

A Review Paper on Femtocell Technology

Keerti Nair¹ Mohit Kumar² Kausar Ali³

¹B.Tech Student ²Assistant Professor ³Associate Professor
^{1,2,3}Department of Electronics & Communication Engineering
^{1,2,3}VIT, JAIPUR

Abstract— As nowadays there has been increasing use of wireless communication networks due to which the researchers have found a different type of technology called the Femtocells. Femtocell are reduced scale (range of 10^{15} , Picochip) cellular access points which are mainly for indoor use. Femtocells are mini base stations that are used directly in homes by the user so that they can directly connect to the cellular network through the femtocell instead of the any other macro cell, which increases call quality. Femtocells reduce the load on macro cell networks by introducing IP as a backhaul for voice and data. The application of femtocells has provided good quality service and high performance network gains. However, femtocells had several challenges of interference which effects the capacity and quality of network. But to cope up with these challenges, We have management techniques which include interference cancellation and interference Avoidance.

Key words: Femtocell Technology, CCTR, FGW

I. INTRODUCTION

The growing number of cellular network users raises issues about coverage extension in some areas such as rural locations or underground locations. In the metric system, Femto (f) is the prefix for a factor of 10^{15} . The term femtocell was originally used to describe residential products, with picocell being used for business purposes and metrocell for public or outdoor spaces.

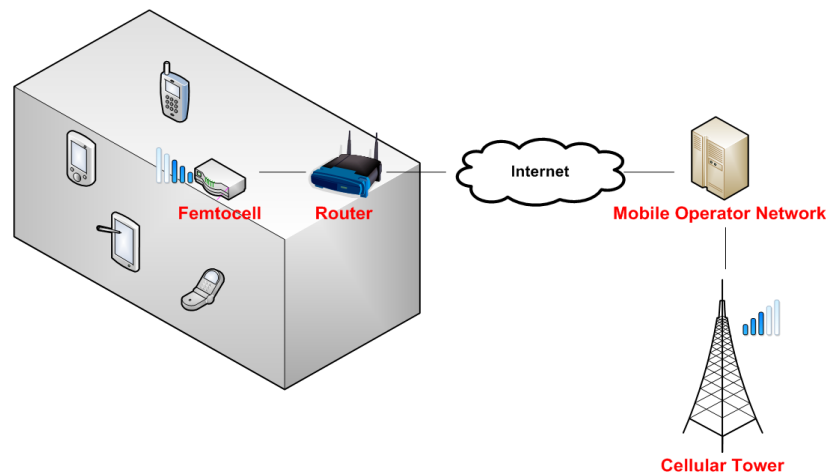


Fig. 1: Femtocell Architecture

Femtocells are also known as Small cells. These small cells are fully featured, short range mobile phone base stations which are used to connect mobile phone service from larger towers (macro cell). They offer excellent mobile phone coverage and data speeds at home, offices and some public places for both voice and data. Small cells have been developed for 3G and the newer 4G/LTE radio technologies. Femtocell is a solution to increase the system capacity to complete the high demand for the next generation of services on wireless access and is compatible with any cellular technology, but the vendors are focusing more on CDMA, 3G, and the recent LTE stand.

II. HISTORY

It's been more than ten years from the time, the people who operate, began to lessen the size of the covered cell by a base station (BS) to have an increasing number of people to subscribe for performing phone calls. This became more critical when data based services came into existence, because these services need higher throughputs in order to be considered attractive. As people user mobile phones more and more, the indoor use of mobile phones increased. This was seen since 2002, cell phone subscribers worldwide have outnumbered fixed-line subscribers .The environment (indoor) is so problematic that the users rapidly became dissatisfied and looked for an alternative.

This technology of femtocell is not actually new. It has already been proposed in the mid-90 by Silventoinen.

III. ARCHITECTURE DESCRIPTION

A. Integration of Femtocell to the Core Network:

The Universal Mobile Telecommunications System which architecture voice which is tunneled and the data traffic in between the mobile Core Network (CN) and FAP which is femtocell access network , with the help of broadband. When a mobile handset is used in the femtocell network, voice or data are encoded and transmitted from the subscriber router to the

mobile user-switching center through IP network. The operator gives a radio network controller that supports multiple femtocell points of access. While making a call or sending a message, an Internet Protocol Security tunnel carries encrypted voice and data from the FAP to FGW. The FGW is a security gateway that lies between the FAP and core network. The traffic to the FGW is made through an interface called IU-H. There can be three or more configurations for this integration where the access point can be to radio network, concentrator (CCTR) or SIP Application Server.

B. Timing and synchronization:

Timing and synchronization are some of the challenges faced in the deployment of femtocell. The access point should synchronize with the operator's core network without the intervention which is done manually. It is then attached to the core network via an Internet protocol backhaul and it can only use protocols of timing like Network Time Protocol and many more. Further, the femtocell is placed and used in indoor, and GPS antenna cannot be used for time synchronization. High-precision oscillators (crystal) can deal with the timing problem, but are so expensive for consumer grade devices

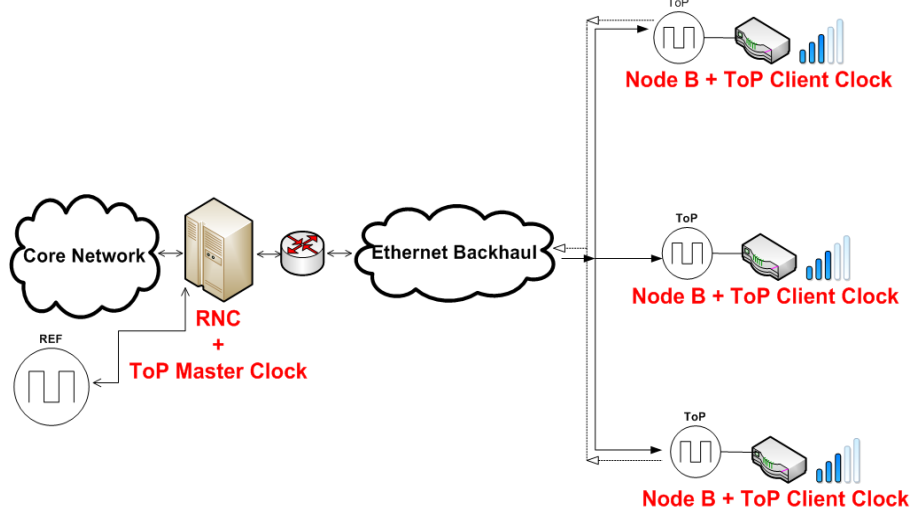


Fig. 2: Timing over synchronization

C. Handover:

Voice communication requires few real time needs, only the femtocell gives a handover on which we can rely which is hard so that seamless network transmission is provided to the user.

- Femtocell - femtocell
- 2G- Femtocell
- 3G- Femtocell

When there is a process which has femtocell being transitioned to macro cell, mobile station chooses the appropriate candidate of handover, connects to the new access point after authentication is done. Recent handsets are configured to automatically change to 3G because of the high capacity of traffic the process of transition from macro cell to femtocell is complex as the mobile station may have to choose between two or multiple neighboring femtocells. The node B coordinates the handover by provisioning the base station has a whole detail of allowed access points. The procedure involves many phases such as preparation, processing and execution.

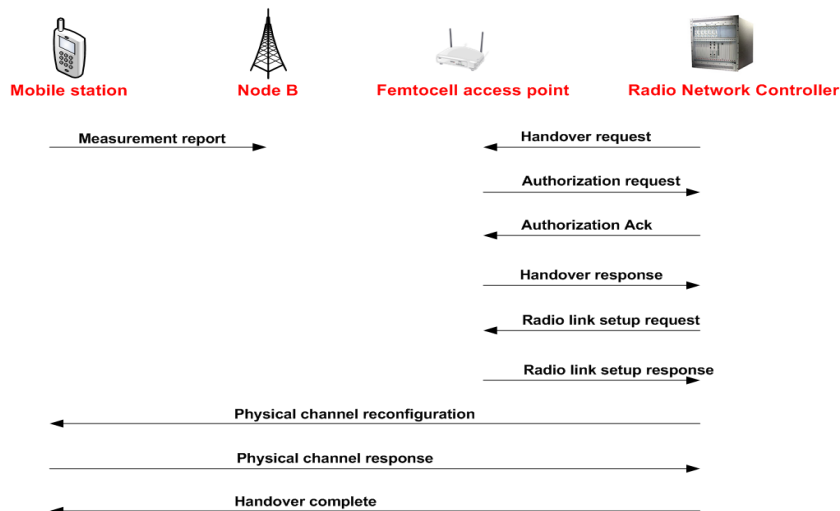


Fig. 3: Femtocell handover

D. Optimization of femtocell design:

As a growing technology, femtocell needs some improvement and optimizations in terms of interference of radio frequency, strength of signal and many more. Semiconductor companies such as Picochip have already developed answers for standards of 2G and that of 3G. This part describes about schemes to lessen interference between two channels, and improve indoor coverage using transmit power adjustments. Like:

- Co Channel Interference
- Plug And Play Deployment
- Coverage

E. Authentication mechanisms:

The Femtocell has been using cellular security protocols. The 2G and 3G networks use different authentication mechanisms. The Authentication of GSM use EAP/SIM and use of EAP-AKA. Both concepts are developed further below:

1) EAP-SIM

Femtocell uses EAP-SIM to establish an IPsec tunnel to reach the gateway of network. EAP/SIM does the job of storing a hidden key on the unit of mobile SIM card for encryption in the tunnel. The SIM does the using of secret key and a number which is chosen randomly (RAND) given by the client to create a 32-bit response and a 64-bit cipher key. The 64-bit cipher strictly depends on the SIM secret key. This type of combination gets changed only if there is modification of the secret key. This allows intruders to breach the system by tunnel (VPN) opening and authentication of the unit of mobile to the gateway of network.

2) EAP- AKA

This is one of the most secured system because it involves identity privacy support, re-authentication, and creates larger keys. At the time of the authentication and authentication vector is made by the operator based on a sequence number and key... The authentication vector involves the random number RAND, a 128-bit session key for check of integrity and for the s=encryption a 128-bit session key is used. Two of these protocols have drawbacks, still the minimum security requirement for femtocell design should involve authentication between others mutually and the independence related to session.

IV. DEPLOYMENT

The commercial use of cellular networks has evolved more and more in last few years. As per the statistics, more than 85 % of the Americans have cell phones, which drives the investment more in technologies such as femtocell by the operators. Femtocell is not limited to indoor use only, and could be a better choice for subway stations, and other public areas which are underground.

Callers usually lose signal from towers of cell when they are driving under bridges, or over tunnels, or traveling in subways. These situations can easily be solved by introducing a type of system that will be amongst the networks which are cellular of convention related to the access points of femtocell which are created at several places in urban areas. This type of the deployment will also help the people who are travelling to seamlessly surf the internet or make clear quality of calls. According to ABI research, worldwide user's number will rise to 102 million for 32 million access points. On another hand, compared to other various countries, US also do not give permission to use cell phones on planes. There are still safety concerns regarding the interference which is caused with the systems related to aeronautics. One more concern is whether or not femtocell is suitable for aircrafts for providing the service which is cellular onboard for a few number of users.

V. CHALLENGES TO FEMTOCELL

One of the main challenges faced by femtocell technology is related to the spectrum allocation to the system named, second tier. The main path that can be taken is, Spectrum splitting (spectrum sharing). In the first approach the femto and macro cells are given orthogonal frequency bands. However, in the 3G context, it is always not possible, as additional spectrum is not owned by the operators. The procedure of giving a spectrum of 3G in Europe turned out to be a big auction, that cost operators cost very big amount of money. Another Challenge is the sharing of radio sources between femtocells. A foreign User Equipment shall be given access to the femtocell network also when it is within the range. IP Backhaul is also one of the methods to overcome the challenge of call drops.

VI. APPLICATIONS OF FEMTOCELL

- 1) Improve quality of coverage to the end users who are indoor and increased revenue additional for the mobile network such as internet service, video calling
- 2) The tension of bills of electricity is a very big problem for the operators.
- 3) The entire smart home appliances are nowadays connected to the FAP, for the point that they are secure in terms of communication and of the home or office.
- 4) In an indoor environment Digital Newspaper: the device recognizes the stories related with the article published in newspaper and display on the newspaper pages.

VII. CONCLUSION

In this paper, we examined femtocell in an indoor environment to enhance good quality service and high performance to the mobile network, where the path loss was analyzed within the indoor environment. We discovered that femtocell at the indoor environment experience no interference, whereby the end users enjoy good quality and smooth communication within the cellular network from the service providers. In addition, the capacity performance is achieved due base station being close to the end users within the indoor environment for quality and coverage of data. This definitely will reduce the costs of service provided to us, like bills of electricity, maintenance cost etc. On the other side the subscribers are beneficial for an improved rate of QoS at lower rate.

REFERENCES

- [1] <https://www.researchgate./net/>
- [2] <https://www.fujitsu.com>
- [3] <http://www.eecs.berkeley.edu/~gfanti/femtocells>