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A REVIEW ON FEMTO CELL TECHNOLOGY

B.Anusha and M L.Nihitha priya
Shruti Bhargava Choubey
Department of Electronics and Communication Engineering
Sreenidhi Institute of Science and Technology
Hyderabad, India.
Email:anushabusireddy10@gmail.com,nihithapriya@gmail.com

Abstract —The popularity of wireless networks has attracted the attention of researchers to improve the network system and this motivated the operators to find a new technology called femtocells with the aim of meeting the increased coverage and data demand in the indoor environment. The application of femtocells in both indoors and office environment has provided good quality service and high performance network gains.

Key words — femtocell, interference management and **macro cell.**

I. INTRODUCTION

The main aim of mobile operators is to increase the system capacity and data transmission within a large cell coverage area, due to the popularity of wireless network service. The wireless network has taken over from wired service in terms of high data rate service and mobility it provides to end users. To achieve this aim, several standard technologies have been developed such like 3GPPs High Speed Packet Access (HSPA), Long Term Evolution (LTE)and LTE advance, 3GPP2s Evolution-Data Optimized(EVDO) and Ultra Wide Band (UWB) to provide high speed communication to end users . Furthermore, certain requirement must also be met along with this aim to achieve high rates, like Signal to Interference plus Noise Ratio (SINR) must be received, higher order Modulation and Coding Scheme.

II. OVERVIEW OF FEMTOCELL.

- **Concept of Femtocell**

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 smallbase station. So small, infect that can be placed in a customer's residence. 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. Network Architecture Connecting femtocells to existing operator networks requires a network architecture that addresses the security needs of operators and mobile users, 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 operate. Femtocell Architecture achieve the objectives of mobile subscribers and operators. The femtocell network architecture supports the following key requirement:

• **Service Parity:** Femtocells support the same voice and broadband data services that mobile users are currently receiving on the macrocell network. This includes circuitswitched 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.

• 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 "zerotouch" 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.

III.WORKING OF FEMTO CELLS

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. 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 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 thenetwork. 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.

IV.DIFFERENT TYPES OF FEMTOCELLS.

The work on Femtocell began with a group of engineers, investigating a new way of application that could deploy to mobile communication system to increase the capacity of the network. This idea gained momentum and as such many companies joined in the investigation of femtocell technology. Femtocells are low power device that combine Home NodeB and Radio Network Controller (RNC)
functionality to provide coverage to mobile users in an indoor environment or a home base station which provide coverage to mobile users through femtocell access point (FAP) at the indoor environment. One of the vital functions of femtocell in 3GPP is that it operate on Closed Subscriber Group called CSG, this only allow limited and registered User Equipment (UEs) to connect to Home e NodeB (H(e)NB) and disable other UEs in the network. There are other access modes that allow connection of other UEs in the network such as the open access mode and hybrid access mode.

A. 2G FEMTOCELLS

2G femtocell is based on Global System for Mobile
Communication (GSM) air interfaces. It has some drawback and economic viability, but some of the reason why 2G femtocell is generally embraced is that the cost is low and good quality voice service is provided to the end users. The main challenge of GSM is that the power control is not flexible enough to cope with the evolving interference issues and this consequently does not provide high data rates.

B. 3G FEMTOCELLS

3G femtocell is based on the air interface of Universal Mobile Telecommunication System called UMTS Terrestrial Radio Access (UTRA). It provides higher data rate compare to 2G femtocells and it has the ability of connecting to the network through the IP base. Furthermore, the power control is better than Global System for Mobile (GSM), which can be used to prevent interference to macrocell user. The UMTS femtocells are standardized by 3GPPs as HNBs and developed into HSPA femtocells,
to provide better services.

C. THE OFDM BASED FEMTOCELLS

The categories of this are WIMAX and Long Team Evolution (LTE) femtocells. They provide a variety of high data rate

service to the end users [2] by making use of OFDM as their physical layer technology. LTE femtocell is being considered as the future technology at the indoor environment.

V. BENEFITS AND INSTALLATION

a. 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.

b. Benefits

Due to the substantial benefits, femtocell tech 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.

c. Better coverage and capacity:

– Due to short transmit-receive distance
• Lower transmit power
• Prolong handset life
• Higher SINR
• Higher spectral efficiency

d. Improved macro reliability:

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

e. Cost Benefit:

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

f. Reduced subscriber turnover:

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

g. 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].

h.. 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.

i. 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

j. Femtocell Benefits to Mobile Operators

• Improves coverage
• Reduces backhaul traffic
• Provides capacity enhancements.
• 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.

VI. 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.

VII 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.

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.

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.

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.

VIII. CONCLUSION

The concept of femtocell technology has significant improved network performance in the indoor environment. Furthermore, it provides advantage to mobile operators, in terms of increased revenue and better quality of service. Based

on research work from literatures, the femto cell technology is a promising alternative for next generation wireless communication networks. However, Interference has being one of the main problems in femto cell network. The interference includes those between neighbouring femto cells and between macro cells and femto cells, due to the sharing of the same licensed frequency spectrum with an existing macro cells. Researchers have provided different types of techniques to cope with interference problem in femtocell networks. Some of the techniques are interference cancellation and interference avoidance. Finally, it is important to note that with an efficient interference schemes the network capacity and coverage can be increased.

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