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ECO-FRIENDLY ENERGY EFFICIENT TRANSMISSION

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Abstract---- Green Communication helps us in providing an Eco-friendly environment. The vast requirement and development of Green Communication leads to energy saving transmissions. As more than one Component Carrier (CC) can be jointly utilized in Base Station (BS), the energy consumption of BS is a vital concern. In this paper we propose a technique for energy- efficient data transmission. We use two CCs and it supports both Real Time (RT) and Non-Real Time (NRT) users. The downlink transmission in BS Orthogonal frequency division multiple access based carrier components are considered. Simulation results show the energy consumption of the proposed system is much better when compared with the existing systems.

Keywords---- Green Communication, OFDMA, energy efficiency, eco-friendly environment, Radio Resource Allocation.

I. INTRODUCTION

The cellular communication industry has witnessed explosive growth. Wireless communication networks have become much more pervasive than anyone imagined when cellular concept was first developed in 1960s and 1970s (Rappaport-2001). The demand in wireless communication has driven the need to develop new higher volume, high reliability wireless telecommunication systems. New standards and technologies are being implemented to allow wireless networks to replace fibre optic or copper lines between fixed points several kilometres apart. Similarly, wireless networks have been increasingly used as replacement for wires within homes, buildings and office settings through WLANs. Bluetooth technology is also a promising candidate for trouble free wireless communication. The telecommunication world is opted to be the main cause of consumer of energy and took place as the major participant in the emission of Carbon footprints in to atmosphere and enormous consumption of energy by networks. Hence energy efficient communication attracts attention towards it. It is spotlighted that the total energy devoured by the communication networks and the internet is above 3% of the world wide electric consumption and is anticipated for a rapid increase in future [1]. Telecommunication sector has about 6 million subscriptions in the world [2] 2% of the total emission of CO_2 [3]. The production of 0.75 million tons of CO2 for every 1 terawatt hour (TWh) energy consumption [4] are due to ICT sectors and is increased twice for every five years[5]. In order to prevent the rise in global temperature less than 2^{o} C, it is essential for reduction in the emission rate of CO2 of up to 15% to 30% [6]. It is estimated that the worldwide energy swallowed by internet is equal to 14 power stations [7]. This leads to the increase in global warming. Global warming is described as increase in the average temperature of Earth's atmosphere and oceans. Since the early 20th century, the mean surface temperature of our Earth has been enlargement to about 0.8 °C (1.4 °F), with concerning two-thirds of the growth occurring since 1980. The rise in temperature in climate system is unambiguous, and scientists are 95-100% sure that it is primarily occurred by increasing applications of greenhouse gases produced by human activities such as the blazing of fossil fuels, deforestation, etc. These findings are identified by the national science academies of all major industrialized nations.

This grow up in global warming is due to the mount in CO2 emissions into the atmosphere. The carbon-di-oxide is also released by the base stations during transmission and reception of signals. The remedy for this is to use the green communication which helps in the reduction of carbon di oxide in to the atmosphere. The core tenant of our Green Communications vision is to reduce overall energy consumption within framework of optimizing system capacity and maintaining user Quality of Service. Green Communications is the result of six years of academic research in the area of quality of service mesh networks. Its highly innovative technology offers a cost-effective solution to the needs of Wi-Fi coverage in crowded public places: city centers, stadiums, conference centers. Its two founders, Khaldoun Al Agha and Guy Pujolle are acknowledged by experts in the world of research and industrial transfers. It has some merits like eco-friendly environment; lessen carbon foot print in the atmosphere and there by lower the global warming in our Earth.

A rate adaptive resource allocation method for Multi-User Orthogonal Frequency Division Multiplexing (MU-OFDM) is proposed in [7]. [8] Says about the implementation of efficient algorithm for allocating sub carriers and power among users for multi user orthogonal frequency division multiplexing. Quantized water filling packet scheduling algorithm for high data rate nomadic users has been proposed in [9]. It can be finding in [10] that the data rate could not be efficiently and adaptively adjusted according to network traffic loads and proposed a technique for dynamic power adjustment to enable energy efficient data transmissions by utilizing only necessary transmission power. A Holistic approach for energy efficient radio networks by using 3 levels of mutual supplementary saving concepts, such us component, link and network levels has been proposed in [11]. It also employs a computationally efficient scheme according to the fluctuating traffic loads. Radio resource management schemes like Connection Admission Control (CAC) and Packet Transmission Scheduler (PTS) which are the two levels of it is proposed in [12]. It can also be found in [13] a multiuser OFDM subcarrier algorithm, bit and power allocation algorithm is proposed to minimize the total transmit power and derived a multiuser adaptive subcarrier and bit allocation algorithm. [14] Focused in the efficiency of the resource management scheme from the practical point of view.

II. OVERVIEW OF OFDM AND OFDMA

The network with high throughput requires huge energy consumption. Reducing the amount of consumption of energy and there by meeting the high throughput in the networks is the immediate task required now a days. OFDM is recently selected as High Performance Local Area Networks (HIPERLAN) transmission technique as well as becoming part of the IEEE 802.11 WLAN standard. The basic system principle is that original bandwidth is divided into a large number of narrow sub-bands in which the mobile channel can be considered non-dispersive. The sub carriers are orthogonal to each other and hence carriers can be overlapped. Hence no channel equalizer is required. And instead of implementing a bank of sub-channel modems, they are implemented using single IFFT/FFT algorithm. The use of DFT exchanges the bank of sinusoidal generators and demodulators, which thus notably lowers the implementation complexity. OFDMA has been comprehensively studied for successive generation wireless communication systems. To achieve high performance in OFDMA, the system resource is to be awarded properly to various users. Each terminal occupies a subset of sub-carriers and Subset is called an OFDMA traffic channel.

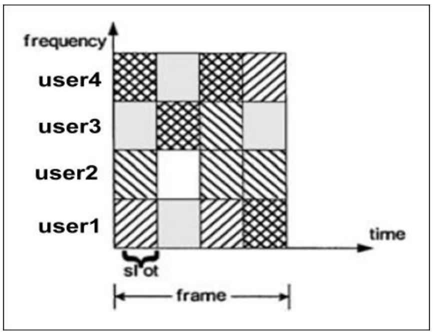

Figure 1: OFDMA

III. SYSTEM MODEL

A. Basic Assumptions:

In a single cellular network, the downlink load is higher when compared to the uplink load. Hence, the downlink transmission is taken into consideration. This concept is implemented in BS. Two CCs can be used by the BS at the same time. They are classified as Primary Component Carrier (PCC) and Secondary Component Carrier (SCC). PCC is given first priority for each transmission. Whenever the PCC is found to be engaged, the transmission is performed by using the alternate CC i.e. the SCC. The bandwidth of each CC is in Hz. The total bandwidth is divided into N sub channels and each sub carrier in sub channel suffers from the same amount of fading. A group of M OFDM signals is called as a single frame and the channel state in each frame is maintained fairly stable. The Allocation Unit (AU) furnishes, sub channel on frequency axis and OFDM on time axis. In LTE-A the frame structure scheduling process is executed sub frame by sub frame. Each sub frame has considerable number of sub channels and 2 time slots. The Resource Block (RB) consists of 7OFDM symbols in 1 time slot and 12 Sub Carrier in 1 sub channel.

B. Block diagram and its description:

The classifier is used to classify the incoming session as Real Time (RT) and Non-Real Time (NRT) essions. The classified RT and NRT sessions are queued in the separate queues.

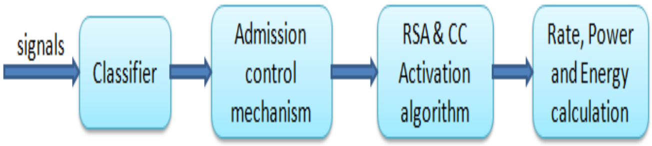

Figure 2: System Flow

C. Admission Control Mechanism:

The admission control mechanism is used to judge whether the session is to be blocked in the scheduling queue or allowed to the next block. It is also used to determine the correct CC to be assigned to the session when it is allowed to the network.

ALGORITHM:

1. Compare the energies $E_k < \rho E_{max}$

Where

E_k – Energy of K_{th} carrier

E_{max} – Maximum available energy in each sub frame

ρ - Upper Marginal Factor

2. If (1) is yes

Check the SCC status whether it can be used.

Else
Block the session and return.
3. PreOnFlag - indicator; to determine whether the new user session can access SCC
PreOnFlag = 0; can't access SCC
4. If (3) is yes
PCC can be used when N_1<S.
Else
CC k* with minimum E_k is selected and check N_{K*}<S.
5. If (4) is yes
Assign the session to CC1
Else
Block the session and return.
6. When the Else condition of 4 is performed
Assign the session to CC K*
Else
Check (N_k < S) && (E_k < E_{max}).
7. If the Else condition of 6 is performed
Assign the session to CC K*
Else
Block the session and return.

The output of the Admission Control Mechanism is given as the input to the next block.

D. Resource Scheduling Algorithm (RSA):
It includes 2 Algorithms, they are
- Energy Adaptive Rate Control Algorithm (EARCA)
- Radio Resource Allocation Algorithm (RRAA)

1. Energy Adaptive Rate Control Algorithm (EARCA):
It is used to maintain the fairness among the users in certain level natural log function of level 1 is based on classic PF and to adjust the NRT user's allocated capacity based on his/her path loss feedback and current used energy.
The design approach of EARCA:
1. Large NRT users are placed in a cell.
2. RB's are allocated based n PF criterion and equal power is allocated in each RB.
3. Average data rate as a function of path loss gain is calculated
4. Natural log function based on filtering method of minimum mean square filtering method.
5. Normalize the natural log function so as the reduction ratio of NRT user having maximum channel gain equals to 1.

2. Radio Resource Allocation Algorithm (RRAA):
RRAA is designed on the basis of Resource Allocation Approach in the beginning of decision epoch in every sub frame.
It has 2 sub algorithm, they are
- Bandwidth Allocation Algorithm (BAA)
- Resource Block Allocation Algorithm (RBAA)

2.1 Bandwidth Allocation Algorithm (BAA):
It is used to determine that how many RB's should be assigned to each user session. The algorithm is as follows:

1. User feedbacks the channel gain to the base station so that the averaged square channel gain is calculated as input arguments.
2. Number of required R's is '0' for all users initially.
3. To guarantee minimum data requirements 1 RB is given to all users.
4. Remaining RBs are allocated according to allocation metric.
5. The user which has decrease in energy consumption after allocating RB's will be given another RB.
6. After allocation, the number of required RBs for the selected user will be added by 1.

After BAA; RBAA is executed subsequently

2.2 Resource Block Allocation Algorithm (RBAA):

The algorithm for the RBAA is described as follows.

1. Find the user who has huge channel gain
2. Examine whether, Number of current allocated RBs of user is equal to Number of required RBs.
3. If (2) is yes Find another user with largest channel gain till while loop is over.
4. After while loop, allocate RB to the user session picked in this run.

After executing the two sub algorithms, the following steps are carried on.

- RBs for every user session is determined
- Data rate of each user session is equally distributed over all allocated RBs.
- Energy for each RB is determined.

Component Carrier Activation Algorithm (CCAA):

The component carrier activation algorithm is used to determine the practical use of SCC according to fluctuating network traffic load to conserve main energy consumption of Base Station (BS).

IV. SIMULATION RESULTS

1. CLASSIFIER OUTPUT:

The classifier classifies the signal into Real Time Signals and Non Real Time Signals. Real-time signal extraction is concerned with the estimation of signals of interest believed to be present in a time series, where the estimation procedure involves only current and past data. These signals are typically components of the time series that have a significant impact on the overall dynamics, and are pertinent to the particular application. The NRT signals are always the discrete signals with less urgency. Hence Real Time signals are always given high priority. The signals with high frequency are classified as the RT signals and the rest of the signals are classified as NRT signals. RT signals are mostly the sinusoidal format and the NRT signals are the stored signals which are about for transmission. The incoming signals are categorized into RT and NRT based on the above procedure.

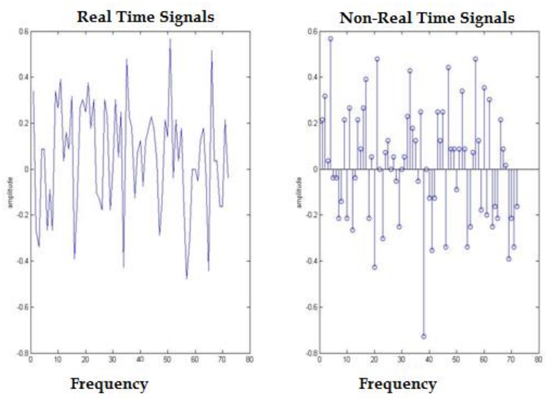

Figure 3: Classified RT and NRT signals

The signals are then sent to the scheduling queue in which the RT and NRT signals are given in the respected queues. The queue is generally in the form of FIFO where the first incoming signal is delivered out first. The queue which I used here is that the length of the queue is calculated and the queue which has the highest length is given the high priority and that signal is delivered out first. This type of prioritizing queue helps us in reducing the time consumption. The output of the queue is given to the rest of the algorithms and the outputs are thus obtained.

2. Data Rate Calculation:

The rate at which the signals are transmitted in the channel is calculated as the data rate, which can be calculated by dividing the number of bits transferred by the time taken by bits.

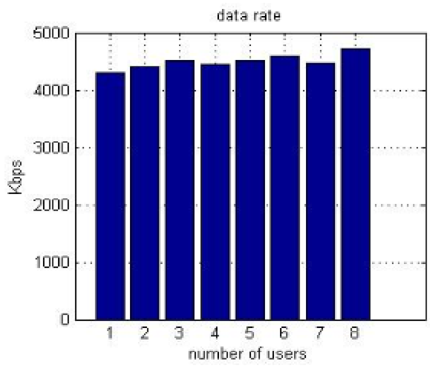

Figure 4: Data Rate Graph

The obtained graph shows us that the system has the high data rate which shows that the system has high Quality of Service.

3. Arrival Time:

The arrival time is calculated by dividing the total time by the product of number of channels and the number of samples. This arrival time is combined with the user and is plotted in the above graph. This arrival rate is used to in the scheduling queue in order to avoid congestion.

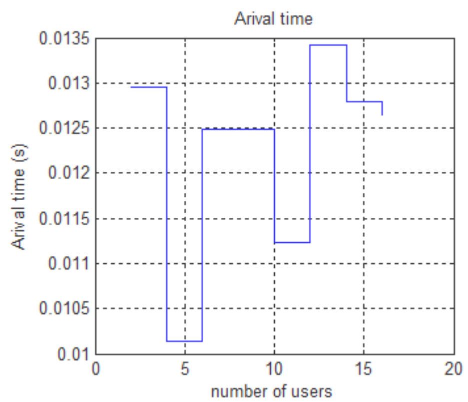

Figure 5: Arrival Time Graph

4. Fairness Index:

The fairness index is used to determine whether the users or applications are receiving a field share of system resources. The fairness of the system must be always high as it determines the quality of service. It is calculated by dividing the channel capacity with the number of channels. The obtained output is plotted in the graph with X label as the number of users and the axis as the Fairness Index.

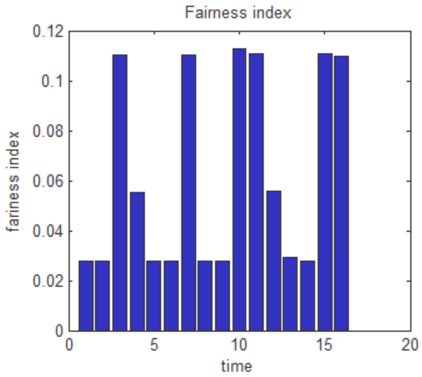

Figure 6: Fairness Graph

5. Energy Consumption:

The energy consumption of the signal is calculated bt suing the formula as follows:

$$y(n) = \left(\frac{x(n)}{f(n)}\right) * conj\left(\frac{x(n)}{f(n)}\right)$$

Where,
x(n)- input signal
f(n)- input signal frequency
y(n)- energy consumed
The energy thus calculated is plotted in a graph and is shown below.

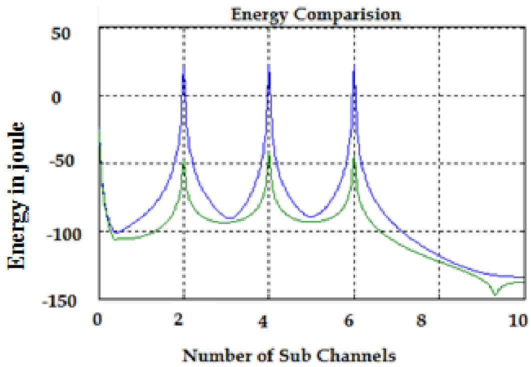

Figure 7: Energy Consumption Graph

V. CONCLUSION AND FUTURE WORK

The OFDM signals are thus generated and the signals are classified into the Real Time and Non-Real Time signals. The classified signals are then prioritized in the scheduling queue in the FIFO basis. The rate, power and energy of the signals are calculated and plotted in the graph. In future it is planned to use MIMO combined with OFDM to reduce the amount of energy consumed by each base station. Using MIMO we can improve the spectral efficiency and communication performance.

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BIOGRAPHY

S.Mugunthamala received her B.Tech degree in Electronics and Communication Engineering from Kalasalingam University, Tamil Nadu, India in 2012, and M.E in Communication Systems at National Engineering College, Kovilpatti, Tamil Nadu, India in 2014. At present working as Assistant Professor/ ECE in Kalasalingam Institute of Technology. Her research interests include wireless communications and mobile networks, broadband multicarrier/OFDM techniques, adaptive resource allocation.

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