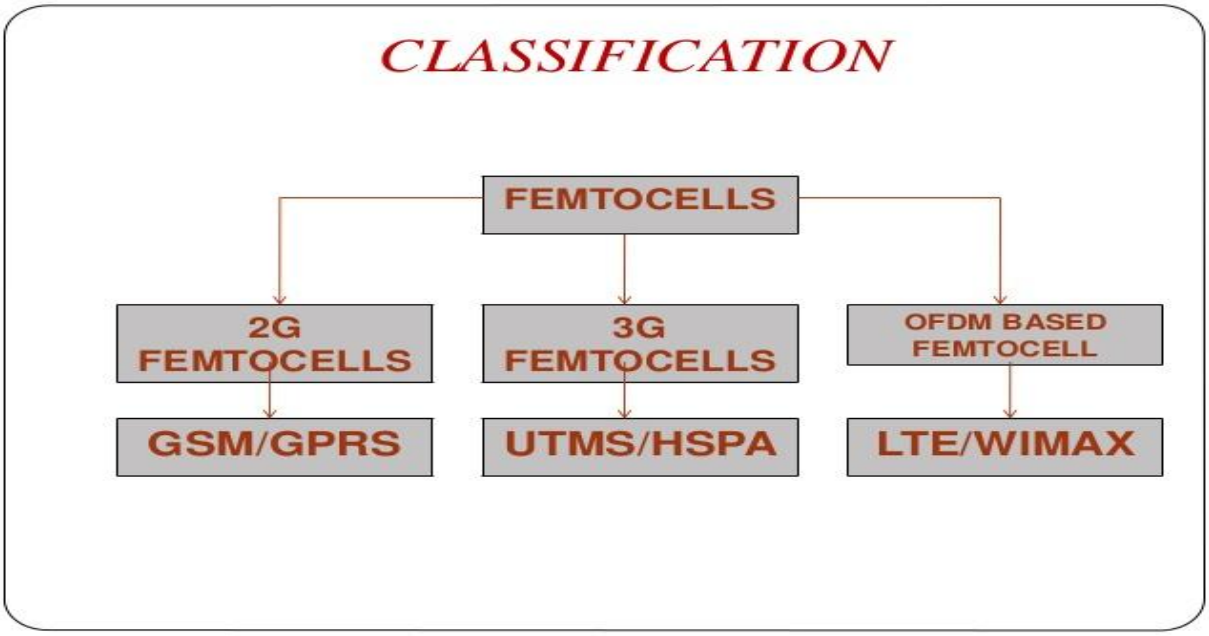


Fig4.2 Classification of femtocell

2G femtocells

Based on global system for mobile communication.

- Low cost.
- Good quality voice service.

Challenge of GSM

1.Power control is not flexible enough to cope with the evolving interference issues.

2.Does not provide high data rates

3G femtocells

- Based on UMTS terrestrial radio access(UTRA)
- The power control is better than GSM.
- UMTS standardised by 3GPPs as HNBs and developed into HSPA femtocell.

UMTS

- Dervied from GSM by replacing GSM radio sub system with one based on CDMA techinque
- It offers a much larger capaity.

- Requries a lesser number of cellsites.

OFDM Based Femtocells

- The categories are WIMAX and LTE femtocells.
- Use OFDM as their physcial layer technology.

LTE

4G standards capable of acheving data transfer rate of upto 100 mbps.

4.3 Benefits Of Femtocell

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.

Better coverage and capacity

Due to short transmit-receive distance

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

Improved macro reliability

BS can provide better reception for mobile users

- Traffic originating indoors can be absorbed into femtocell networks over Ip backbone

Cost Benefit

$60,000/year/marcrocell vs. $200/year/femtocell

Reduced subscriber turnover

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

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]

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 serviceson his/her mobile phone.
- Depending on the pricing policy of the MNO, special tariffs at homecan be applied for calls placed under femtocell coverage.
- For enterprise users, having femtos instead of DECT or Wi-Fi dualmode phones enables them to have a single phone, so a single contact

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 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 .

Advantages

- A Femtocell is used for compensating poor cellular coverage inside the homes – in some places.
- A Femtocell can also give lower call charges while the caller callingfrom home, using the Femtocell as it directly connects to the corenetwork through the internet.
- Some vendors are also planning to incorporate all the three features –Wi-Fi, cellular and DSL into the same box to achieve maximufunctionality.
- The voice calls/data calls through the Femtocells are encrypted andthe cell phones automatically switches over to the Femtocells whenthey come in their range – eg. in homes, where they are installed.
- Femtocell units can handle up to three or four simultaneous calls, from the same operator, depending on the model. They can operate withnormal cellphones, without any enhancements.
- Femtocell units can help related cellular services like 3G by offering abetter speed and data rate when inside buildings, where the coverage and data rate is generally lesser than outside.
- Generally, the cell towers are back-hauled by using lines withbandwidth of around 2 Mbps (in some places) and hence when newer services like 3G are introduced, these lines may not be sufficient andhence may require a upgrade. But with Femtocells, since the subscribers internet connection is used, there may not be an issue with existing infrastructure if Femtocells are adopted in a large scale.
- Femtocells can not only extend the cellular macro network but can also become the primary network if enough Femtocells are adopted inan area. So, all future upgrades etc. can be done by the Femtocells itself, reducing the number of macro base stations required to cover an area – but this is a long shot, based on the current situation and the problems described below.

Security

Femtocell security risks

- There are a number of concerns that exist about femtocell security. Bycategorising these femtocell security concerns it is possible to address them and ensure that any risks are minimised.

User privacy:

Since a variety of data about the user, including thevoice calls and data themselves pass over the Internet. As a result it isnecessary to provide security for these IP communications and preventany monitoring of the data.

Denial of service and general service availability:

- A significantarea of concern for service providers in terms of their femtocellsecurity strategy arises from the fact that the link between the
- and the cellular core network is across the Internet and it isIP based. Accordingly the service provider is open to denial of serviceattacks which overload the network and degrade the service or eventotally prevent legitimate users accessing the cellular network.

5.APPLICATIONS

5.1 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.

5.2 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.

The large Cable TV companies in the US, such as Comcast, previously had agreements to resell mobile services on the Sprit network. 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.

6.CONCLUSION AND FUTURE ENHANCEMENT

6.1 Conclusion:

Femtocells are on a road to now here.Unsatisfactory coverage and the increasing number of high-data-rate application vare 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 need before form factor, usability and quality of service are adequate. Can take a couple of years. 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.

6.2 Future Scope:

Research is being done on femto cells that work on 4G network for business enterprises that can handle more calls simultaneously. Since a femtocell hub is primarily used in home and utilizing internet bridge it makes sense to eventually see it with other home appliances as well.

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