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Qos-Aware Memetic-Based Optimal Cross-Layer Resource Allocation in Mixed Lte Networks

M. Leeban Moses, B. Kaarthick

Abstract: With the recent advancements and due to the rapid growth of LTE networks, Machine Type Communication (MTC) plays a vital role in the characterization of Internet of Things (IOT).Human-to-Human (H2H) communication and MTC are the two different types of communication handled by LTE-A networks. Due to the co-existence of H2H communication and MTC in LTE-A networks, a serious challenge may arise for scheduling critical MTC with H2H communication networks. To maintain the Quality of Service (QoS) requirements for H2H communication and to provide data traffic for MTC networks LTE networks faces a serious challenge for allocating the resources blocks to the users. In this paper we propose a resource allocation algorithm for optimizing the problems faced by critical MTC and H2H communication networks by maintaining the QoS requirements from a cross-layer design perspective. A novel cross layer memtic based resource allocation algorithm is presented in this paper by investigating the resource allocation problem for different combinations of Channel Quality Indicator (CQI) modes for critical MTCDs and H2H UEs. The Performance and computational complexity of the proposed algorithm in different cases of CQI is measured in terms of cell throughput and probability of delay bound violation (PBDV) is analyzed and the simulations results shows that the proposed system is more efficient compared to other resource allocation algorithms.

Keywords: Machine Type Communication (MTC),Human to-Human (H2H)Quality of Service (QoS),memtic based resource allocation algorithm,Channel Quality Indicator (CQI)

I. INTRODUCTION

The Internet of Things (IoT) is a progressive worldview that gives the connectivity and accessibility of smart objects that encompass people in their day by day life such as different types of sensors, RFID & NFC tags, Vehicle to Vehicle Communication, health care devices, etc. According to a recent survey more than 30 billion devices will be connected to the internet to provide communication within few years. The increasing demands for MTC deployments is anticipated to pose major difficulties over existing wireless LTE networks.

In MTC networks the machines communicate to other machines automatically without the help of humans which is termed as IoT. The MTC communicates only the sensor data values which require low data rate and bandwidth but the communication should be reliable. In H2H communication its data hunger and should provide high data rates to meet the specific QOS requirements. Therefore both MTC and H2H communication provides different characteristics.

Massive-MTC and Critical-MTC are two different types of machine to machine communications (M2M) based on the types of data they provide for communication [1].The Massive-MTC networks includes the traffic free data's such as sensors that are implemented in agricultural field, logistical data's and other time uncritical jobs. The Critical-MTC networks include low latency applications and reliable connectivity that includes emergency patient monitoring system, traffic safety, etc. Generally the MTC requires small bandwidth and low data rates to transmit the data's but the latency should be maintained depending upon the types of M2M communications.

In the releases of Third Generation Partnership Project (3GPP) from 8 to 12 i.e., LTE-CAT4, LTE-CAT0 [2] provides much lower SNR for M2M communications since there is no dedicated link that has been established for MTC devices compared to H2H users and only 6 Resource Blocks(RBs) per frame can be monitored with an average power up to 15 dB [3]. In 3GPP Release 13 and 14 Narrow Band Resource Allocation (LTE-M) has been provided with dedicated channel link for MTC type of devices by implementing different modes in Discontinuous Reception (DRX).

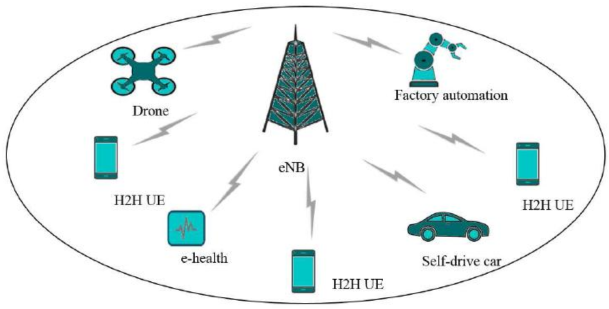

Fig. 1. Coexistence of critical MTC and H2H UEs

The evolved Node B (eNB) in LTE system is mainly designed for broadband communication for H2H interface. But due to the advancements in IoT, eNB has also established connection with MTC devices and the technological advancements leads to the increase in frequency spectrum of 6GHZ to achieve the requirements of 5G technology.

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* Correspondence Author
M. Leeban Moses*, Department.of Electronics and Communication Engineering, Bannari Amman Institute of Technology, leebanmoses@bitsathy.ac.in,
B. Kaarthick, Department.of Electronics and Communication Engineering, Coimbatore Institute of Engineering and Technology, kaarthick.cbe@gmail.com

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The figure above represents LTE-M structure of the different MTC devices and H2H users communicate in a single cell structure of one eNB.

In order to achieve MTC devices and H2H devices in a single LTE network many leading technological companies and different telecom operators such as Nokia [4], Ericsson [5] and Qualcomm [6]has proposed many technologies. But EXALTED [7] was the first company to produce LTE-M networks in the European Union's Seventh Framework Program (FP7) in which both the MTC and H2H operates in a single cell structure of an LTE network. Compared to all the other technologies available for MTC type of communications, LTE-M network has been selected because of their resource block allocation strategies and the security mechanisms that has been adapted for the licensed band.

The exiting features of the network made LTE-M communication possible as per the user requirements. But when the number of users in a cell structure increases and the number of MTC devices increases in a particular cell structure, there exhibits a problem about the allocation of resources to the H2H and MTC users. In this paper we address such resource allocation problem for the users in a cell structure with H2H users and MTC devices.

II. LTE Background for Resource allocation

Resource allocation problem in LTE-M networks has been viewed seriously by many authors in the literature studies by considering the traffic scenarios for both H2H users and MTC devices. Afrin &Brownin [8] has proposed a delay sensitive LTE uplink packet scheduler in which they allocate the resource to the users upon finding the deadline of the packets. This deadline of packets from different users can be estimated by witnessing the earliest packet age in the buffer. Mostafa & Gadallah in [9] has proposed a statistical priority-based scheduling metric in which the Statistical priority is calculated by assessing particular statist ical characteristics of the information, based on the sort of in formation that could be used to show the significance of a gi ven data value.

The statistical priority scheduler analyses channel-based and deadline-based scheduling techniques and allocate the radio resources to the highest informative value MTC devices. To implement the above scheduler there should be a major change in MAC protocol.

Vishnevsky &Samouylov in [10] has implemented a Multiservice queuing system with map arrivals for modeling LTE cell by using Markovian arrival process. In this system an ON OFF arriving model has been estimated by probabilistic approach for MTC devices based upon their priority request and H2H connection is established by priority scheduling process.. Zhou *et al*in [11] has implemented a game-theoretical random access for MTC devices in overlapped cellular networks. In this process A coalition game theoretical clustering was adapted to prolong the network lifetime by Sierpinski triangle in zones A and B, while in zone C, the devices are free to communicate with eNB.

Aydin & Kwanin [12] has proposed a meta-heuristic based simulated annealing resource allocation algorithm in which the user exploits the channel condition information for calculating scheduling matrix in every scheduling process. This improves the spectral efficiency and QOS requirement among the users compared to proportional fair algorithm. Da Mata &Guardieiro in [13] has proposed a genetic algorithm for resource allocation in mixed traffic environment.This algorithm introduces new operations of initialization, crossover, mutation and a QoS-aware fitness function which improves the resource allocation among the users.

Aijaz & Tshangini in [14] has proposed a Invasive Weed Optimization (IWO) algorithm under the co-existence of MTC and H2H by considering statistical QOS services. The resource allocation problem is considered as a maximization of effective capacity-based bits-per-joule capacity under statistical QoS provisioning and is overcome by first transforming the original problem into a mixed integer programming (MIP) problem and then formulating its dual problem using the canonical duality theory. Abdelsadek & Gadallah in [15] has proposed a optimal resource allocation scheme for delay-sensitive MTC deployments coexistent with H2H users. This resource allocation algorithm maximizes the throughput of H2H UEs while satisfying the QoS requirements of delay-sensitive M2M devices with statistical guarantees. This is achieved by modeling the scheduler as a bank of M/D/1 queues and considering them jointly.

Giluka & Rajoriain [16] has proposed a Class based dynamic priority scheduling to support MTC devices in LTE networks. A class with high priority will be served first by the scheduler than a low priority class. If a flow belonging to low priority class is not served within the RTTS range of the class then the flow will automatically get shifted to next high priority class. In a TTI, if a flow is not being served then its RTTS value decreases by 1 ms. This provides QOS services to both MTC and H2H devices. Gotsis & Lioumpas in [17] has defined an analytical model for predicting the system performance on the basis of queuing theory concepts and considered the interaction between classes with different priorities.

Ghavimi & Chen in [18] has proposed a group-based M2M communications, in which MTC devices are clustered based on their wireless transmission protocols, their QoS characteristics, and their requirements. The resource allocation problem is solved by first transforming it into a binary integer programming problem and then formulates a dual problem using the Lagrange duality theory. Garg in [19] has proposed a memetic based resource allocation algorithm and compared with Genetic algorithm.

Wu & Che in [20] has proposed a memetic based differential algorithm for MTC devices. Two different vectors such as a job-machine assignment vector and a speed vector are considered to accelerate the convergence of the algorithm the algorithm considers the efficient speed adjusting and job-machine swap heuristics and they are integrated into a local search approach by an adaptive meta-Lamarckian learning strategy. Decerle & Grunder in [21] has proposed a memetic based resource allocation algorithm for MTC devices with the application of healthcare and home appliances with time window and synchronization constraints. A mixed integer programming model is developed by using memetic algorithm by considering the two original crossover operators. Maia &Vieira in [22] has proposed a fair QoS-aware dynamic

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LTE scheduler for MTC devices to ensure the diversity of service requirements and to control the performance reduction in the classical mobile services of H2H communication. This algorithm dynamically adjusts to the level of congestion of the network based on the current traffic information of each device to support the M2M traffic by satisfying the QoS requirements, to ensure the fair allocation of resources and to control the impact of H2H traffic performance. Elhamy & Gadallah in [23] has proposed a balanced alternating technique for MTC uplink scheduling over LTE. This algorithm dictates a Resource allocation for MTC devices that offers a balance between throughput and delay requirements which is adaptive to traffic characteristics since it considers both channel state and system deadlines in an adjustable manner according to network needs.

III. SYSTEM MODEL & PROBLEM FORMULATION

Generally MTC devices contains data in a random manner with variations in the packet size of data. Hence it will be more difficult for the MTC network to allocate the resource blocks to the users. To allocate the resource block to the network for critical MTC devices, each of the devices in the network will be allocated with a number which is called as QoS Class Identifier (QCI). Each QCI will be numbered on the basis of the priority requirements, delay and throughput. The QCI will be classified into two types depending upon the bearer class as Guaranteed Bit Rate (GBR) and non-Guaranteed Bit Rate (N-GBR).The table 1 specifies the details about the different QCI for MTC devices.

QCI	Bearer Class	Priority Level	Packet Delay Budget	Guaranteed Bit rate
1	GBR	2	1s	25Kbps
2	GBR	3	1s	10 Kbps
3	GBR	4	10s	50 Kbps
4	GBR	5	10s	25 Kbps
5	N-GBR	1	100 ms	-
6	N-GBR	6	1minute	-
7	N-GBR	7	10minute	-
8	N-GBR	8	1hour	-
9	N-GBR	9	1day	-

Table 1: QoS Class Identifiers(QCI)

The resource allocation problem described in this paper is the coexistence of H2H users along with the MTC devices in which the resources are defined as Physical Resource Blocks (PRB) with a bandwidth of 180KHz.

Let $\mathscr{I}$={1,......,i,....I} denotes the available PRB

$\mathscr{J}$= {1,......,j,....J} denotes the number of users

$\mathscr{A}$= {1,......,a,...A} denotes the number of H2H UE

$\mathscr{B}$= {1,.....,b,...B} denotes the number of MTC devices

TTI = Transmission Time Interval(1ms)

The important feature of MTC devices is that their transmission of packets will be very small such that low data rates can be provided to allocate resources which will not affect the QoS requirements. But the latency of each packets should be considered according to the different priority level of the users which is depicted in figure 2 and their latency does not affect the performance of QoS.

The important feature of H2H devices is that it needs high data rate to improve the QoS requirements. The major difference compared to MTC devices is that , when the data rate increases its QoS requirements also gets increased.

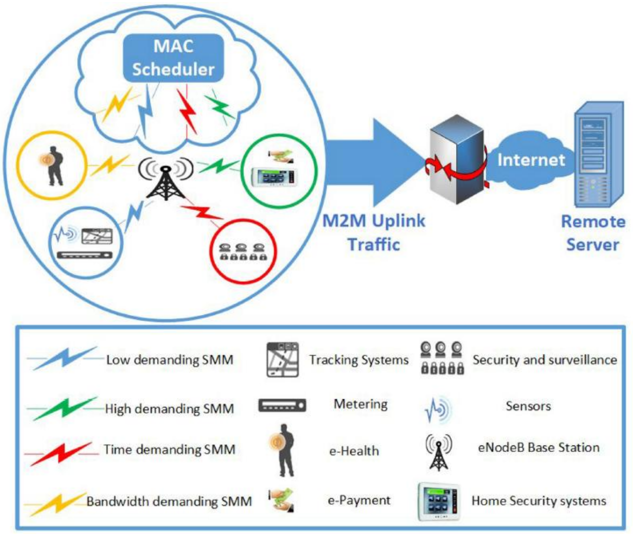


Figure 2 : System model for MTC and H2H users

In like manner, we figure the cross-layer asset assignment issue as an maximization problem. The target capacity to be augmented is the total attainable information

pace of the H2H UEs. The imperatives are communicated with the end goal that the QoS prerequisites of all users are fulfilled. The optimization problem can be mathematically formulated as Cross layer I × J Binary Indicator Matrix C. The cross-layer optimization problem for H2H users and MTC devices can be formulated as

$$Max(C) \sum_{j \epsilon A} \sum_{i=1}^{I} R_{i,j}\, C_{i,j} \qquad (1)$$

where, $R_{i,j}$ denotes the achievable rate of user j over i th PRB $C_{i,j}$ denotes the Binary indicator matrix of user j over i th PRB

To achieve this above equation we formulate a condition which is able to find that all the PRB are allocated to only one user and this can be framed mathematically as

$$\sum_{j=1}^{J} c_{i,j} \le 1 \qquad (1a)$$

The above equation will be satisfied for all the values of I ∈ $\mathscr{I}$. A least ensured information rate for the H2H UEs is forced by limitation given below

$$\sum_{i=1}^{I} R_{i,j}\, S_{i,j} \ge R_U(max)\ ,\text{J} \in \text{A} \qquad (1b)$$

The conditions formulated above is based on MTC devices and H2H UE. then we formulate a cross layer Constraint depending upon the requirements of MTC devices and H2H users.

for all the values of J ∈ $\mathscr{B}$ (1c)

For MTC devices ,there should be maximum number of allowable PRB and this condition is made possible only when we account the PRB to be a binary number and this condition is elaborated in the below equation.

$$\sum_{i=1}^{I} S_{i,j} \leq N_J(max) \qquad ; j \in \mathscr{B} \qquad (1d)$$

$$S_{i,j} \in \{0,1\} \qquad ; i \in \mathscr{I} ; j \in \mathscr{J} \qquad (1e)$$

In order to estimate the value of achievable data rate its necessary to calculate the value of signal to noise ratio.

$$\gamma_{i,j} = P_{i,j} \frac{h_{i,j}^2}{N} \qquad (2)$$

where $h_{i,j}^2$ is the channel power gain,

$P_{i,j}$ is the transmitted power of j th user over i th PRB

$N=N_0B$ is the noise power

B=180KHz denotes the bandwidth of PRB

On achieving the SNR value ,an index number is allocated to the Channel Quality Indicator or QoS class identifiers depending upon the values attained from the SNR. Depending upon the value of QCI a priority value is assigned and the user will be allocated with a wide band reporting. The reporting of CQI in a wide band may be periodic or A periodic in time domain.

IV. Memetic-Based Optimal Cross-Layer Resource scheduler

In this segment, we figure the cross-layer requirement of delay sensitive MTCDs and present the techniques that can be used to deal with the subsequent improvement issue in various operational instances of CQI detailing. The Common situation of CQI is to be accounted for each TTI for each client on each PRB. The block diagram in figure 3 depicts the step by step process of the memetic based cross layer resource scheduling algorithm. To present this algorithm we need to reframe the optimization problem which is presented in the equation (1a) to (1e). In order to briefly elaborate the characteristics we first assume that the channel Quality Indicator for all the H2H users and MTC devices are wideband and periodic.

In order to provide constant channel conditions for every H2H users and MTC devices in the scheduling period, the channel model is considered to be wideband with shadowing and path loss parameters. The channel allocation for every user will be of constant service and is deterministic and can be evaluated by using Poisson process for MTC devices. The traffic created by MTC devices can be solved by using the buffer dynamics of M/D/1 queuing algorithm. This queuing model in LTE-M networks guarantees QoS services to the users that produces probability of delay-bound violation (PDBV) for the cross layer constraints of MTC devices and H2H users and can be given as

$$P_r(D_j > K_j) \leq V_j^{max} \qquad ; j \in \mathscr{B} \qquad (3)$$

where P_r denotes the probability of delay-bound violation

K_j denotes the delay bound

$D_j = W_j + \tau$; W_j denotes the Waiting time

$\tau = 1/R_j$; denotes the service time

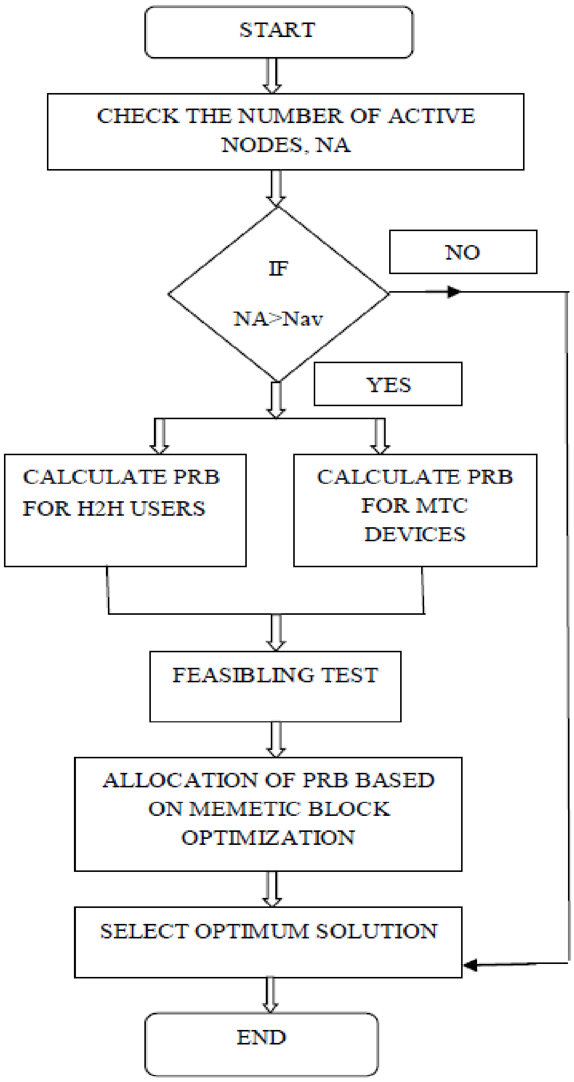


Figure 3: Flowchart representing the process of Memetic cross layer scheduler

Using the Cross layer constraint formulated by the PDBV for LTE-M networks in (3) and the optimization problem formulated due to the cross layer constraint of H2H users and MTC devices, we reframe the optimization problem discussed in (1) to (1e) as,

$$\max C^T X \qquad (4a)$$

$$PX \leq B \qquad (4b)$$

$$g(x) \leq V^{max} \qquad (4c)$$

$$X \in \{0,1\} \qquad (4d)$$

where x denotes the decision variable of the indicator matrix,

C denotes the Cost vector and is given by

$$C = \begin{cases} R_j^T & ; J \in A \\ O_k^T & ; otherwise \end{cases}$$

P denotes the matrix of inequality.

Using the cross layer constraints the optimization problem has been created in eqn 4 is solved by using Memetic algorithm and the problem formulated is termed as Binary Non-Linear Programs (BNLPs) category which is evaluated as a step by step approach.

Step1: Initialization

In the coexistence of H2H users and MTC devices, the initialization process is used to calculate the number of users available in the existing LTE-M network. Let N_A denotes the number of active devices including H2H UE, N_{av} denotes the number of RBs available in each TTI.

If $N_A > N_{av}$, then there should be some selection process to allocate the resource among the users which we term it as a memetic scheduling approach. If $N_A < N_{av}$, then the resource can be directly allocated to the users in a separate bandwidth of 180MHz.

Step2: Calculation of minimum PRB requirements of $\mathscr{H}$ users

When $N_A > N_{av}$ the resource allocation process begins with the calculation of minimum PRB for H2H users from the dataset of total number of users j including MTC devices.

Algorithm: for all $J \in \mathscr{H}$ do

$$PRB_J(min) = \frac{R_J(min)}{r_j}$$

end for

Here $R_j(min) = \lambda_j$ represents the arrival rate of H2H users

$$T_j = \begin{cases} R_j ; R_j \leq \lambda j \\ \lambda j \, ; \, R_j > \lambda j \end{cases} \quad (5)$$

The above condition states that the achievable rate of user j is dependent on the arrival rate of H2H users and its directly proportional to the average cell throughput.

Step3: Calculation of minimum PRB requirements of $\mathscr{B}$ users

After completing the process of minimum PRB requirements of H2H users it is required to evaluate the of minimum PRB requirements of MTC devices

Algorithm: for all $j \in \mathscr{B}$ do

for $q = \frac{\lambda j}{R_j}$: $N_u(max)$ do

if $Pr[D_j > B_j \mid Rj = qr_j] \leq V_j(max)$

(or)

$q = N_j(max)$

then

$PRB_j(min) = q$

Break this for loop.

end if

end for

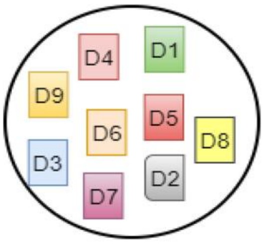
The probability of delay bound value is estimated and is compared with the maximum threshold value. The resource block gets allocated for the MTC devices who exceeds the value of threshold compared to the value of PBDV.

Step4: Memetic optimization scheme

In the primary period of planning, users are chosen dependent on the vitality status and the channel nature of dynamic LTE-M gadgets. we first need to distinguish the dynamic hubs in the cell before the choice stage. Based on the buffer status report (BSR) eNB checks if a LTE-M gadget is dynamic if it has information in its cradle prepared for transmission else it will be considered as a non-dynamic gadget.

Step4.1 Solution Representation & Population Initialization

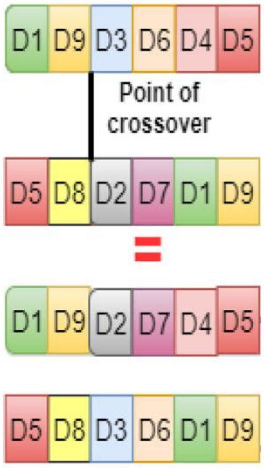
The identified users for resource allocation from step2 and step3 are first initialized to represent a solution for the users. Besides, a population is characterized as a lot of arrangements S where every arrangement is displayed as an exhibit S of size J.



Here D1 to D9 represents the number of users present in a LTE-M network with the co-existence of MTC devices and H2H users. Here the population term ids used to denote the array of solution S with the size of J and the device is based upon the fitness function. The various colors in the boxes of D represents that all the devices are arranged according to the priority levels.

Step4.2 Crossover:

Let the crossover between two solutions be represented as S_1 and S_2. Let v1 be characterized as factor somewhere in the range of 0 and 1 which will be contrasted with the likelihood that Crossover will occur between two arrangements .

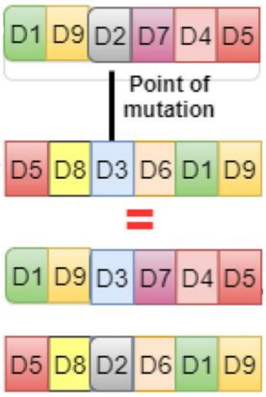


$$\begin{cases} v_1 \leq \beta_c \text{ Crossover will happen} \\ v_1 \leq \beta_c \text{ Crossover will happen} \end{cases}$$

Here βc denotes a constant value that indicates the probability of crossover.

In the event that v1 was higher than the likelihood of hybrid, the last mentioned is performed on the arrangement of RBs J at an arbitrary position meant as ρ_s.

Step4.3 Mutation:



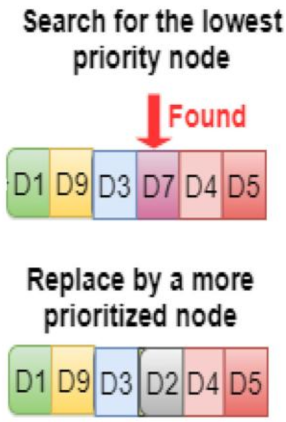
Let $v2$ denote a variable between 0 and 1 and β_m denotes the probability of mutation

$$\begin{cases} v_2 \leq \beta_m \text{; Mutation will happen} \\ v_2 > \beta_m \text{; No Mutation} \end{cases}$$

In the event that v2 was higher than the characterized likelihood, transformation is performed on the arrangement of RBs J at an arbitrary position signified as ρ_m.

Step4.4 Local search improvement:

The Local search improvement calculation checks and incorporates a LTE-M devices if the last is running an application with higher Priority level than the ones in the arrangement.



The higher priority devices can even now be considered for Scheduling regardless of whether they are not qualified enough for choice due to their low vitality and channel conditions. Along these lines, fairness is improved in light of the fact that there's a high likelihood that these devices could be cell edge hubs.

Step4.5 Population Evaluation

In Memtic algorithm Population Evaluation is denoted as the pre evaluation process of resource allocation.

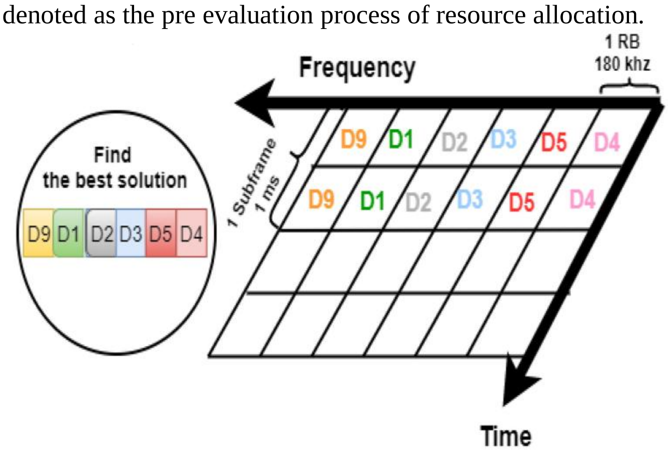


Figure 3: Population Evaluation of Memtic algorithm

Each parent arrangement is supplanted in the populace if its kid arrangement gives better wellness. The last signified as Si is processed on the produced arrangement and contrasted with the one of the beginning arrangement Si as pursues

$$\begin{cases} if\ \overline{F_{s'_i}} > F_{s_i};\ S'_i \text{will replace S in the population} \\ if\ \overline{F_{s'_i}} \le F_{s_i};\ S_i \text{ remains in the population} \end{cases}$$

Step5: Max-Space Algorithm

After allocating the number of nodes to the users in the LTE-M environment in step4, it is necessary for the algorithm to represent in frequency domain in order to improve its QoS requirements among the user. LTE-M constrains the measure of assets that can be distributed to one RB for each gadget in each TTI. In any case, when the quantity of accessible RB is higher than the quantity of dynamic hubs, the scheduler leaves additional RBs void in each TTI. Also, it might occur that a LTE-M device arrives at its defer limit with a required throughput higher than the one given by a solitary RB.

Max-Space algorithm allots additional RBs with a goal to organize critical LTE-M gadgets without disregarding QoS prerequisites regarding delay and throughput. On every RB, every hub accomplishes diverse channel quality in light of its Sounding Reference Signal (SRS) data sent through the last image of an uplink space. Based on the information provided by the SRS signal, the eNB searches LTE-M devices for allocating resources based on the priority of user which can be estimated as,

$$U_i = \frac{d_i}{PDB_i^n}$$

where, U_i denotes the urgency factor,

d_i denotes the number of MTC devices

Depending upon this urgency factor , the scheduler allocates more than one resource blocks per TTI to the users until the needed throughput is reached. Otherwise only one resource blocks will be to the users without breaking MS strategy.

V. PERFORMANCE EVALUATION

In this segment, we present and talk about the recreations after effects of assessing the presentation of the proposed strategies also, calculations. The Performance criteria of the proposed Memetic-Based Optimal Cross-Layer Resource Allocation algorithm is contrasted with the Proportional Fair (PF) scheduler and the asset portion dependent on the measurements alluded to as Maia algorithm. The table 2 represents the parameters are initialized to solve the resource allocation problem.

Simulation parameters	Range
Radius of the cell, C	500m
Number of eNBs	1
Simulation time	1000TTI
Number of runs	30
Transmitter power	15 dBm
Noise figure	18 dB
Number of PRBs	100
Distribution of MTCDs/UEs	Fixed and uniform
H2H arrival rate	64, 128, 256 kbps
M2M arrival rate	10,20,30,40 kbps
Delay bound	0.2 ms

Table2: Simulation parameters and their ranges

The uplink resource allocation model is created for only one cell in the mixed traffic environment by performing 3 different simulation experiments. The simulation experiments are considered for critical MTC devices as well as the H2H UE in a single cell environment with only one eNB located at the centre of the cell with a radius of 500m as mentioned in table1. The sources of H2H traffic includes voice data services such as Voice-over-IP (VoIP) and multimedia services such as live streaming video applications. The sources of MTC devices include different critical devices used in medical and industrial applications and the data arrival in the critical MTC is considered to be a Poisson arrival process and the arrival rate of the data are considered to be uniform.

The simulation results shown in Figure4 depicts the throughput analysis of the co existence of critical MTC devices and H2H users. Initially the number of MTC devices are fixed to 10 and the throughput is evaluated numerically for the variation in number of H2H UE from 5 to 25 and is compared with the simulation parameter results. The analysis shows that when the number of user equipment increases the throughput also increases for fixed number of MTC devices.

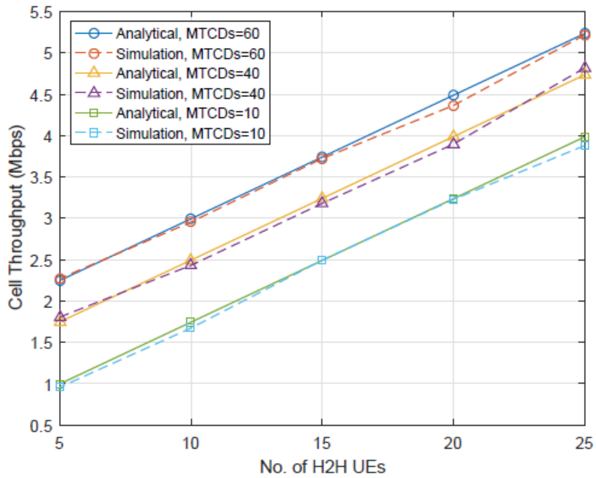


Figure 4:Throughput analysis for the comparison of analytical results with simulation results by varying number of MTC devices and H2H users

The simulation results shown in Figure5 depicts the PBDV analysis by varying number of MTC devices with fixed number of H2H users. Initially maximum PBDV is attained by varying number of MTC devices and is assumed that there are no H2H users. Then the average number of PBDV is obtained by fixing the number of UE constant as 5,10,15 and by varying the number of MTC devices. The explanatory outcomes are very near the recreation ones with an adequate mistake that diminishes with the expansion of the Number of users. This is obvious by contrasting the distinction between the outcomes on account of 60 MTCDs versus the 10 MTCDs case

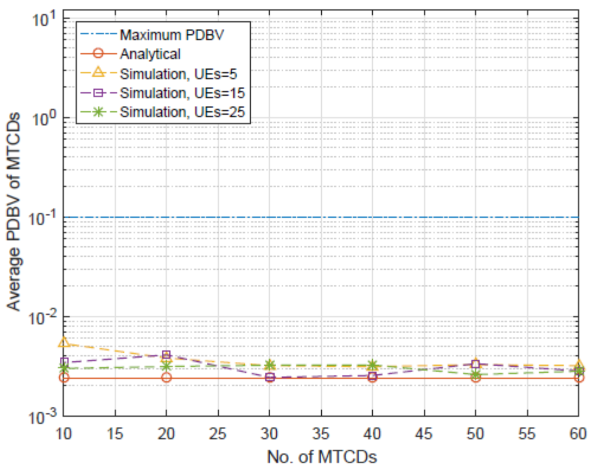


Figure 5:PBDV analysis by varying number of MTC devices with fixed number of H2H users

The simulation results shown in Figure6 depicts the throughput analysis by varying number of H2H users with fixed number of MTC devices. The obtained throughput is compared with Maia algorithm and Proportional Fair (PF) scheduler and the results obtained shows that the proposed algorithm provides higher throughput. The proposed scheduler is also compared with different arrival rates of the UE. The results shows that when $R_H^{min}= \lambda_{min}$, the throughput will be high (when H2H users increases) compared with the throughput obtained when $R_H^{min} = 128kbps$.

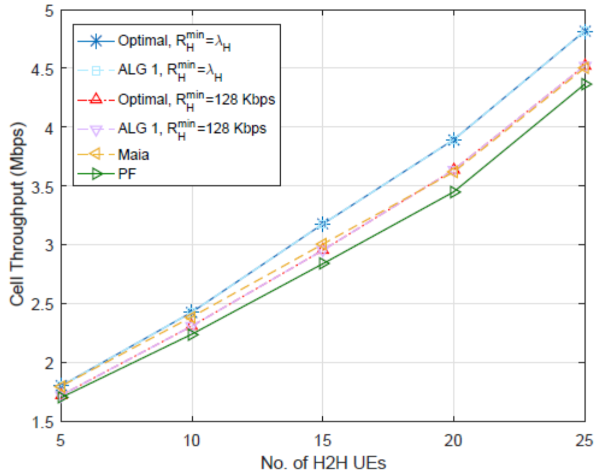


Figure 6: Comparison of Throughput analysis by varying number of H2H users with fixed number of MTC devices

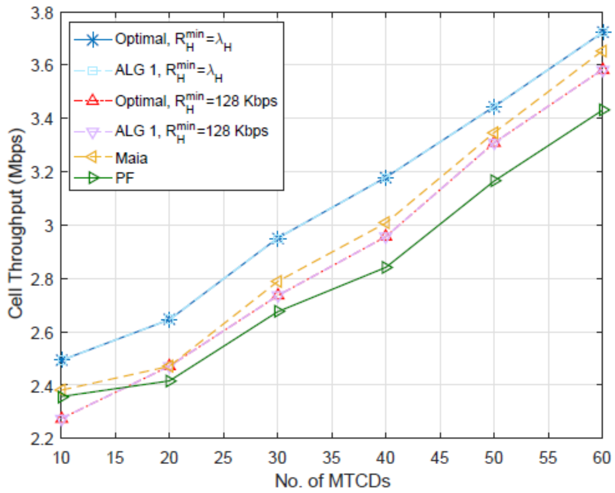


Figure 7: Comparison of Throughput analysis by varying number of MTC devices with fixed number of H2H users

The simulation results shown in Figure7 depicts the throughput analysis by varying number of MTC devices with fixed number of H2H users. The obtained throughput is compared with Maia algorithm and Proportional Fair (PF) scheduler and the results obtained shows that the proposed algorithm provides higher throughput. The proposed scheduler is also compared with different arrival rates of the users. The results shows that when $R_H^{min}= \lambda_{min}$, the throughput will be high (when MTC devices increases) compared with the throughput obtained when $R_H^{min} = 128kbps$.

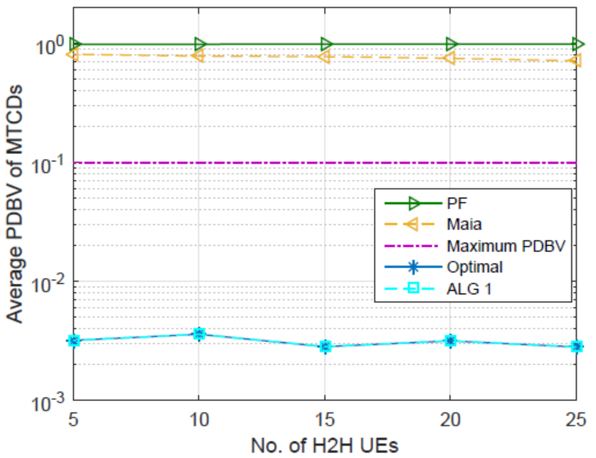


Figure 8: Comparison of PBDV analysis by varying number of H2H users with fixed number of MTC devices

The PF scheduler targets reasonable allotment on all the scheduled users including the MTCDs which are low data rate users. On the opposite side, the Maia scheduler subdivides the PRBs between the MTCDs and H2H UEs before planning. This effects the H2H traffic, which contributes the real piece of the cell throughput, by decreasing the quantity of the accessible PRBs for it. In any case, the proposed calculations assign a large portion of the assets to the H2H UEs to boost their throughput thinking about the QoS prerequisites of the users. This presumes the fulfillment of the QoS prerequisites of the users, as talked about beneath, is not to the detriment of the cell throughput, however utilizing a more productive plan.

The simulation results shown in Figure8 depicts the PBDV analysis by varying number of H2H users with fixed number of MTC devices. The QoS prerequisites of the users gets satisfied for the low values of PBDV. The proposed algorithm shows that the value of PBDV is minimum compared with all the other optimal algorithms.

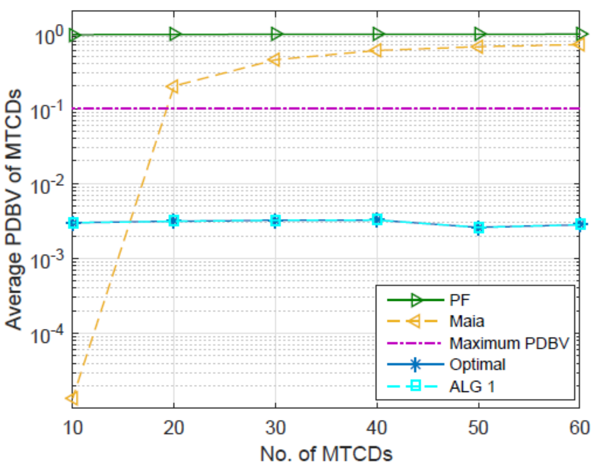


Figure 9: : Comparison of PBDV analysis by varying number of MTC devices with fixed number of H2H users

The simulation results shown in Figure9 depicts the PBDV analysis by varying number of MTC devices with fixed number of H2H users. The proposed algorithm shows that the value of PBDV is minimum compared with all the other optimal algorithms. The figures8&9 dictates the proposed calculations to fulfill the cross-layer imperative at all cases. On the other hand, the PF scheduler doesn't think about any deferral prerequisites for the users. The Maia scheduler fulfills the defer necessities at low quantities of gadgets, be that as it may, the infringement of the postpone necessities increments with the expansion of the quantity of MTCDs.

VI. CONCLUSION

This paper proposes a QoS-Aware Memetic-Based Optimal Cross-Layer Resource Allocation algorithm for a cross layer environment consisting of MTC devices and H2H users. In a cross layer environment, the QoS requirements, the Throughput and the probability of delay bound violation (PBDV) becomes a challenging task and this is considered to be the optimization problem which is discussed in this paper. To provide solution for the optimization problem, a step by step Memetic-Based Optimal Cross-Layer Resource Allocation algorithm is proposed and is simulated by comparing with different types of the existing algorithm. The results showed that, the throughput analysis and the PBDV analysis produce better results compared with the existing algorithms. The analysis of this algorithm is outperformed when compared to the existing algorithms because of the evaluation based on the number of users in H2H environment and critical MTC devices. The reproductions results approve the scientific examination and uncover that the proposed techniques beat the other resource allocation algorithm from past examinations in the literature.

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M. Leeban Moses received BE degree in ECE from Veltech Engineering college, Chennai, affiliated to Anna University, Chennai in 2010. M.Tech Degree in Communication Systems from Ranipettai Engineering College, Vellore affiliated to Anna University, Chennai in 2012. He is currently working as Assistant professor in Bannari Amman Institute of Sathyamangalam. His research interests include wireless communication, Networking.

Dr.B.Kaarthick received BE degree in ECE from K.S.R college of Technology, Tiruchengode, affiliated to Periyar University in 2002 . M.Tech Degree in Communication Systems from Kumaraguru College of Technology, Coimbatore affiliated to Anna University, Chennai in 2004. Ph.D degree in Information and Communication from Anna University of Technology, Coimbatore in 2011. He is currently working as Professor and Head of ECE department in Coimbatore Institute of Engineering and Technology. His research interests include wireless communication, Antenna design, Networking, Internet of Things.