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Confederation based RRM with Proportional Fairness for Soft Frequency Reuse LTE Networks

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Abstract:- **In this RRM the resource is dynamically allotted in distributed and centralized manners so that spectral efficiency is maximized across the entire network. To do this a distinctive interference mapping technique is implemented to assistance with determining whether distributed or centralized mode is relevant per base station. A brand new radio resource management (RRM) technique for enhancing the downlink performance in soft-frequency reuse based lengthy term evolution (LTE) systems is presented. Whenever a distributed approach is granted to some base station it cause the whole spectrum while whenever a centralized approach is imposed on the base station it are only allotted a subset of the spectrum. The suggested then utilizes the confederation conception a feeling that when the allocation approach is determined the individual base stations can seize control of the allocated resource. When coupled with proportional justness scheduling, this RRM may also take advantage of multiuser diversity. Therefore, to be able to implement the SFR approach effectively in LTE heterogeneous cellular systems (Honest), all Smuts have adaptive interference avoidance capacity [5].It'll be shown through mathematical analysis and computer simulations that this method offers significant enhancements in terms of sum rate and excellence of service by growing the guaranteed data rate per user.**

Keywords:- **Heterogeneous Cellular Network, Radio Resource Management, Interference Mapping, LTE, OFDMA, Soft Frequency Reuse.**

I. INTRODUCTION

However, thinking about that LTE also utilizes micro-, Pico- and femtocells basestations (BSs), as small cell BSs (SBSs) within each microcell [2], when all subcarriers are occupied, spreads to more interference in the SBS's user equipment's (UEs). Soft frequency re-use (SFR) pattern maximizes spectrum utilization in Lengthy Term Evolution (LTE) networks by permitting all macrocell base stations (MBSs) to perform transmission within the entire available spectrum [1]. In addition, the existence of femtocells, as low cost alternative to Pico cells, leads to additional interference as they are set up and controlled through the finish-user [4].Therefore, to be able to implement the SFR approach effectively in LTE heterogeneous cellular systems (Honest), all Smuts have adaptive interference avoidance capacity [5].In 4G Honest, which employ orthogonal frequency division multiple access (OFDMA), downlink interference is practically reduced using radio resource management (RRM). This includes frequency spectrum allocation and power control this however reduces ale the interfering BSs to completely exploit multiuser diversity and consequently reduces the achievable throughput. Thus, in order to capture this, you should assess the combined performance of RRM and scheduling together. Probably the most popular scheduling calculations in OFDMA systems include maximum sum rate (MSR), maximum justness (MF), proportional rate constraints (PRC), proportional justness (PF) and also the cumulative distribution function (CDF) based scheduling policy Due for this reason, PF based scheduler is commonly applied within the cellular environment In general, OFDMA RRMs could be classified into three groups, that are, distributed, centralized and self-organizing network (Boy)Distributed RRM works by allowing each SBS to allocate its UEs' subcarriers based on measurements from the interference received while the centralized RRM utilizes a central node to compute the subcarriers allocation for those Usher best distributed RRM may be the self-organizing approach which utilizes 1 / 2 of the accessible spectrum and adjusts the allotted subcarriers in line with the interference received in the surrounding atmosphere. Within this formula, connecting node is visualized through the central processor if you're Absences that a minimum of one of their customers is interfered. Motivated by the necessity to achieve greater spectral efficiency and better Qi's, this paper presents a confederation- style Boy RRM coupled with a routing formula. The confederation aspect works well for minimizing overhead signaling while the routing formula can be used to maximize spectral efficiency. The proposed utilizes a novel downlink interference mapping method in the type of a matrix of conflicts (Mock) to trace how these links affect certain UEs and look for possible interference instances per user. Once the Mock signifies no potential interference, the BS will work the PF scheduling because of its Issuing the whole available spectrum. Otherwise, a centralizers-routing is invoked to avoid the interference instances [3]. In most cases, the centralized approach is used only when the Mock within several BSs undergoes certain changes. The suggested technique uses the Boy functionality to facilitate effective and efficient use of this method, and that's why it's categorized as Boy-RRM.

II. PRELIMINARIES AND SYSTEM MODEL

This paper views a downlink scenario of SFR based HetNet. The downlink transmission uses N subcarriers OFDMA with adaptive modulation using BPSK, QPSK,16QAM, 64QAM and 256QAMN subcarriers are divided into I separate groups with index i and every group hazing subcarriers where inner customers is going to be allotted with I -1subcarriers groups for inner customers and 1 subcarriers group for the outer customers [5]. Because this frequency pattern doesn't provide empty sources for SBSs' customers, the assumption is the Subsist qualified to make use of the whole spectrum. The micro- and Pico- cells BSs are associated with the macro cell with an OMS (operator management system)while some femtocell access points or Home Node BSs(HNBs) are linked to a Feta Management System (FMS),that is controlled by an OMS with the IP backhaul. We think about the Boy functionality works for all's. By using this capacity, each BS has the capacity to establish the neighboring BSs link instantly. We further think that standard funnel gain or channel state information (CSI) feedback between UEs and their serving Baste may use either, time-division duplexing (TDD) or frequency-division duplexing (FDD). Within the situation ford, the funnel gain information in allotted sources can be acquired from the uplink transmission. Around the other hand, within the situation of FDD the CSI are only able to be acquired by the full feedback funnel. Since this post is needed for channel dependent scheduling, and never specific towards the proposed scheme, there's no more information exchange betweenUEs and it is serving BSs.

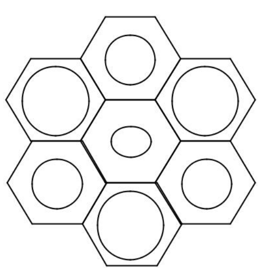


Fig.1. Proposed system cell site

III. SIR THRESHOLD ANALYSIS AND EVALUATION

For much better clearness, allows think about a homogeneous cellular network that contains only femtocells to represent the SBSs. Presuming, for the time being, AWGN channels which adaptive power control and PF scheduling aren't used in the BS bandwagon channels, it may be easily proven that, while using proposed algorithm, the received SINR in the allotted subcarriers of UE, Lower Bound Resource Utilization, Guaranteed, Rate [6].

Soft Frequency Reuse

In Soft Frequency Reuse (SFR) the cell area is divided into two regions; a central region where all of the frequency band is available and a cell edge area where only a small fraction of the spectrum is available. The spectrum dedicated for the cell edge may also be used in the central region if it is not being used at the cell edge. The lack of spectrum at the cell edge may result in much reduced Shannon Capacity for that region. This is overcome by allocating high power carriers to the users in this region thus improving the SINR and the Shannon Capacity.

1. The Signal to Interference and Noise Ratio is given as:
   SINR = Signal Power/(Intercell Interference+Intracell Interference+AWGN Noise)
2. Typically the term capacity was used to describe the number of voice channels (or users) that a system can support. But with modern digital communication systems it usually refers to the Shannon Capacity that can be achieved (in bits/sec/Hz).

RESOURCES SCHEDULING ALGORITHMS

A number of the radio resource scheduling algorithms have been proposed in the literature and are described briefly in the following subsections.

a) Proportional Fairness Resource Allocation Scheme

In PF scheduling algorithm for OFDMA, the priority for each user at each resource block is calculated firstly and then the user with maximum priority is assigned the RB and the algorithm continues to assign the RB to the user with next maximum priority. This process continues until all RBs are assigned or all users have been served with RBs.

The priority of k-th user for j-th resource block in time 'n' is calculated as follows

$$P_{k,j}(n) = RDR_{k,j}(n) / R_k(n)$$

Here $RDR_{k,j}(n)$ denotes the requested data rate for the k-th user over the j-th RB in time n and $R_k(n)$ is the low-pass filtered averaged data rate of the k-th user. RDR is
estimated using AMC (Adaptive Modulation and Coding) selection which is based on current transmission channel condition. RDR for retransmissions is clearly separated from the RDR of new resource requests as retransmissions must be treated specially to guaranty their successful reception at the receiver and in that case RDR is estimated as follows

$$RDR_{k,j} = R_{MCS}\ (SNR_{AC})$$

Here R_{MCS} is the rate estimation function and SNR_{AC} is the accumulated signal to noise ratio over the transmission channel.

On each interval of scheduling, the $R_k(n)$ is updated as follows

$$R_k(n+1) = (1-a)\ R_k(n) + a\ .\ RDR_k(n)$$

where 'a' is average rate window size and $RDR_k(n)$ is the aggregate data rate of user k time n.

b) Softer Frequency Reuse based Resource Scheduling Algorithm

In order to reduce the frequency selective scheduling gain loss and to increase the data rate at cell edge, the softer frequency reuse scheme is proposed. In this scheme the frequency reuse factor both at cell centre and cell edge is 1. The high power frequency band is different between neighbouring cells.

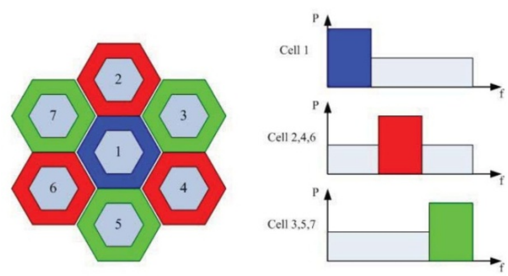


Figure2: Frequency Planning and Power Allocation for SFR Scheme

The designed frequency scheduler runs in a way that the cell edge users have the greater probability to use the frequency band with higher power and the cell center users have the higher probability of using frequency band with lower power.

We need to do a little modification in PF scheduling algorithm as follows

$$P_{k,j}(n) = RDR_{k,j}(n) / R_k(n) * F_{k,j}$$

where $F_{k,j}$ is the priority factor and can be one of the following

$F_{1,1}$, User k at cell center, RB j is low power
$F_{1,2}$, User k at cell center, RB j is high power
$F_{2,1}$, User k at cell edge, RB j is low power
$F_{2,2}$, User k at cell edge, RB j is high power
$F_{k,j}$ can have the value between 0 and 1.

Here we can easily assign the values to $F_{k,j}$ to control the resource assignment to users at cell center and cell-edge.

DIGITAL MODULATION TECHNIQUES

Modulation is of utmost importance to all wireless communications. Most wireless transmissions as of today are digital with limited available spectrum; thus the type of modulation employed is crucial. The transition of analogue to digital modulation offered improved data security, enhanced quality communication, additional information-carrying capacity, compatibility with digital data services, swift system availability as well as RF spectrum sharing to accommodate added services.

However, factors such as bandwidth availability, permissible power and inherent noise level of the system are major restrictions developers of communication systems face in the industry which affect spectral efficiency; thus slowing down how fast information can be transmitted in an allotted bandwidth . Other factors include the increased data rates, higher mobility, larger carrier frequencies, and system reliability due to increase in services demanded by users. Digital Modulation techniques provide numerous benefits such as greater capacity to transmit large quantity of data with high noise immunity. Another silient advantage is easy detection of its distinct transmission state at the receiver in a noisy medium.

When a digitally transmitted signal is initiated as analogue waveform, trade-off is always made due to loss of some information in quantization process required to convert the analogue signal to a digital signal. The choice of digital modulation techniques employed is very important, particularly in uplink-downlink transmission where resources such as bandwidth and time slots are limited.

The performance of a modulation technique is measured in terms of its Bandwidth and power efficiency. Bandwidth efficiency is the ability of a modulation technique to accommodate data within a limited bandwidth while power efficiency is the capability of a modulation technique to preserve the bit error probability of the digital message at low power levels. So we have chosen PSK as digital modulation technique. The performance of different forms of PSK such as BPSK (2-PSK), QPSK (4-PSK), 8-PSK and 16-PSK have been evaluated in order to find which modulation technique will be suitable to get maximum benefit from available network.

In a communication system the quality of the transmission is usually quantified by either the Bit Error Rate (BER) or the Packet Error Rate (PER), where a packet contains a number of bits. The main goal in the design of digital communication system is to achieve least probability of error and effective utilization of channel bandwidth.

Spectral efficiency refers to the amount of information that can be transmitted over a given bandwidth in a specific digital communication system. It is a measure of the number of bits transferred per second for each Hz of bandwidth and thus the spectral efficiency S_E is given by:

$$S_E = \frac{C}{W} = log_2\left(1 + \frac{S}{N}\right)$$

where both the signal and noise are linear scale and the spectral efficiency is measured in b/s/Hz.

The key to achieving this higher level of service delivery is a new air interface. Orthogonal

Frequency Division Multiplexing (OFDM) is an alternative wireless modulation technology to CDMA. It is a digital modulation and multiplexing technique suitable for 4G technology.. The driving force behind the need to satisfy this requirement is the explosion in mobile telephone, Internet and multimedia services coupled with a limited radio spectrum.

The spectral efficiency of OFDM signal can be found by multiplying the spectral efficiency of modulation technique by the number of Subcarriers. The BER performance of an OFDM signal in a fading channel is much better than the performance of QPSK/FDM which is a single carrier wideband signal. Though the underlying BER of an OFDM signal is exactly the same as the underlying modulation, that is, if 8PSK is used to modulate the sub-carriers then the BER of the OFDM signal is the same as the BER of 8PSK signal in Gaussian channel. But in channels that are fading, the OFDM offers far better BER than a wideband signal of exactly the same modulation. The advantage is due to the diversity of the multi-carrier such that the fading applies only to a small subset.

Signal to noise ratio (SNR) is the difference between the signal strength a system reproduces compared to the strength or amplitude of its background noise. According to Shannon's Theory of information, the maximum capacity of a channel of bandwidth *W*, with a signal power of *S*, affected by white noise of average power *N*, is given by

The next difference between the third and fourth generation is bandwidth. At first glance, the bandwidth of both 3G and 4G are the same, between 5 and 20 MHz. However, the rate of data is what makes the difference between the two. While the data rate of the third generation only goes up to 2 Mbps, the fourth goes all the way up to between 100 Mbps to 1 Gbps.

3G system is based on wideband CDMA that operates in 5 MHz of bandwidth and can produce download data rates of typically 384 kb/s under normal conditions and up to 2 Mb/s in some instances. 3G phone standards have been expanded and enhanced to further expand data speed and capacity. The WCDMA phones have added high speed packet access (HSPA) that use higher level QAM modulation to get speeds up to 21 or 42 Mb/s downlink (cell site to phone) and up to 7 and/or 14 Mb/s uplink (phone to cell site), whereas 4G, also known as LTE, uses a completely different radio technology. Instead of CDMA, it uses orthogonal frequency division multiplexing (OFDM) and OFDM access. This modulation technique divides a channel usually 5, 10 or 20 MHz wide into smaller subchannels or subcarriers each 15 kHz wide. Each is modulated with part of the data. The fast data is divided into slower streams that modulate the subcarriers with one of several modulation schemes like QPSK or 16QAM. It also defines multiple input multiple output (MIMO) operation that uses several transmitter-receiver- antennas. The data stream is divided between the antennas to boost speed and to make the link more reliable. Using OFDM and MIMO lets LTE deliver data at a rate to 100 Mb/s downstream and 50 Mb/s upstream under the best conditions. In 4G the theoretical upper data rate is 1 Gb/s.

Available bandwidth, permissible power and inherent noise level of the system are the constraints which should be considered while developing the communication systems. Due to error-free capability in digital modulation, it is preferred over the analogue modulation techniques. The Worldwide interoperability for Microwave Access (Wi-max) uses combinations of different modulation schemes which are BPSK, QPSK, 4-QAM AND 16-QAM and it is a promising technology which offers high speed voice, video and data services.

In analog communications an analog signal is taken and it is modulated using an analog carrier, whereas in the digital communications a digital signal or binary data is taken and modulated using an analog carrier.

The main objective of our work is to measure Bit Error Rate with different modulation schemes and come to the best configuration to achieve better utilization of bandwidth.

$$C = W\log_2\left(1 + \frac{S}{N}\right)$$

This paper is the comparative study of digital modulation techniques that can be used in OFDM. The outcome of this study, and the comparison of the results, will enable us come up with the combination of different encoding-decoding and modulation-demodulation techniques which will best suit the current expectations of end-users.

4G speeds are much faster compared to 3G. 4G speeds are meant to exceed that of 3G whose maximum current speeds are at about 14Mbps downlink and 5.8Mbps uplink. To be able to qualify as a 4G technology, speeds of up to 100Mbps must be reached for a moving user and 1Gbps for a stationary user. So far, these speeds are only reachable with wired LANs. The fourth generation is faster, it is said to be four times faster than its predecessor. This allows for a connection speed more comparable to DSL and home cable networks. It is great news for those completing work and accomplishing important tasks away from their home and office. When uploading large documents and communicating via the internet, a fast connection is important, whereas 3G does not favour such speed as compared to that of 4G.

BIT ERROR RATE ANALYSIS

Binary Phase Shift Keying (BPSK)

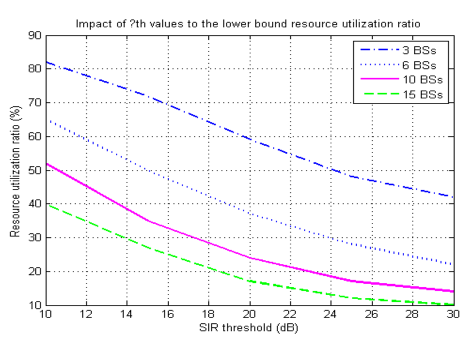
Phase modulation offers PSK which is divided into techniques such as BPSK, QPSK etc. In these techniques data is conveyed by changing the phase of the carrier wave. BPSK digital modulation technique is the simplest form of the phase shift keying modulation. It uses two phases which are separated by a phase shift of 180° which makes it to be referred to as 2-PSK.

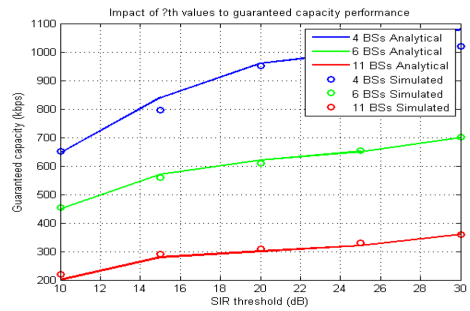
The signal shifts the phase of the waveform to one of the two states to represent binary symbol of either 1 or 0 respectively. Coherent BPSK has one dimensional signal space with two message points, in order to generate a BPSK signal, the input binary data in polar form with symbol 1 and 0 are represented with a constant amplitude level of $\sqrt{E_b}$ and $-\sqrt{E_b}$. The signal transmission encoding process is carried out by a Non Return Zero level encoder (NRZ). The output binary wave together with the sinusoidal carrier $\emptyset_1(t)$, whose frequency is given by $f_c = \frac{n_c}{T_b}$ are fed into the product modulator and the desired BPSK wave is attained as the output of the modulator.

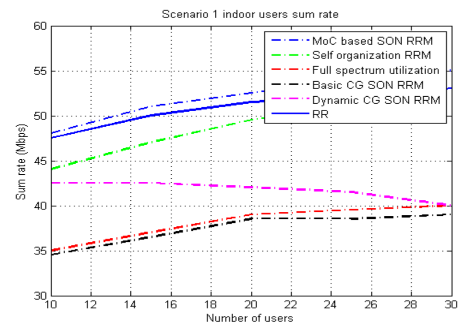
To demodulate the original binary sequence of 1 and 0 the incoming BPSK signal is passed into a correlator, which is made up of the multiplier and the integrator. The incoming signal together with the coherent reference signal $\emptyset_1(t)$ is multiplied and the output is fed into the integrator. The output of the correlator x_1 is compared with a threshold of 0 and decision is made based on the decision rule. If $x_1 > 0$ the device generates output of 1 but if $x_1 < 0$, the device generates output of 0.

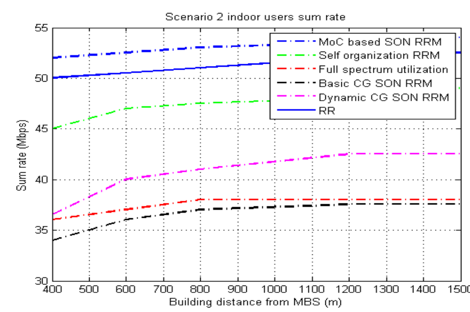
BPSK is employed majorly in satellite communication due to its implementation simplicity and robustness. Other advantages of BPSK include 3dB power improvement and double information carrying capacity when compared to BASK. However it is important to note that this modulation technique is bandwidth inefficient due to the fact that it is only able to transmit 1bit/symbol, thus making it inapt for high speed data rate application.

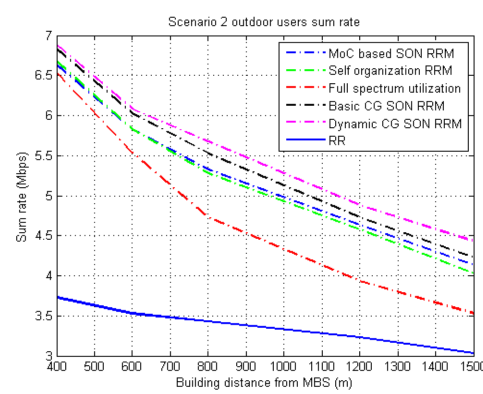
SIMULATION RESULTS

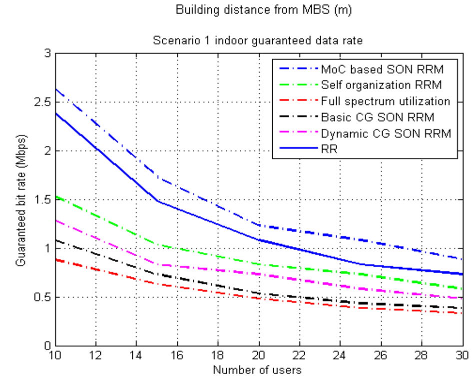


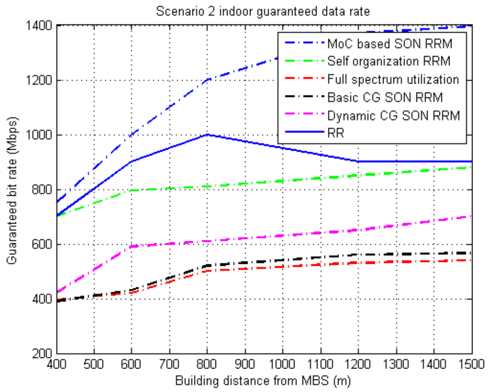


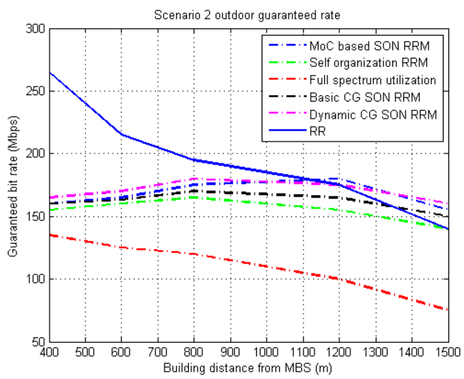


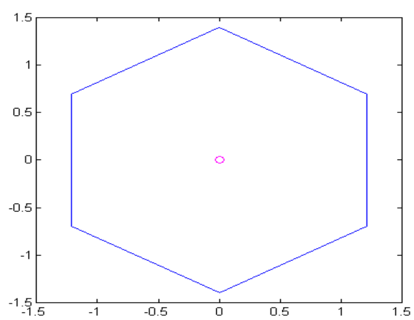


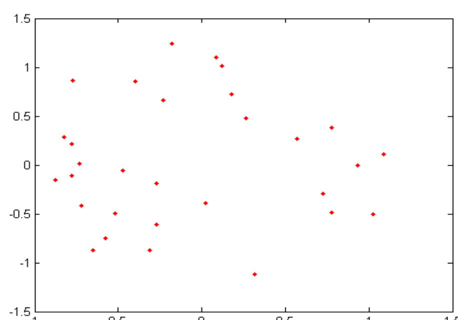












IV. CONCLUSION

As the distributed approach permit the PF scheduler to make use of the full spectrum, the centralized approach utilizes the interference map along with a routing technique to identify available subcarriers for the PF scheduler to maximize spectrum utilization. This paper presented a confederation style RRM in which distributed and centralized approaches are put on improve the data rate and Qi's in SFR based LTE Honest. It was shown the way the suggested interference map tracks interference between one BS and also the surrounding UEs. It was shown the suggested formula has the capacity to improve the guaranteed data rate along with the sum rate for those LTE HetNet users in a variety of situations including different quantity of users and distances in the MBS. The outcomes shown that the suggested is a great candidate to maximize the downlink performance in LTE Honest.

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