ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

Evolution, Coverengence and Deployment of Femtocell Network: A new look into the future

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ABSTRACT

Capacity increase in the modern mobile communication networks are increasing rapidly. All People all over the world are not only voice using the voice services but also large needs of data services with their portable cell phones. Many of these services, including global usage of internet anywhere, anytime to search the information, downloading large amount of data, video streaming and video calls require high speed internet connections and generate large amounts of data traffic to the existing network. The customer expectations are rising and soon the mobile users will have to achieve the same data rates as the current fixed internet connections. Coverage has always been an important issue in mobile networks. It has traditionally been a problem in rural areas due to the long distance between base stations and in indoor that is inside buildings and underground locations due to the wall attenuations and diffraction effects. Mobile network operators now selected femtocell service and plans for providing both voice and data to residential and Commercial Purpose. Normally, Femto (f) is the prefix for a factor of 10 to the power of 15. Femtocell is very Low Power base stations in order to reduce the cellular access points for indoor use. The Mobile cellular gateway is simply connected via broadband service and supports a limited number of mobile users for indoor use. It becomes a more valuable solution for locations where cellular tower are not to be installed or locations not covered by macro cells. Femtocell is more compatible with any cellular wireless technology; however wireless vendors are now getting more focused on 3G UMTS, CDMA and the recent 4G LTE-A standard. Now a day's Wireless network is transforming from primarily using tower base-stations into the enormous use of smaller wireless cells including Pico and Femto cells. Furthermore, it is shown how the femtocells do not cause serious problems to the macro network; on the contrary, by careful planning macro layer performance can even be enhanced.

Index Terms—**LTE, UMTS, CDMA, 3G, 4G**

I.INTRODUCTION

Femto cells are cluster of small cells which are used to provide high data rate, capacity and cost effective. The Femto cell includes a base station that is similar to Wi-Fi access point. The FAP (Femto cell access point) can be divided into two types depending upon the capacity and number of users under the FAP. They are classified as home FAP which can support 3-5 users and enterprise (Commercial) FAP which can support 8-16 users. This classification is mainly based on the probability of the subscribers who can access the Femto cell, which is why home FAP will have less demand than enterprise FAP.In accordance with the cellular technologies FAP can be classified as UMTS FAP, GSM FAP, and Wi-Max FAP. A Femto cell provides a better cellular coverage within a building by using a small internal low power base station-Femto cell. The user traffic in Femtocell Base Station is backhauled to the mobile operator core network over IP via the residential broadband wire line connections DSL and optical network which is available locally in the site of deployment.

In this way the user can enjoy cost effectiveness and better coverage along with provision of additional services. The network operator with the use of Femto cell can provide better coverage along with linking users to their network. Femto cells will change the design of wireless networks. With Femto cells, we are bringing the network to the subscriber, which is really a dramatic shift. But Femto cells won't replace the High Power macro network. They will complement it by providing service in specific targeted areas that the macro network cannot economically reach. Femto cells are necessity to expand the service expectations**.**

II NETWORK ARCHITECTURE

2.1 New Network Elements

The new essential network elements in the femtocell solution are the

- Home NodeB (HNB),
- Home NodeB Gateway (HNB GW)
- Iu-h interface
- Home NodeB Management System
- Security Gateway (SeGW)

This section deals with the interface called Iu-h defined in the 3GPP HNB standards. The Iu-h interface operates between the HNB and the HNB GW.

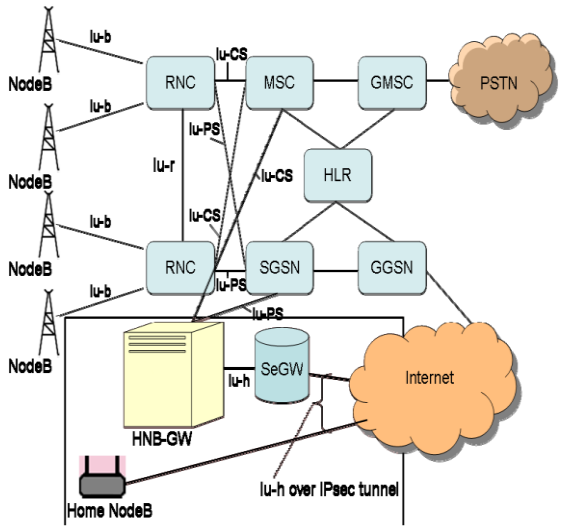

Figure2.1: Architecture of Femtocells

2.1.1 Home NodeB

The 3G Home NodeB is the device that is installed to the user premises, serving as a femtocell. The HNB is able to operate with 4 to 8 existing UEs and offer them the same services as if they were operating under a regular NodeB. The device is low cost and relatively small in size and can be installed to the user's home or office to the location he/she chooses. The operator has no exact control of the location. The HNB is powered from the user's electric network using most likely an external power adapter.

2.1.2 Home NodeB Gateway

The Home NodeB Gateway is the device used to connect the HNBs to the UMTS network. It's needed because it has been agreed not to use the standard Iu-b interface for the connection to the HNB. The HNB-GW concentrates connections from a large amount offemtocells. The new Iu-h interface is used between HNB and HNB-GW. HNB-GW disconnected the CN using the standard Iu interface and the network sees it as a standard RNC.The HNB-GW can be located anywhere at the operator's premises.

2.1.3 Iu-h Interface

The Iu-h is the interface between the HNB and HNB-GW. Iu-h provides transport for the control and user plane messages. RANAP user adaptation (RUA) is used over Iu-h to provide transparent transfer for the RANAP messages and another control plane protocol called the Home NodeB Application Protocol (HNBAP) is as well introduced. HNBAP is used to carry the HNB specific control information between the HNB and HNB-GW.

Transparent transport is also provided for the Iu user plane protocol layer, which is terminated at the CN, not at the HNB-GW. The Iu-h interface is tunnelled over the residential internet connection of the customer and over the public internet.

2.1.4 Home NodeB Management System

The Home NodeB Management System (HMS) uses an interface based on the TR-069 standards widely used in DSL modem and DVB set-top-box management and updates. The management system sends the configuration data to the HNB and helps the HNB in HNBGW and SeGW discovery. It can also initiate HNB software updates and perform HNB location verification.

2.1.5 Security Gateway

The Security Gateway (SeGW) is a logical element which can be physically implemented separately or as an integrated solution with the HNB-GW. SeGW terminates the IPSec tunnels for TR-069 and Iu-h protocols and acts as a firewall between the operator's core network elements and the public internet.

III OVERVIEW OF FEMTO CELL

3.1Evolution of Network

Due to the demands of wireless network access in the past few decades leads to remarkable growth with the number of wireless subscribers reaching more than 4 billion. Major part of these subscribers comprises of Mobile users.

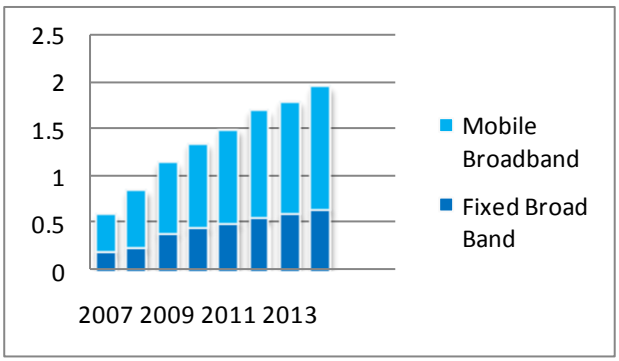

Figure: 3.1 Increase in Date Rate

3.2Origin of Femtocell Deployment

There are several companies developing femtocell solutions at the moment. The companies can be divided into two categories. The traditional telecommunications hardware manufacturers like Alcatel Lucent, Huawei, Motorola, Samsung and Nokia Siemens Networks. Second, the companies specialized to femtocells, like ip.access, Ubiquity's and Radio frame. Most of these companies have a specified femtocell solution available. Some companies like Nokia Siemens Networks are more concentrated on offering a femtocell gateway solution, which could be used to connect standard femtocells from different vendors to the network.

Currently WCDMA 3G is the dominating technology for radio access in femtocell development, although there are solutions based also on 2G GSM and

CDMA. Most vendors have a solution that provides an Ethernet connection for IP backhaul but many have models also including a DSL modem. Femtocell manufacturing is based on co-operation of many suppliers. British company Pico Chip is specialized on manufacturing a femtocell solution on a single-chip. Their product is a solution for 3GPP WCDMA standard femtocells and it supports both HSDPA and HSUPA. The chip includes a 400MHz ARM processor for processing and it includes an interface for connecting common mobile phone radios. Ethernet and full security features are supported for backhaul. The same chip is used in femtocells made by companies including IP access, Ubiquisys, Alcatel Lucent and Motorola

3.3Convergence of Network

Mobile cellular networks have gained reputation for poor indoor coverage resulting in inferior call quality, QoS issues becomes more predominant as mobile users begin using 3G services. Due to the penetration losses, the indoor user requires high power from the serving Base Station (BS), which means other users would have less power and as a result the overall system throughput is reduced. It is also very expensive to have a large number of capacity networks. The large number of BSs would pose larger burden on network planning and optimisation as well. This emphasises the need of having some indoor coverage solutions, for example of femto cells where Femtocells are small low powered base stations, which provide radio coverage to the mobile users in an indoor environment. These are installed in an indoor area by the end user just like a Wi Fi router and provide almost all of the cellular functionalities to the end users .The FAP is then connected t o t he operators core network through the users broadband internet connection.

IVISSUES AND CHALLENGES

4.1. Quality of Service Issues

The term Quality of Service (QoS) refers to the requirements that are imposed by IEEE 802.11 on all aspects of an Internet connection. Some of these requirements are adequate signal-to-noise ratio (SNR), frequency responses, loudness levels, response time, loss, etc. The intent is to guarantee a standardized level of quality and performance for the consumer's data flow needs. The issue with QoS for femtocells is that in order to achieve QoS requirements there often needs to be hardware changes.

4.2. Frequency / Bandwidth Issues

The electromagnetic spectrum is a scarce and crowded resource. Femtocells operate on the same licensed spectrum that is allocated to cellular service providers.

To deal with this overcrowding issue two methods have been used: the Co-channel Frequency Deployment and Orthogonal Channel Deployment. The Co-channel Frequency Deployment simply allows the femtocell and the cellular macro-cell to use the same frequency band. With co-channel use, however, there are identified interference issues. Orthogonal Channel Deployment is in many ways the opposite of Co-channel Frequency Deployment. In this method macro-cells and femtocells use separate channels. The advantage to this method is that there is less potential for interference, the disadvantage is a reduction in the overall system capacity..

4.3. Interference Issues

As stated earlier, there is limited spectrum on which cellular systems can operate and the spectrum is controlled by licensing. Femtocells utilize the spectrum already licensed for cellular providers. Thus, interference is a key issue associated with femtocells. When multiple femtocell devices are being serviced by the same macro-cell there can be adjacent channel interference. There can also be interference issues when several femtocell devices are used in close proximity to each other, regardless of whether or not they are serviced by the same macro-cell. Generally though, femtocells are used in areas of poor or limited cellular coverage and in these cases interference from overcrowded networks is not an issue. Also, a benefit of the low power output of the femtocell is that multiple femtocell devices would have to be very close to each other to cause interference.

4.4. Handover Challenges

When a mobile device in a WiFi network moves to the outer edge of its Received Signal Strength (RSS) limit it needs to perform a "handover" of connection from one access point to another. The major concern for femtocell handover is that the coverage area of an individual femtocell is very small. For this reason, it becomes essential that there is a seamless handover to and from femtocells so the user can maintain continuous signal connectivity. There are generally three types of handovers for both WiFi and Femtocells. The first is a simple base station to base station handover where a user moves from the range of one base station to another. The second occurs between base stations and Femto Access Points (FAPs). The base station to FAP handover happens when the mobile user moves from an outdoor area to an indoor area. When the user starts outdoors it sends a request to a cellular base station and when the user then moves indoors the FAP will accept the request and pick up the signal. For this to work there has to be synchronization between the FAP and the cellular base station. The final handover scenario is where the user moves from one FAP to another. This generally happens when there are multiple FAPs in the same vicinity, in an office building for example. The challenge associated with handovers for femtocells is that they are not usually connected to a network environment where mobility is addressed.

Due to the fact that the femtocell must be associated with an IP address, when a user is mobile the IP addresses would have to change.

4.5. Regulatory Challenges

One of the biggest differences between WiFi and femtocells is the fact that WiFi operates in an unlicensed spectrum while femtocells operate in a licensed spectrum and require regulatory approval. This becomes an issue because the spectrum and radio regulations will vary from one country to the next. International agreements can also be involved when a user takes their femtocell from one nation to another. In a licensed spectrum the provider pays substantial sums to be able to use a portion of the spectrum exclusively and regulators will enforce transgressions. This means that a femtocell operator could not just move their femtocell to another country and operate it. The varying spectrum allocations from one country to another can also prevent unauthorized usage.

A femtocell has several means to identify where it is. The first is a Global Positioning System (GPS) receiver that is built into the femtocell. This immediately identifies the location of the femtocell. Another means is by mapping its IP address to the femtocell's originating country. A femtocell also can sense other cell site identities in its area and can identify its "neighborhood." If a femtocell sees that it is in an unauthorized area it can disable itself or notify the provider. Due to the regulatory issues operators cannot use their femtocells in frequency spectrum that they do not own and control.

4.6. Security Challenges

The security of a device or network is always a paramount concern for users, especially on a wireless medium. There are three major security vulnerability concerns for femtocell network technology. The first comes from the wireless link into the femtocell; it is possible for external wireless transmissions to potentially gain unauthorized access to the femtocell. The second concern is the backhaul link that is used between the femtocell and the gateway into the service provider's core network (the Internet link). The third concern is the femtocell itself, as it is potentially possible for nefarious network users to get into the femtocell and take control of it remotely. There are several ways to prevent or counter these security issues. The first is to ensure secure authentication. Authentication needs to be required by the service provider or the operator to correctly identify valid femtocells within the network. Another means of ensuring security is the use of Internet Protocol Security (IPsec). IPsec is a protocol for securing IP communications by authenticating and encrypting each IP packet. It also establishes mutual authentication and provides cryptographic keys for additional security. Extensible Authentication Protocol (EAP) is an authentication framework for wireless networks and also provides a means of ensuring wireless security

V. CONCLUSION

Thus the Femto Cells are normally a Plug and Play deployment it provides High Data Rates with reduced cost and high reality. There are Different types of femto cells that are available in the market in order to coverage the area which will not cover by the large powered Macro base stations. In this paper discussed about all the femto cell types and how the interference should be managed between macro and micro cells. Still the Femto cell area in the keen notification research in order to provide high data Speed in the upcoming 5G Technology. All the service provides seeking Femto cells in which to increase the accessing area within the macro coverage area.Interenference is major problem in the deployment of the Femto Cells in real time.

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