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Resource Allocation Energy Efficient Algorithm for H-CRAN in 5G

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Abstract- In today's generation, the demand for data rates has also increased due to the rapid surge in the number of users. With this increasing growth, there is a need to develop the next fifth generation network keeping in mind the need to replace the current 4G cellular network. The fifth generation (5G) design in mobile communication technology has been developed keeping in mind all the communication needs of the users. Heterogeneous Cloud Radio Access Network (H-CRAN) has emerged as a capable architecture for the newly emerging network infrastructure for energy efficient networks and high data rate enablement. It is considered as the main technology. Better service quality has been achieved by developing small cells into macro cells through this type of network. In addition, the reuse of radio resources is much better than that of homogeneous networks. In the present paper, we propose the H-CRAN energy-efficient methods. This energy-efficient algorithm incorporates an energy efficient resource allocation management design to deal to heterogeneous cloud radio access networks in 5G. System throughput fulfillment is elevating by incorporating an efficient resource allocation design by the energy consumption model. The simulation results have been demonstrated by comparing the efficiency of the introduced design with the existing related design.

Keywords: 5G, energy efficiency, H-CRAN, resource allocation.

I. INTRODUCTION

Significant increase in data rates, in sophisticated applications and connected devices, dictates the transition to traditional RAN (Radio Access Network)[1]. CRAN (Cloud Radio Access Network)[2] has been included as a very important consideration in the 5th generation (5G)[3]. Resource allocation is the most important of the potential proponents for improving system performance in 5G. With the help of this, power allocation in CRAN[4], Spectrum and suitable user assignment from CRAN are performed well. Recent research shows energy efficient resource allocation plays an important contribution in 5G and on the other side networks. In this reference, energy efficient resource allocation by incorporating cloud computing has been included in Heterogeneous CRAN (H-CRAN)[5]. Its structure is different from today's cellular systems. This includes an additional number of Remote Radio Heads (RRH) mounted around the Macro Base Station. This type

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of network is very helpful in achieving high Energy Efficiency (EE) as compared to the conservative cellular network. Its effective resource allocation techniques optimize limited spectrum resources in H-CRAN by minimizing inter-user interference. The presenting energy-efficient networking procedures in traditional cellular networks have not been absolutely successful in reducing network energy consumption. The challenges of 5G networks such as throughput, power constraints and latency can be addressed by this. It was considered an assuring solution for increasing the energy efficiency of 5G networks.

The fifth generation from the upcoming 5G (mobile communication system) is required to largely support high energy efficiency, ultra-high reliability, high data rates, low latency connections[6]. C-RAN (cloud radio access networks) and Heterogeneous networks (HetNet) are hopeful technologies in 5G to alleviate energy consumption and renovate the energy efficiency of existing networks. HetNet allows high-speed data transmission by deploying small cell base stations (SCBS) over a small area[7]. Macro BS is designed over a large area to provide seamless coverage. Intensive deployment of SCBS is used to support mobile connections at scale. With its help, the network throughput can be increased significantly. Such network deployment increases the likelihood of widespread coverage overlap, between base stations (BS). Serious inter-BS interference with the same problem can also join HetNet. As an effect, the advantages of HetNet in ultra-dense mobile networks would be nullified by the complex BS coordination required. Includes BBU (Baseband Unit) and RRH (Remote Radio Head) in order to baseband signal processing and separation of RF from C-RAN. BBU pools are implemented through cloud computing platforms of centralize BBUs. Centralized baseband signal processing is responsible for efficiently sharing channel position information (CSI) between BBUs. On a large scale, cooperative communication is allowed by C-RAN using CSI information. This helps in reducing severe inter-BS interference. Being implemented on cloud computing platforms, computing resources dynamically based on traffic demands are incorporated into baseband signal processing. The rigid capacity demand between BBU and RRH can be enforced due to the separation of BBU and RRH. For this reason, the limited front haul capacity can affect the execution of the C-RAN efficiency of the mobile network. However, so far the research work of energy efficient H-CRAN is a inspiring underdeveloped research topic. In part, functions related to baseband signal technology functions are executed on the BBU pool of H-CRAN[5]. So fundamentally the energy consumption models related to H-CRAN are quite different from those of conventional cellular networks[8]. As a result, current energy-efficient networking solutions cannot be used straight on CRAN. The dissociation of RF and baseband signal processing has been an important contributor to the BBU pool and RRH/ERRH linking[9]. However, the availability of optical fiber links on a large scale is very limited. It is capable of providing high capacity. For this reason, it will be imperative to incorporate effective wireless fronthauls into the deployment of H-CRAN. Wireless fronthaul optical fiber links may hinder H-CRAN by not providing high capacity. The optical fiber fronthaul will not perform well even if the network traffic load is not steady. The potential of the fronthaul may prove to be a unique networking constraint in designing an H-CRAN energy-efficient model.

II. RELATED WORK

Resource allocation with energy-efficient 5G-HCRAN has attracted significant attention[10]. It improves EE performance by reducing the complexity of matrix inversion calculations during beam form printing and power consumption of the baseband. RRH may favorably access the BBU pool in 5G-HCRAN, which makes the system more vulnerable to tidal phenomena caused by human migration. MSNWF applied for H-CRAN, which is in line with green communication, can reduce energy consumption. This paper[11] introduces a dual-order resource allocation algorithm constructed on individual QoS demands of users in H-CRAN. The prime directive resource allocation uses the distribution and self-organization algorithm of corresponding principle to connect users to the system based on the user's required QoS and also earnings into account changes in the bandwidth of the SBS owing to the setting. In this paper[12], EH is united into the scheme to decrease grid energy consumption. A combined optimization disruptive is assessed that studies user connotation, power allocation, access control and EH totaling to make the most of system EE in bits/sec/Hz/watt for downlink in H-CRAN, including grid A macro base station is included. Energy and many Green RRHs (GRRHs) are fully powered with aggregated energy. An EE optimization delinquent in HCRAN is articulated as a fractional mixed integer nonlinear programming problem, and is answered using the Mesh Adaptive Direct Search (MADS) algorithm. The projected algorithm is too less multifaceted and yields optimal solutions in a finite and fewer iterations than external estimate algorithms and exhaustive search algorithms. The effects of EH on various system of measurement of the system and on grid energy and power allocation to users have been observed. In this paper[13], the effect of radio

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resource management on the energy efficiency of H-CRAN is studied. It has advanced a network energy feeding model that catheterizes the energy consumption of base stations (BS), fronthaul and BBU pools in H-CRAN. Grounded on the network energy calculation model, the network energy efficiency optimization problem has been formulated and the H-CRAN energy efficient radio resource management (HERM) algorithm is designed to unravel the problem.

Energy-efficient mobile networks have been expansively deliberate in topical years. In this segment, traditional mobile networks are looking at solutions in cloud and LTE based radio access networks using energy efficient networking[14].

A. Energy Efficiency in Traditional Mobile Networks

In any mobile network, radio access networks consisting of BS are the major energy consumers. Most focus on energy-efficient networking solutions to reduce the energy consumption of BS in traditional mobile networks. These solutions are divided into three different categories. The first category provides management of radio source algorithms to enhance the energy efficiency of mobile networks. The additional category provides the BS in low-power mode energetically depending on the traffic load. For this, the BS sleep mode algorithm is used. Power is provided by the third category, with the help of which the mobile BS gets renewable energy. These solutions are not directly appropriate in cloud-based radio access systems due to the architectural alterations amid C-RAN and convective mobile networks. Provides some insight into building energy-efficient mobile networks[15].

B. Energy Efficiency on Cloud-Based Radio Access Networks

Cloud-based radio access networks are emerging in the mobile network world as a promising next-generation networking architecture. With this emergence, energy-efficient C-RAN is becoming a crucial research theme. C-RAN includes solutions to the problems of energy efficiency from many different aspects. Resource Allocation A Joint User Association Algorithm, Liu et al. [1] have incorporated a network energy consumption model based on an H-CRAN to optimize energy efficiency. Peng et al. [2] Enhanced Soft Fractional Frequency Reuse (S-FFR) considers energy-efficient H-CRAN for RRH and fronthaul energy consumption planning. Tang et al. [3] has focused on reducing network energy consumption by considering the problem of cross-layer resource allocation into C-RAN. Pompilly et al. [4] have been considered by optimize the energy efficiency by c-RAN. Improves energy efficiency through aggregating virtual base stations ethically to traffic conditions by using an elastic resource utilization framework. Limited fronthaul capacity by dynamically grouping is considered. Dhifallah et al. [5]has used entry control planning and coordinated beam forming to reduce transmission power in a simultaneous C-RAN. The scheme has been proposed in the down link C-RAN combined with the fronthaul capacity constraints. Oliva et al. [6] proposed a novel architecture called the Zhaul to integrate the fronthaul and backhaul. This includes effective transport network solutions. Work has been done on some networking equipment, e.g., RRH and Fronthaul with energy efficiency in mind.

III. PROBLEM FORMULATION AND SYSTEM MODEL

This section explains the framework of the energy efficient C-RAN model related to 5G[16]. In this model, C-RAN and Heterogeneous Cloud Radio Access Networks are combined. Energy saving has been achieved in the proposed model in three ways. Three methods of this are shown in Figure 1. The first method is shown on the radio side of C-RAN. In this, a new BS sleeping mechanism has been created by incorporating CAC. In the second way, the clouds are shown on the side. It is designed to integrate baseband processing workloads by incorporating an advanced CAC scheme to improve QoS through virtual BBU placement. Along with this, mobile devices have been pointed in the third way. It incorporates the MEC model into the HC-RAN framework. With the help of this in mobile devices, energy can be saved. Energy and processing applications can be divided into tasks by offloading the calculations. With this, high energy savings can be achieved by simply executing the MEC server in the BS cloud. The discussion related to these proposed frameworks is covered in detail in the following subsections.

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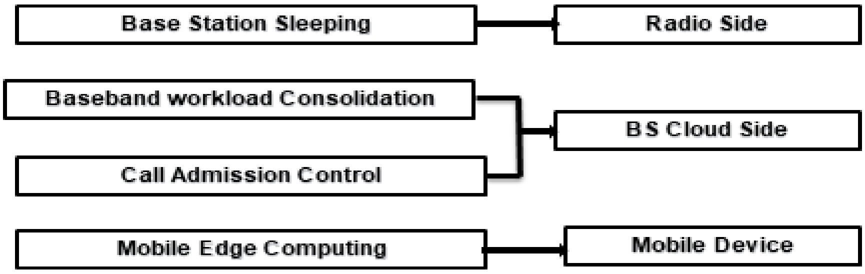

Fig 1. Proposed Framework black Diagram (is this framework provided in[16]

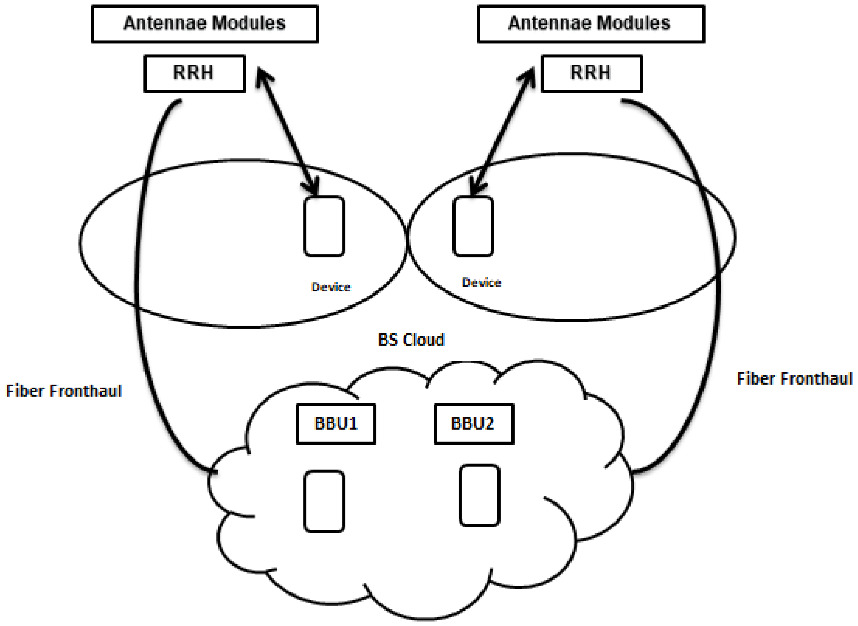

Fig 2. C-RAN Architecture

The C-RAN Architecture is separated into three parts namely RRH, Fronthaul and BS Cloud/BBU Pool. As revealed in Figure 2. It uses virtualized GPP to perform baseband processing by integrating BBU on BS cloud. Full C-RAN centralization is implemented on the cloud side, similar to C-RAN Architecture. The architecture of the proposed Energy Efficient H-CRAN framework by extending the CRAN architecture is displayed in Figure 3. Packet Data Convergence Protocol (PDCP), Radio Link Control (PHY-L1), MAC, and Physical Layer One (PHY-L1) are added by centralizing 100% baseband processing in the BS cloud. Serving Gateway (S-GW)[17] and Mobility Management Entity (MME) can also be included for baseband processing[18].

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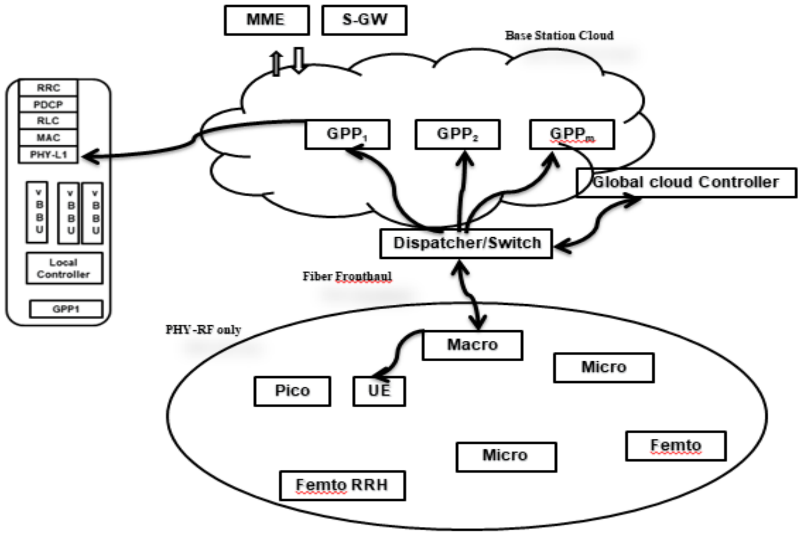

Fig 3. H-C-RAN Framework Architecture

Virtualized GPPs are very economical. With its help, any signal can be processed from any RRH. Baseband has been processed on these. GPP is virtualized in a VM for baseband processing. They are known as VBBU. The high bandwidth BS cloud is connected using optical fiber cable from the radio side. RRH to GPP is incorporated using a switch or dispatcher to distribute the baseband signal. Core Modules of H-CRAN Framework[2] The core modules of H-CRAN Framework are sourced from BS Cloud. Baseband workload consolidation, BS sleeping/switch off, and CAC are included in this framework. The MEC framework[19] has been incorporated into the mobile device.

IV. Energy Saving within C-RAN

This section introduces the technologies cast-off inside C-RAN and MEC to address the need for energy efficient cellular networks[20].

A. Energy consumption model

According to this model, the distributed LTE-A Hetnet system has been designed by building the Power model as the baseline. The instantaneous number of BBUs in the cloud used in this model are calculated using the SA, GA, and threshold values. The average number of BBUs is more effective in our method[21].

Multiple BBUs are hosted in a single cloud infrastructure. In which cooling, housing, and power supply are shared. Reducing the energy consumption per RRH BBU is a very important task in this type of voter. The process of dynamically allocating baseband computational resources with the help of virtualization is done. Along with this, BBU application is done only when needed. The energy consumption is also likely to be high by BS Cloud and the fronthaul link generated by RRH. The shortcomings present in all this power consumption models necessitate a new model by which to reflect the cloud-based cellular architecture with a diversity of computational resources.

V. Proposed H-CRAN Energy Model

The power consumption is calculated separately for both RRH and BBU. Power consumption in fronthaul and cooling has been revised.

A. Power Consumption at The Radio Side

The power consumption model[22] has been resultant with the generalized component related to the RRHJ power consumption model. It is referred to as P_J, which are as follows:

$$P_j = N_{TRX} \cdot \frac{\frac{(\rho_i P_{max})}{\eta_{PA}} + P_{RF}}{(1-\sigma_{DC})(1-\sigma_{MS})}$$

Since it is very close to the RRH antenna, the cooling and feeder are negligible. Cooling is provided for RRH with the help of natural wind. Applicable on both PRRH and MRRH related models.

B. Power Consumption in The Fronthaul

Copper connections, fiber, or microwaves, or a combination of these, are used for C-RAN in the fronthaul. Features of fiber include low latency and high bandwidth. Hence this model fiber fronthaul link has been used. The BS is linked to the cloud in the RRH from the star topology. Fiber fronthaul link is designed by incorporating power

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contribution[23]. It is referred to as $P_{fronthaul,}$ which are as follows: (data missing in equation

$$P_{fronthaul} = \left[\frac{1}{\max\limits_{dl}}\left(\sum_{a=1}^{m} N_a\right)\right] P_s + \left(\sum_{a=1}^{m} N_a\right) P_{dl}$$

C. Power Consumption at the BS Cloud

The total power ingesting in the BS cloud (PBS cloud) include of cooling power (P cooling) in the data center, as in the sum of power consumptions of all active GPPs[24]. It is referred to as $P_{BScloud,}$ which are as follows:

$$P_{BSCloud} = P_{cooling} + \sum_{i=1}^{NG} P_{GPP_i}$$

VI. SYSTEM MODEL

In this section, an Energy Efficient Heterogeneous Cloud Radio Access Network (H-CRAN) is constructed from a BBU pool consisting of a small RRH (SRRH) and a macro RRH (MRRH). It is shown in Figure 4. A resource has been developed and demonstrated. The mapping between BBU and RRH is depicted with the help of allocation structure. Resource allocation in H-CRAN between User Devices (UEs) for network slicing is included by RRH. In BBU pool resource allocation, RRH is responsible for sending resources and signals to the respective UEs. In addition, a certain number of BBUs for RRH are used in the BBU pool to act as computing resources. It has several ui serving each slice. One URLLC slice, one MMTC slice and one EMBB slice are served by H-CRAN.

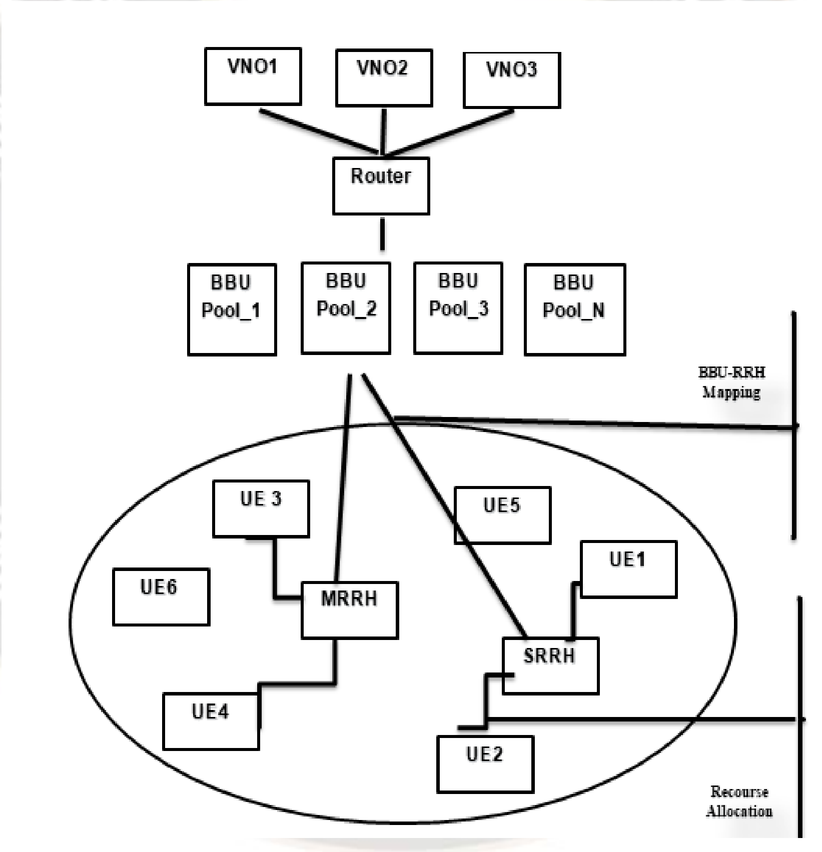

Fig 4. System Model to the Energy Efficient H-CRAN.

Here U, I, R, and K are represented like the set by UEs, BBUs, RRHs (Inclusive SRRH and MRRH) and Resource Blocks (RBs), respectively. h_{ri} is used to define the mapping pointer in RRH_r. hr_i = 1 is set to represent BBU_i and RRH_r connected, otherwise hr_i = 0. Binary assignment indicator with the help of W_{rku} is used to represent UE_u to RB_k connected to RRH_r. W_{rk} = 1 otherwise rk_u = 0 is used to connect RRH_r to UE_u and RB_k. The transmission power P_{rku} of RRH_r on RB_k is used for UE_u. UmMTC, UuRLLC and UeMBB are defined as the set of UEs to include mMTC slices, uRLLC slices and eMBB slices, respectively. Their traffic based on an affirmative periodical nature is used to slice URLCs. The constant size of the bits in each packet and the maximum allowable delay URLC generates from time to time. Users determine make like the data rate demand by u ur, where ur rrh is the group by u_i related with r, and d_{rrrh} characterizes the data rate demand by r, which can be elective with d_r = p.

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Remark in order to we do not inflict some data rate demands in order to UEs attached of MMTC slices, since MMTC does not inflict stricter QoS requirements than EMBB and URLLC.

In this section HRAN is showing energy related techniques for resource allocation with the help of algorithm. Whensoever we partake to connect in a network, we have to look for the source and destination. So, the source and terminus are initialized originally. The second stage describes the values by initial energy, transmission powers, number of users, population size and number of iterations. With this initial values, the node's position is traced. The selection of the leader node for resource allocation in the boundary of the region is done on the foundation of transmission power and reception power. The leader node collects the onward nodes by analyzing the power analysis. The forwarder node chooses the forwarder node by means of the maximum density, minimum dentition and maximum packet size in the selection method. Execution of all steps of an energy efficient algorithm for a given number of iterations. Meanwhile the energy efficient apparatus is based on the highest energy node assortment, the final resolution got is optimal. Describe the values by initial energy, transmission powers, number of users, population size and number of iterations in the order of the future algorithm. Start coordinates stand for BS, RRH, MUE, RUE, and D2D pairs. Now, for each sub-channel, assign energy wise to any cellular user and ERUE maximum reaming energy and data rate to a sub-channel and treat this task matrix as the initial population. Recognize the forwarder node grounded on the initial energy assessment.

Algorithm

1: Input: N Network and No. of nodes, No. of iterations

2: Initialize EPBS, EPk, EPn, EM, EK, EN.

3: Initialize coordinates of EBS, ERRHs, EMUEs, ERUEs and initial energy.

4: Entrust 1 cellular user of each sub-channel based through energy

Node_id. UpdateRange (, EPk, EPn)

for db in neighbhour do

If nid (EPn , then src->nid k(i,j) ; If , then mn (EPk) nid.

5: Figure out remaining energy, data rate, and distance to each user

6: Give RUE and forwarder node of maximally one sub-channel

based through the calculated energy and data rate.

7: ponder present assignment matrix is the initial energy value, estimate the remaining energy and recognize the forwarder node.

8: Select leader node.

9: If energy of EXi newk is better than EXi Ek then

10: Accept.

11: Else Reject.

12: Do the steps from 4 to 9 for No. of iterations.

13: Output: Highest Energy Node

Algorithm should support your system model and provide simulation parameter table for algorithm used for simulation.

VII. SIMULATION RESULTS

The introduced algorithm is evaluated in this part. The energy efficiency presentation to the introduced H-CRAN is shown with the help of Performance Metrics.

A. Performance Metrics

The undermentioned execution metrics have been present in order to evaluate the introduced algorithm.

- Power Consumption: In the whole network, both radio and BS cloud are used for calculations to calculate the total power consumed.

$$P_{hcram} = P_{radio} + P_{fronthaul} + P_{BScloud}$$

- Throughput: The figure of info bits effectively received or delivered per second is represented as the data rate or throughput.

$$R_j = \sum_{k \in U} r_{UE}^k$$

- Energy Efficiency: The network power consumed relative to the system capacity is shown with the help of power display. Energy efficiency (ηEE) in step with joules is the ratio of attainable throughput (bits/second) to typical network power consumption, which can be obtained [12] as follows:

$$\eta_{EE} = \frac{\sum_{j \in R}^{N_R} R_j}{Network\ Power\ Consumption}$$

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B. Performance Analysis

The parameters related to the simulation system to evaluate this, seven macro Bs have been employed involving the 7-cell architecture.

The simulation parameters in the proposed model are set as per the 5G specifications. Each GRRH radius present in the macro cell is set at 200 m and all simulation radius at 1000 m. Each GRRH and maximum transmit power are set to 12 W and 24 W respectively. Minimum data rate with 100 kbps is included for any user. The reference distances are set at 10 meters according to the far field of the antenna. The path loss exponent is placed at 2. The zero mean of 10 dB is set to shade the Gaussian variable. Circuit power is equal to 10 W for Macro BS. The EH rate with 0 W to 15 W per unit time has been determined for any GRRH range. 5 kWh battery capacity is used for GRRH.

The effect on total network Energy consumption at shown with the help by Figure 1. In this, the Energy consumption at the network is displayed on contrast at the normal traffic load. The entire network power consumption tends by increase with the network traffic load, as the BS cloud present in the network consumes a large amount of resources. It is possible to increase power consumption with more traffic radios. The effect on the total network throughput is shown by the help of Figure 2. The effects of increased traffic load are demonstrated for entire network throughput. Along with this, the effect on energy efficiency is shown with the help of Figure 3. The proposed energy efficient HetNet scheme has outperformed. The proposed method has better-quality performance in energy efficiency, power consumption and network throughput.

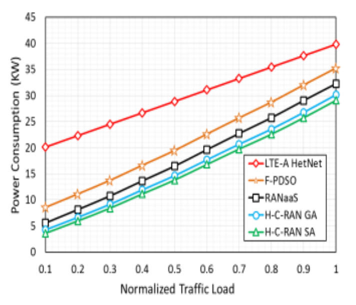

Fig 5(a) Power consumption of total network Vs Normalized traffic load in network

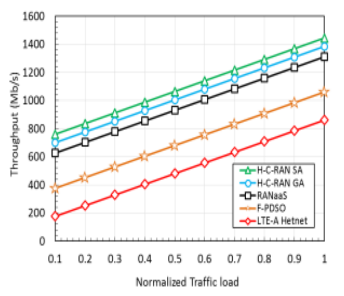

Fig 5(b) Effects of Normalized traffic load on the total network Throughput

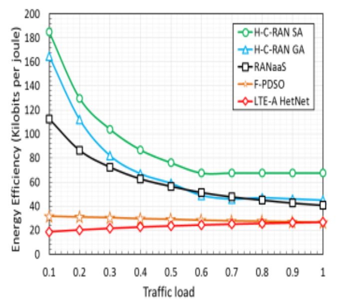

Fig 5(c) Energy Efficiency of Network

VIII. CONCLUSION

The energy-efficient H-CRAN algorithm is proved with the help of this paper. This paper covers the use of multiple cloud radio access networks in 5G networks by incorporating energy efficient resource allocation management. Energy Efficiency (EE) Optimization 5G networks have energy consumption models with improved performance by improving system throughput. The simulation results show that energy efficiency (EE) optimization improves 5G networks. Energy savings have also been achieved with the help of the proposed methods. In the future, work can also be done using energy efficiency in the fronthaul. It covers only fiber to fronthaul. Work related to energy saving can be done in the fronthaul. Improvements in bandwidth efficiency are also possible with the help of this function.

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