Controlling the Interference between Femto Cell and Macro Cell in LTE

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Abstract

Femtocells are aimed at providing high performance voice and data communications in and around the immediate home environment. Connected to the Operator's mobile network over existing broadband connections in the home, femtocells have the potential to make indoor coverage for mobile communications truly pervasive while delivering additional benefits to both the Operator and end-user.In this paper, our main aim is to mitigate the interference generated when we go on insert the femto cell to a region containing more than one base station, the same causes the throughput of the base station to be decreasing when we go on inserting the femto cell to that region. we are going to employ the Coloring algorithm concept to mitigate the interference of the femto cell.The developed algorithm works by creating the interference graph by using the coloring algorithm , once we get the graph ,we apply the coloring algorithm to that ,and find the chromatic number of that graph, that chromatic number gives number of zones to be created in the femto cell region, once we divide the zones ,we send the users to particular zone depending upon SINR value and mean while we allocate the number of channels to that particular user.

Keywords: SINR, LTE, Femtocell.

Introduction

Only a few years ago, the idea of a cellular base station in the home would have seemed impossible, especially given the public perception of a base station: never enough of them to make a call, but not something that should be seen. The reality today is very different, with the industry moving to extremely low-power home base stations, or femtocells, not much bigger than existing in-home wireless equipment.

These small devices have a low price tag to match: they are affordable as consumer products in themselves, and present an economically viable case for operator subsidy. To understand what is driving this change, consider the pressures on mobile operators today, balancing the relentless advance of technology and new services with increasing costs, reducing revenues and growing competition. One of the operators' biggest challenges is to improve mobile coverage in an environment that is both demanding and potentially lucrative – inside buildings[1]. When services were mainly voice-based, operators stuck to deploying large macro cell base stations with sufficient transmit power to overcome losses through walls. This works most of the time in most locations, especially with low data-rate services like voice and messaging. But for the higher data-rate services promised by 3G, the macro cell approach becomes inadequate, because of signal attenuation caused by both sheer distances from the base station, and attenuation through walls. 3GPP.

The *Third-Generation Partnership Project* (3GPP) is the standards-developing body that specifies the 3G UTRA and GSM systems. 3GPP is a partnership project formed by the standards bodies ETSI, ARIB, TTC, TTA, CCSA and ATIS. 3GPP consists of several *Technical Specifications Groups* (TSGs).

The scope of 3GPP when it was formed in 1998 was to produce global specifications for a 3G mobile system based on an evolved GSM core network, including the WCDMA-based radio access of the UTRA FDD and the TD-CDMA-based radio access of the UTRA TDD mode.

The task to maintain and develop the GSM/EDGE specifications was added to 3GPP at a later stage. The UTRA (and GSM/EDGE) specifications are developed, maintained and approved in 3GPP. After approval, the organizational partners transpose them into appropriate deliverables as standards in each region.

UMTS
Universal Mobile Telecommunications System (UMTS) is one of the **third-generation (3G)** cell phone technologies, which is also being developed into a 4G technology. Currently, the most common form of UMTS uses W-CDMA as the underlying air interface. It is standardized by the 3GPP, and is the European answer to the ITU IMT-2000 requirements for 3G cellular radio systems.

3G LTE beginnings
3GPP, the Third Generation Partnership Project that oversaw the development of the UMTS 3G system started the work on the evolution of the 3G cellular technology with a workshop that was held in Toronto Canada in November 2004[2].
The workshop set down a number of high level requirements for 3G LTE:
- Reduced cost per bit.
- Increased service provisioning - more services at lower cost with better user experience.
- Flexibility of use of existing and new frequency bands.
- Simplified architecture, Open interfaces.
- Allow for reasonable terminal power consumption.

In terms of actual Figure s, targets for LTE include download rates of 100Mbps, and upload rates of 50Mbps for every 20MHz of spectrum. In addition to this LTE must be able to support at least 200 active users in every 5MHz cell (i.e. 200 active phone calls). Targets have also been set for the latency in IP packet delivery. With the growing use of services including VoIP where latency is of concern, Figure s need to be set for this. As a result a Figure of sub-5ms latency for small IP packets has been set.

LTE Technologies
Some of the target performance objective for LTE:
Peak data rate:
- Instantaneous downlink peak data rate of 100 Mb/s within a 20 MHz downlink spectrum allocation (5 bps/Hz).
- Instantaneous uplink peak data rate of 50 Mb/s(2.5 bps/Hz) within a 20 MHz uplink spectrum allocation

Control-Plane latency
- At least 200 users per cell should be supported in the active state for spectrum allocation up to 5 MHz.

Mobility
- E-UTRAN should be optimized for low mobile speed from 0 to 15 km/hr
- Higher mobile speed between 15 and 120 km/hr should be supported with higher performance.
- Mobility across the cellular network shall be maintained at speeds from 120 km/hr to 350 km/hr (or even up to 500 km/hr depending on the frequency band).

Coverage
- Throughput spectrum efficiency and mobility target should be met for 5 km cells and with a slight degradation of 30 km cells. Cells ranging up to 100 km should not be precluded.
Although the work on 3G LTE is not completed, the basic technologies have been agreed along with their modes of implementation. Some of the main technologies and changes included are:
- **OFDM** (Orthogonal Frequency Division Mulplex).
- **MIMO** (Multiple Input Multiple Output).
- **SAE** (System Architecture Evolution).

OFDM
The modulation format for LTE will be OFDM (Orthogonal Frequency Division Multiplex) for the signal bearer and the access scheme will be OFDMA (Orthogonal Frequency Division Multiple Access).

MIMO

Another of the LTE major technology innovations is the use of MIMO or Multiple Input Multiple Output. This technology provides LTE with the ability to further improve its data throughput and spectral efficiency above that obtained by the use of 20MHz spectrum.

System Architecture Upgrades

These are naturally only some of the very basic features as a completely new cellular system will involve many changes. One of the major other areas of work is the infrastructure technology or System Architecture Evolution (SAE) which is required to simplify the system, particularly as IP data is more widely used. To handle not only the speeds required, but also the levels of data likely to be carried by 3G LTE a totally new infrastructure technology is needed.

Femto Cell

Femtocell is a low-power cellular base station basically designed for providing better in-building coverage in residential and small business offices. It is cost-effective as because it can be connected to the existing operator's network via broadband like DSL, or Cable, without the need for expensive towers. A call that is initiated from a hand set equipped with femtocell base station would start at cell phone then sent to the femtocell, which would then go from femtocell to internet via broadband connection and end up at cellular network, which is depicted below.[4][5]
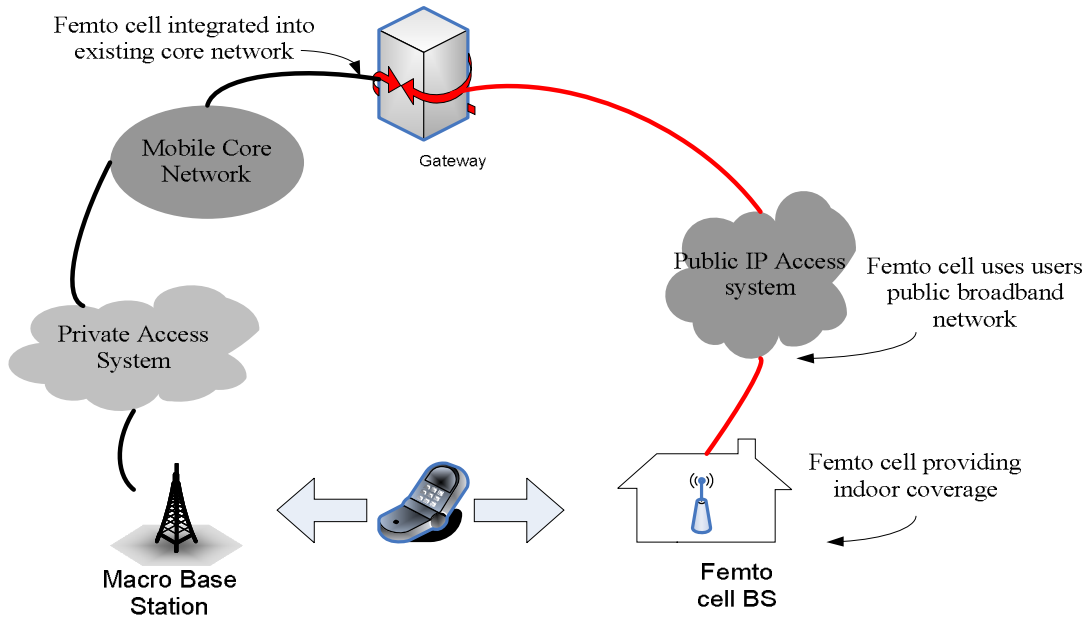
Figure 1: Femtocell Cell BS.

The traditional 3GPP 3G network architecture, made up of numerous macro base-stations, with its centralized RNC function and ATM backhaul was designed to

provide wide-area coverage. It was not however designed to scale, physically or economically, to provide effective coverage for individual indoor/residential situations. Femto cell has overcome this issue of indoor coverage by placement of the base stations in the end user premises.

Design

In this paper we employed the coloring algorithm, According to the concept we create the graph of interference .Once we get the interference graph ,we apply the coloring algorithm to that graph and get the chromatic number ,the chromatic number indicates the number of zones to be created in the network or it indicates the number divisions to be made on the spectrum of 10MHz. Once we get the number of zones, we assign the users to different zones randomly or by using the SINR(Signal to Interference Ratio) value, we allocate the number of channels to each zone in the initial stage itself, [9]once we assign the users to the zones the implementation of coloring completes the femto cell.

Coloring Algorithm

1) Get how many times each PRB used ,Use the table data structure to get the usage of each PRB.
2) Get the Interference graph by applying the below rules.
3) Apply the colouring algorithm to divide the interference graph into number of zones.
4) Divide the cell area into number of zones equal to chromatic number of interference graph.
5) Let, we are dividing into 3 zones:
   • If(PRB_Usage=3) send_PRB_to_Innerzone.
   • Else if(PRB_Usage=2)send_PRB_ to_ middlezone.
   • Else send_PRB_outerzone. [8]

Repeat the above procedure for other cells also

Simulation

The output should be considered for not less than 3 scenarios, as the frequency interruption is very much scenario dependent and it's very much difficult to arrive at an absolute value. So here three scenarios are shown. One scenario has all the femtos very near to each other and to the central base station. In another scenario femtos are loosely bounded to each other. The final scenario has an irregular arrangement of femtos with respect to the central base station. This section depicts the three scenarios, and the corresponding values of interference and throughput. Plot will be drawn for all the scenarios[10].

Scenario 1

This scenario has all the femtos placed near around the central base station. It can be seen in the following Figure . The green color Rhombus shape are femtos placed

around the red colored triangular shaped macro eNB.. Moreover an increase of 10% in throughput is observed. The plot in Figure 4 depicts the same.
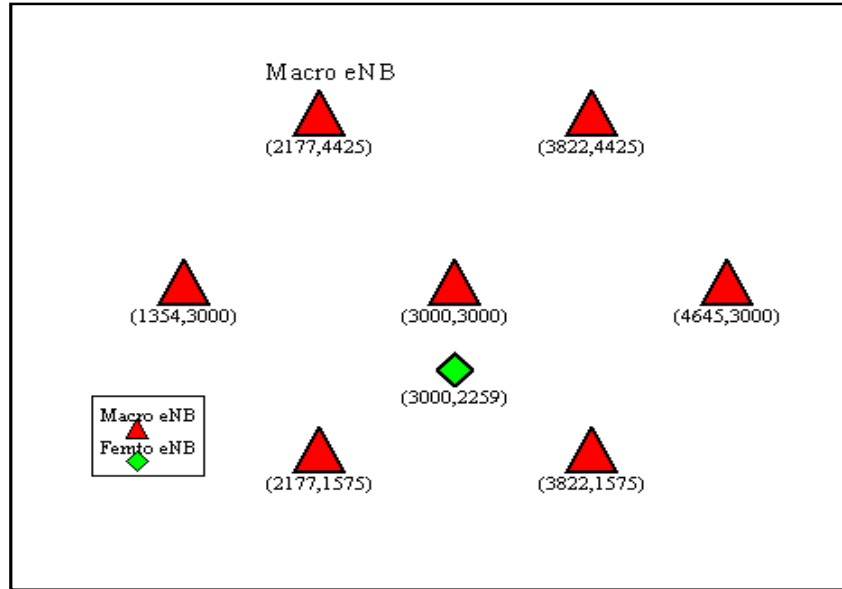

Figure 2

Simlilarly we go on adding the femto cell to the base stations mentioned in the above graph,the following Figure depicts 9 femto cell addition to the macro cell base station.
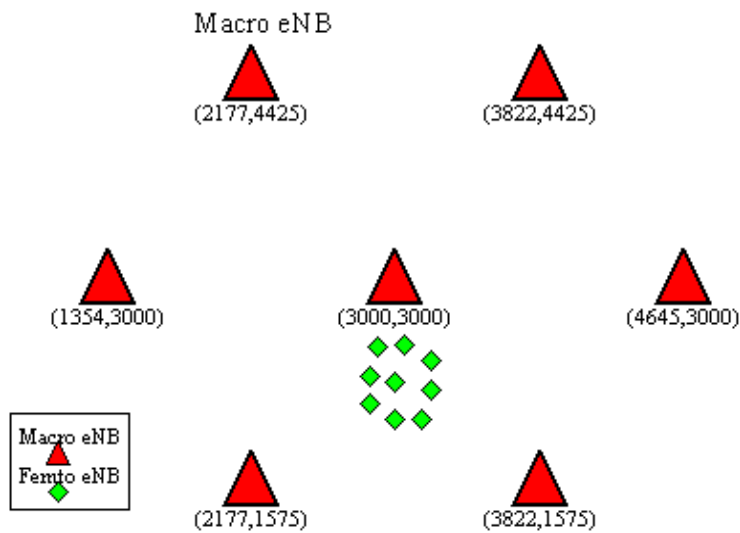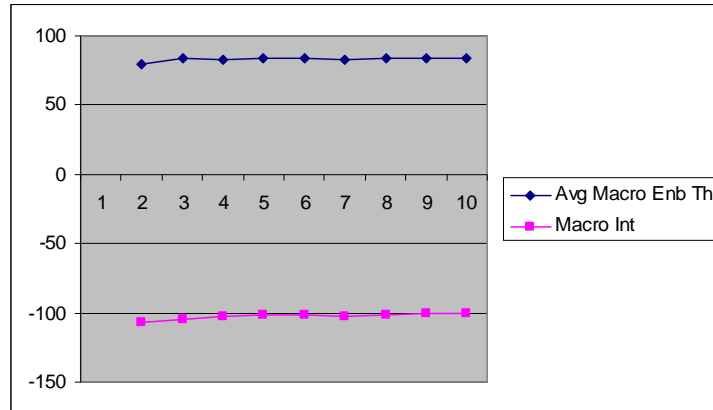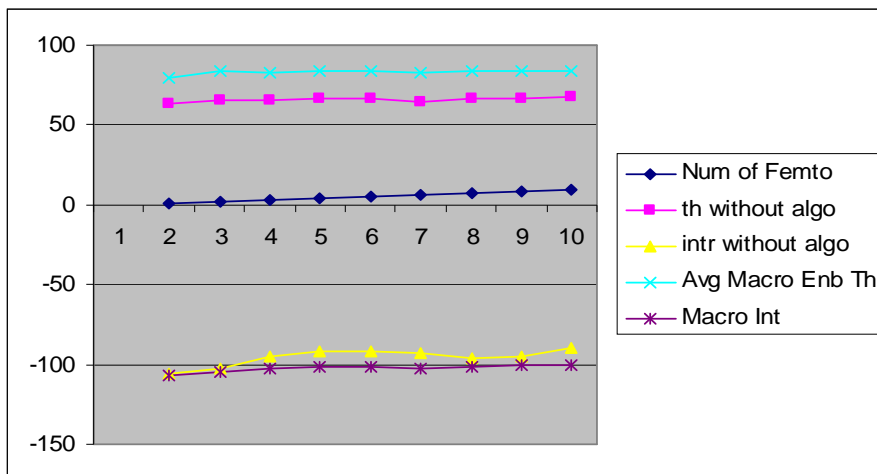

Figure 3

Figure 4: Throughput and Interference values plot for Scenario 1.

Comparison Curve

Based on the values with the algorithm and the values obtained without applying algorithm a plot is derived which shows clearly that in all the scenarios there is more than 5% improvement in the throughput. The Table 2 is the comparison with first scenario. The corresponding plot below depicts the increase in throughput and decrease in interference.

Figure 5: Comparison curve.

Conclusion

The proposed system algorithm reduces interference and increases the performance by more than 5%, and in some scenarios it reaches up to 10%. Though the prediction of absolute value for the performance in case of interference minimization is very difficult and bringing interference to complete zero is practically impossible, it is much better to minimize the interference to a range that the system does not get degraded. The project sticks to this logic and achieved the same. The Macro eNB experience greater relief by the introduction of algorithm. The femtocell placement

and their effect are checked against an ideal Macro eNB arrangement, which works with almost all femtocell placement scenarios. It has been taken care that not to introduce femtos when it actually ill-effecting the macro base station.

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