Implementation and Realtime Analysis of OFDMA Networks using Hybrid Model

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Abstract- **To evaluate performance of any cellular network, throughput evaluation is the fundamental parameter. Orthogonal frequency division multiplexing (OFDM) has become one of the most promising radio interface technologies for future generation wireless networks. In proposed system a hybrid model consist of both analysis and simulation. The benefit of the model is that the throughput of any possible call state in system can evaluated. The probability of possible call distribution is first obtained by analysis which is used as input to event-driven based simulator to calculate throughput efficiency of a call state. By increasing the Net bit rate(R) data throughput can be increased and by introducing fading effect same efficiency can be achieved using Hybrid model. The simulation is being done by using MATLAB simulation.**

I. INTRODUCTION

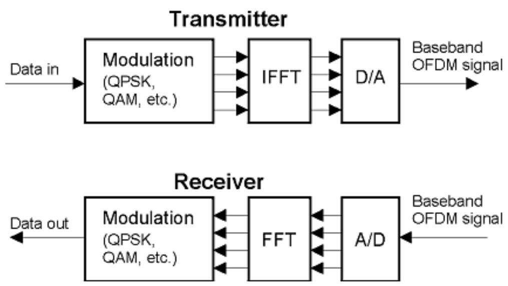
In an orthogonal frequency division multiple access (OFDMA) network, .transmission is achieved by transmitting data via multiple orthogonal channels. One of the most important aspects of any commercial mobile network deployment is its information carrying capacity, and data throughput is one fundamental parameter in the capacity planning for cellular system deployment. The goal of LTE is to improve the spectral efficiency and hence increase the network capacity, improve services, lower costs. In an orthogonal frequency division multiple access (OFDMA) network, transmission is achieved by transmitting data via multiple orthogonal channels. Due to the use of multiple orthogonal channels, OFDM also performs equalization and is consequently robust to inter-symbol interference and frequency-selective fading [2], [3]. Reference [7] has evaluated the performance of the OFDMA network based on analytic and simulation approach separately has considered a hybrid simulation/analysis approach, where a detailed rate distribution obtained via simulation is used as input to a generalized processor sharing queue model, but does not consider the user-level. Simulation approach do not provide the throughput of any intermediate call state because it is not possible to obtain this data, whereas the analytical approach provide average performance. We present a hybrid model of analysis/simulation for determining the average data throughput of a system from the user point of view. Model has the benefit of evaluating the performance of any specific call state from the user perspective. OFDMA networks must not only be able to provide reliable and high quality broadband services but also be implemented cost effectively and be operated efficiently.

II. LITERATURE REVIEW

A. OFDMA BASICS

OFDMA is a multiple-access scheme that has characteristics of OFDM and frequency-division multiple accesses. OFDM transmits data from one user within a time slot, whereas OFDMA simultaneously transmits data for MUs. Inherited from OFDM, OFDMA is also immune against multipath and has other favorable characteristics. OFDMA was proposed for several broadband wireless systems such as the LTE downlink of cellular systems IEEE802.16 standard for wireless metropolitan area network, and digital video broad casting return channel terrestrial. In OFDMA systems, the multiple user signals are separated in the time and/or frequency domains. Typically, a burst in an OFDMA system will consists of several OFDM symbols. The subcarriers and the OFDM symbol period are the finest allocation units in the frequency and time domain, respectively. Hence, multiple users are allocated different slots in the time and frequency domain (i.e., different groups of subcarriers and/or OFDM symbols are used for transmitting the signals to/from multiple users).

OFDM Transmitter and receiver

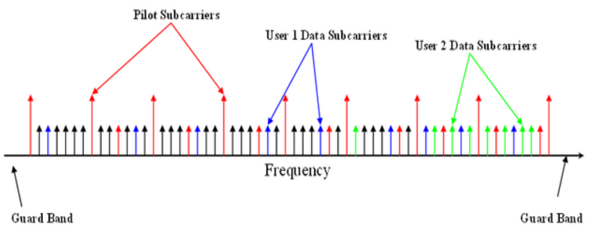


The OFDM concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them. In contrast to conventional Frequency Division Multiplexing, the spectral overlapping among sub-carriers are allowed in OFDM since orthogonality will ensure the subcarrier separation at the receiver, providing better spectral efficiency and the use of steep band pass filter was eliminated.

B.SUBCHANNELS IN OFDMA

There are three types of OFDMA subcarriers:
1. Data subcarriers for data transmission.
2. Pilot subcarriers for various estimation and Synchronization purposes.
3. Null subcarriers for no transmission at all, used for guard bands and DC carriers.

Active subcarriers are divided into subsets of subcarriers called sub channels. The subcarriers forming one sub channel may be, but need not be,



adjacent. Bandwidth and MAP allocations are done in sub channels. The sub channel is a subset of carriers out of the total set of available carriers. In order to mitigate the frequency selective fading, the carriers of one sub channel are spread along the channel spectrum [1]. The formation of these sub-channels from carriers is an important concept in OFDMA systems. The formation can be classified into 2 types; one is the mapping of a contiguous group of subcarriers into a sub-channel called *Adjacent Subcarrier Method (ASM)* and the other is the diversity/permutation based grouping called *Diversity Subcarrier Method (DSM).* In the ASM method, a sub-channel typically contains a group of contiguous subcarriers and it's expected that the channel frequency responses on the subcarriers in a sub-channel will be strongly correlated. This is based on the fact that subcarriers which fall within the coherence bandwidth have similar responses. In the DSM, subcarriers from seemingly random position in the frequency domain are grouped into a sub-channel. Thus, a channel has potential frequency diversity which can be leveraged when the data to be sent on this sub-channel is suitably coded and interleaved. The division in sub channels is a form of frequency-division multiple access (FDMA), where the subscriber transmits 1/*NE* = 1/32 of the available channel bandwidth for the 2048-carrier OFDMA. Regarding interference, the sub channels constitute a form of frequency hopping spread spectrum The capacity can be optimized by managing the whole range of modulation and coding schemes specified in the standard. To maximize capacity we want to assign as many subscribers as possible to the schemes with highest throughput.

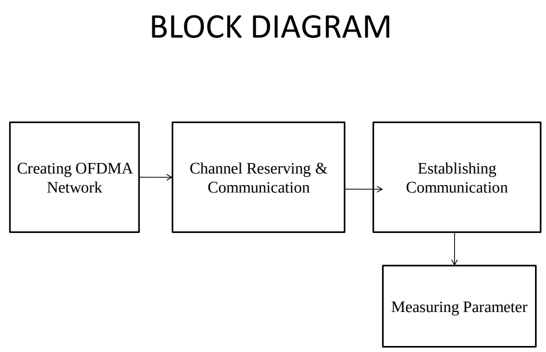
C.EFFECTIVE THROUGHPUTT

The special properties of the throughput maximization, we introduced a scheduling algorithm that yields the optimal transmission schedule. To maximize the system throughput while ensuring the full filament of each user's QoS requirements including the data rate and the bit-error-rate (BER). Hear they use iterative algorithm to maximize algorithm. The notion of effective throughput to characterize the performance of OFDM/SDMA systems by taking into account PER, number of data subcarriers in an OFDM symbol, modulation and coding scheme. Effective throughput for a user can be viewed as the average number of successfully received data bits in an OFDM symbol after excluding erroneously received packets.

Definition —User Effective Throughput:
Let Pe be the PER, N_d the number of data subcarriers in an OFDM symbol, MI the modulation index on data subcarriers, and r_c the coding rate.
Effective throughput is determined by PER, the number of data subcarriers (or the number of pilot subcarriers), modulation and coding scheme. The effective throughput can be easily translated to the average delay for transmitting a user packet when retransmission is employed.

To generate OFDM successfully the relationship between all the carriers must be carefully controlled to maintain the orthogonality of the carriers. For this reason, OFDM is generated by first choosing the spectrum required, based on the input data, and modulation scheme used. Each carrier to be produced is assigned some data to transmit.

III. PROPOSED BLOCK DIAGRAM



Creating OFDMA Network

IV. SYSTEM DESCRIPTION

For OFDMA-based networks, user data is divided and modulated onto a large number of narrow band subcarriers in the frequency domain, and each of them is modulated by low rat data [9]. The subcarriers are orthogonal to each other, meaning that cross-talk between the sub-carriers is eliminated and inter-carrier guard bands are not required. The orthogonality among the subcarriers prevents inter-subcarrier interference because the subcarrier's spectrum has nulls located at the centre frequencies of adjacent subcarriers [9]. A group of consecutive subcarriers is known as a sub channel. Moreover, the time domain is split into consecutive frames that are in turn divided into time slots called OFDM symbols. As a multiple access technique, OFDMA offers the possibility of enhancing the spectral efficiency of networks by assigning distinct OFDM symbols or sub channels to distinct users, thus taking advantage of their diverse time and frequency channel conditions a compared to TDMA and FDMA techniques. For LTE, downlink transmission is based on OFDMA. The radio resources can be considered as a frequency-time resource grid as illustrated in Fig. 1. In the frequency domain, the radio spectrum is divided into a number of narrow subcarriers of 15 kHza spacing. In the time domain, a frame of 10 ms duration is divided into 10 sub frames of 1 ms each. Each sub frame is further divided into 2 time slots of 0.5 ms each. Each time slot then consists of 6 or 7 OFDM symbols depending on the length of cyclic prefix (normal or extended cyclic prefix) [9]. A grid of 1 subcarrier (15 kHz) in the frequency domain and 1 OFDM symbol (0.5 ms) in the time domain is known as 1 resource element, while a grid of 12 adjacent subcarriers (12_15 = 180 kHz) and 1 OFDM symbol (0.5 ms) is known as 1 RB. Hence, a RB is a rectangular block of resource elements, which spans 12 adjacent subcarriers in the frequency domain and 7 OFDM symbols in the time domain (180 kHz _ 0.5 ms). In LTE, a RB is also known as a sub channel, and from now on we refer to a RB as a sub channel. Depending on the transmission bandwidth, a downlink carrier comprises a variable number of sub channels in the frequency domain. The minimum bandwidth of 1.4 MHz corresponds to 6 RBs, while the maximum one of 20 MHz corresponds to 110 RB. The assignment of sub channels to users is carried out by the medium access control (MAC) scheduler, and it is performed on a sub frame-by-sub frame basis, i.e., each 1ms. The scheduler decides which users are allowed to transmit on which sub channel. It should be noted that the minimum resource scheduling unit that the scheduler can assign to a user is comprised of 2consecutive RBs and thus spans an entire sub frame.

A. *Blocking Probability*

According to the guard channel scheme, a new call in a cell j gains a subchannel if it finds that there are less than Rj-rg calls in the cell and that there is at least one subchannel available, otherwise, the new call is blocked in cell j and will be cleared from the system. On the other hand, a handoff call into a cell j gains a subchannel if it finds at least one subchannel available, otherwise, it is blocked.

B. *Channel Modelling*

The medium between the transmitting and the receiving antennas is known as the channel. The characteristics of radio signal changes as it travels from the transmitter antenna to the receiver antenna. The characteristics depend upon the parameters such as distance between these two antennas, propagation scenario (e.g., outdoor-to-outdoor, outdoor-to-indoor, indoor-to-indoor, etc.) and the surrounding environment (e.g., buildings, trees, etc.). The received signal can be estimated if we have a suitable model of the medium. This model of the medium is called the channel model. The radio channel propagation is typically modeled as the combination of three main effects: the mean path loss, the shadowing generally characterized as log-normal [11], [9] and the fading typically modeled as Rayleigh [10]. In OFDMA system, the data is multiplexed over a large number of narrow-band subcarriers that are spaced apart at separate frequencies, the subchannel consists of parallel, flat and non-frequency selective fading. The received signal is then only impacted by slow fading.

1) *Path loss model:*

Path loss is the distance dependent mean attenuation of signal as it propagates through space. A suitable model of path loss depends on the parameters such as type of the environment (e.g., macrocell, microcell, indoor, etc.), the propagation medium (e.g., outdoor-to-outdoor, outdoor-to-indoor, indoor-to-indoor, etc.), the carrier frequency and the distance.

2) *Auto-correlation shadow fading model:*

In reality, clutters from objects such as buildings, trees, terrain conditions etc. along the path of signal propagation differs for every path, and consequently signal attenuation varies from path to path. Shadow fading is used to model variations in the path loss due to such obstacles between the mobile and the base station. Shadow fading is also known as slow fading.

C. *RADIO ACCESS BEARER EFFICIENCY*

The Radio Access Bearer (RAB) is the entity responsible for transporting radio frames of an application over the radio access of the network. From the estimated SINR, a suitable modulation and coding scheme (MCS) is selected for each user provided that the SINR satisfies the threshold for the selected MCS. The higher the SINR, the higher order MCS is used satisfying the SINR threshold value.

D. *Hybrid Model*

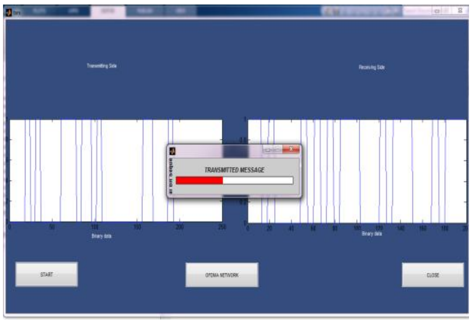
This model combines the analytic and simulation approach, which, unlike traditional simulation approaches, enables us to estimate throughput of any intermediate call state. The probability of call distribution being in a particular state in the system is obtained from analytic expressions and is used as input to the simulation to calculate the throughput of a cell.

Statistical parameters	Value
call distribution	Uniform
call generation process	Poisson
Call mean arrival rate	0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0
call mean holding time	0.5, 1, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0,6.0,7
call inter arrival/ holding time dist	Exponential
LTE System PARAMETERS	
site layout	1hexagonal site with 3 cell
Carrier frequency	2GHz
Subcarrier spacing	15khz
resource block spacing	180khz
Number of sub channels	2,3,4,5,6,7
Data symbol per time slot	11 OFDMA data symbols
Frame duration	-174 dBm/Hz
Thermal noise density	-121.4 dBm
Thermal noise power	1 RB/call

SIMULATION PARAMETERS

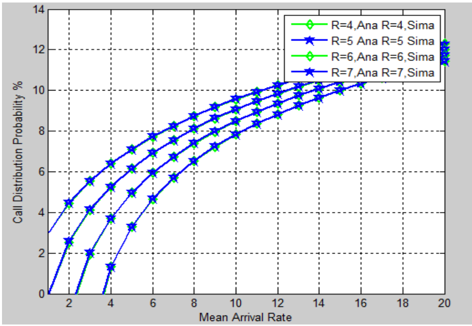
Random bit generation:

From Transmitter by PING process BEACON signal is transmitting to check the receiver side alive. Then Random Bit Generation is passed from transmitter side and it received in Receiver side.



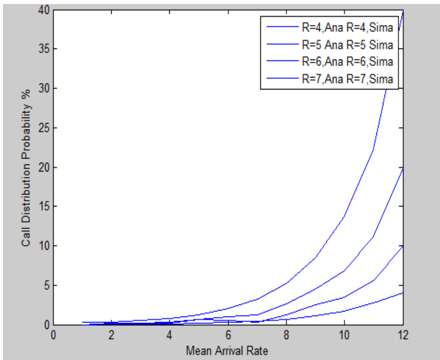
SIMULATION RESULT FOR CALL DISTRIBUTION PROBABILITY:

The performance of the system was evaluated for different call arrival rates for different numbers of subchannels to account for the variation of inter-arrival traffic while the mean holding time remained fixed.



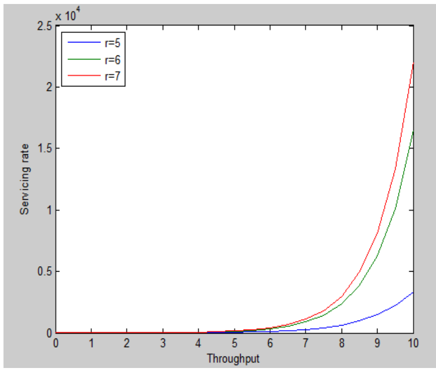
SIMULATION RESULT FOR CALL BLOCKING PROBABILITY:

The performance of the system was evaluated for different mean holding times for different numbers of subchannels to account for the variation of service-time, while the mean arrival rate remained fixed.



SIMULATION RESULT FOR 'THROUGHPUT' PERFORMANCE:

When the throughput increses, servicing rate will get increased and network will give efficient services. If the throughput is in 5 and 6 the servicing rate is not efficient but in 7 the servicing rate is efficient.



The OFDM transmission scheme has the following key advantages:

• Makes efficient use of the spectrum by allowing overlap.

• By dividing the channel into narrowband flat fading sub-channels, OFDM is more resistant to frequency selective fading than single carrier systems are.

• Eliminates Inter Symbol Interference (ISI) through use of a cyclic prefix.

• Using adequate channel coding and interleaving one can recover symbols lost due to the frequency selectivity of the channel.

• Channel equalization becomes simpler than by using adaptive equalization techniques with single carrier systems.

• It is possible to use maximum likelihood decoding with reasonable complexity, OFDM is computationally efficient by using FFT techniques to implement the modulation and demodulation functions.

• In conjunction with differential modulation there is no need to implement a channel estimate.

• Provides good protection against co-channel interference and impulsive parasitic noise.

Claimed OFDMA Advantages

- Flexibility of deployment across various frequency bands with little needed modification to the air interface.
- Averaging interferences from neighboring cells, by using different basic carrier permutations between users in different cells.
- Interferences within the cell are averaged by using allocation with cyclic permutations.
- Enables Single Frequency Network coverage, where coverage problem exists and gives excellent coverage.

CONCULUSION:

By using Hybrid model, data throughput can be increased by increasing the Net bit rate (R). And using event- driven based simulation, range of call arrival rates and mean holding time is found minimum. By introducing Fading effect the same efficiency can be achieved using Hybrid model. In Full duplex communication OFDMA network is created.

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