Intelligent Automation & Soft Computing
DOI: 10.32604/iasc.2023.026523
Article

Base Station Energy Management in 5G Networks Using Wide Range Control Optimization

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Received: 29 December 2021; Accepted: 13 March 2022

Abstract: The traffic activity of fifth generation (5G) networks demand for new energy management techniques that is dynamic deep and longer duration of sleep as compared to the fourth generation (4G) network technologies that demand always for varied control and data signalling based on control base station (CBS) and data base station (DBS). Hence, this paper discusses the energy management in wireless cellular networks using wide range of control for twice the reduction in energy conservation in non-standalone deployment of 5G network. As the new radio (NR) based 5G network is configured to transmit signal blocks for every 20 ms, the proposed algorithm implements withstanding capacity of on or off based energy switching, which in-turn operates in wide range control by carrying out reduced computational complexity. The proposed Wide range of control for base station in green cellular network using sleep mode for switch (WGCNS) algorithm toon and off the base station will work in heavy load with neighbouring base station. For reducing the overhead duration in air, heuristic versions of the algorithm are proposed at the base station. The algorithm operates based on the specification with suggested protocol-level to give best amount of energy savings. The proposed algorithm reduces 40% to 83% of residual energy based on the traffic pattern of the urban scenario.

Keywords: 5G base station; energy management; energy saving; traffic pattern; sleep mode

1 Introduction

The demand for high data rate in 5G networks with the possibility of internet access and flexible applications endure value to the new proposal. Increased data rate in Gbps will produce more energy consumption and increased waste collection to mobile communications [1]. Hence the global carbon dioxide (CO_2) of 2% emission becomes a big question as stated by Mingayin in [2] where the author discusses about the year 2007 which made environmental sustainability asset backed as "Green IT," an big discussion which have been drew out till 2009 is significance because of climate changes. This made organizations involved in spending more cost or else money saving by avoiding excess energy spent for increased action repeatedly. During off peak time the base station used is not that much efficient [3].

Thus, the energy saving and reduction depends on the optimal resource spotted in state of art, environmental sustainability maintenance, enterprise operations, supply chain for reply and returns, products and services, resources utilization and life cycle of each stations used. Malmodin et al. [4] gave wide view on the above mentioned energy management issues and infer that CO_2 emission is controlled as a factor of 0.2 and 0.4.The authors endeavour is to provide environmental impact of information Communication Technology (ICT) that focus in electricity use and greenhouse gas emission [5] that simplifies and digitize at all the levels.

With new wisdom and vision given by Fehske et al. [6] this article specially focus on the global carbon footprint of mobile communication systems rolled out for ecological and economic hassles. Measuring the survival of assessment models, the author predicts increased CO_2 equivalent emissions handhold from the year 2007 to 2020. Thus, when rate of emission increases due to data transfer then raise of mobile traffic volume will be at post disbursal. On enhancing improved spectral efficiency, the system leveraging the three orders of magnitude will analyze more traffic with the same energy consumption.

Compared to prior work, ICT foot print archives less defects in this proposal even when the carbon footprint goes higher than earlier. Taking CO_2 emission as exhaustion this work pioneered the design and implementation as easy for necessity. This proposal minimize the electricity bill (EB) paid in account of all action taken well prior [7]. As a concequence, in 2013 the EB may raise to $22 billion. Energy saving can be optimized by assuming that fraction of cells can be switched off [8]. This proposals primarily concentrate to diverse use of power consumed by base station which may consume high energy from 60–80% of the total energy in wide range of cellular networks.

The Author in [9] discusses about lowering the energy consumption of mobile radio systems in an economical way. The author mainly focuses in deployment of base stations based on numbers of micro sites streamlining to already existing macro sites. These systems aggressively pursue to manipulate output for full load conditions. The adverse impact of sleep mode for the base station to save energy, which makes possibility of active base station having low traffic loads and decreased noise decibels to get off permanently [10]. Total energy consumed by the network can be minimized by taking care of spectral efficiency [11]. It's well known that day time traffic will be more compared to night time which gives same effects when weekdays and weekend traffics which are compared for an output. To make sure that all base station runs in good and effective way during night time and in weekends it's a compulsion to make unnecessary base station to sleep for a while. It is also taken care of the point that whatever is the work load may be the power consumption consumed by the base station will be same which is clearly given by author [12,13]. This main disadvantage with prior introduction gives a way to this proposal, which in-turn makes wide range of control to base station a compulsion for making it to sleep mode.

The traffic is exemplary with least usage when it covers spacious area of base station which are used less. To make the proposed system more effective emphasis is made on questions like when and which base station is in sleep mode? And pointing the parameters for determining sleep decision for concerned base station?

This work concentrates toward the wide range of control to base station in Green Cellular Networking using Sleep mode for Switch (WGCNS) are as follows:

- Pseudo Followed: Base station energy saving is a time consuming process which is concentrated here. To reduce overheads there is a need for a common controller. In the proposed work, the effects given to the network while making a base station to sleep mode is calculated. These parameters concentrate further more with internal and external deepening ownership of traffic and loads named as threshold respectively. Taking all the parameters in consideration the linear complexity is calculated which may arise due to wide range of control to base station during sleep condition. All these are completely modified for best result.

- Practical Results Received: For making this base station sleep mode to work better three heuristic algorithms are used, which operates either partially or without feedback. Also the performance gap of regular used algorithm and optimal search algorithm which reduce consumed energy to 10% in a real traffic is calculated. Besides above said condition the other execution is also calacuted like: i) a crash avoidance based on cross checking whether two base station try to go in sleep mode at a time during controlling besides traffic maintenance ii) a time to measure is repeated to ensure sleep mode occurrence for particular base station because of higher workloads.

2 Literature Review

Saving energy in wireless network seems to be unpredicted as internal and external load introduction was given brief by later works as mentioned in the reference by author [14]. Energy savings can be achieved in similar area with two operators with energy aware cooperative management [15]. Relating to previous work only one state implementation of dynamic base station may be possible on calculating load but this gives un-assurance of result [16]. Also in [17] energy savings is carried out by switching off the base station in night time. This system is carried with an analytical model. But all prior works is carried out only in hexagonal and Manhattan model network. There also exists a computational and energy trade off between wireless and fixed networks [18]. This work is carried with a feature implementation having sleep mode possibility for dynamic works in base station. In [19,20] the authors stated that the energy saving is implemented as multi hop system. In [21] the author carried cell zooming activity which resulted in implementation as it is highly impossible for better result. In the proposed system mentioned with its protocol suites many general problems are detailed and resolved. Whereas in Section 3 sleep mode algorithm is used to show its better results. In Section 4 first-order analysis is computed whereas Section 5 gives the result for real traffic profiles. Finally, conclusion and next state of implementation is suggested. Even after enlarging the area coverage for working base station that moves to off condition using a power controller in previous works secured a 50% energy saving alone [22]. Implementation of energy saving methods for uncountable base station going with awake or to sleep will be a difficult problem and also, they enforce high computation complexity use on high signal overheads [23]. All previous works have discussed about green cellular operation issue which lead a way for better understanding of what's happening till now and what can be modified from existing to mere future. One extension needs to consider is more practical model for base station which in turn depends on its total path usage, instead of fixed energy accumulation model used in utmost all previous work. As described by author in [24,25], a model that utilize both energy in demand and fixed energy accumulation model is designed. Considering the network to be heterogeneous, having varied configuration of base stations like macro, micro, femto and WiFi with application support, which may accumulate more transmission power combined with operational power and varied frequency bands [26].

The existing system works into downlink capacity and overhead resolving methods, in future same steps can be used along with uplink capacity calculation. Here the specified system suggest trying to work with both points together to make this system suitable for any protocols received on working with vital grounding. From most of the literature it is evident that at the most concentration is focused for a friendly, reliable and efficient way as to how energy can be saved in wireless netwok with growing demand [27]. Energy harvesting is concentrated along with quality off service (QoS) in 5G technology [28]. Also, uniform energy can be consumed in wirelees sensor network using mobile sinks which also provide load as balanced one [29]. In recent times research is going on, on how to reduce the cost of operating the base station. Now a days, base station are powered by sun and wind power rather than the conventional diesel generators [30].

The rest of the paper is structured as follows: The proposed technique and traffic pattern is detailed in Section 2. The sleep mode algorithm is given in Section 3. Result and discussion are detailed in Section 4 and Section 5 concludes the major findings of the paper.

3 Proposed Technique and Working Methods

3.1 Proposed WGCNS System

- **Protocol Suites:** This network model put a huge impact in dimensional area called downlink communication for primary stage in mobile internet i.e., connection between the base station and equipment.
- **TCH Model:** Datagram switching is applied for simulation of traffic channel model (TCH). An assumption that the used equipment x is working in time t that range with independent Poisson distribution with mean arrival rate $\lambda(j, t)$. The result may be an exponentially distributed random variable with mean$1/\mu(j, t)$. Thus, Eq. (1) gives the arrived transport volume which is given by,

$$\gamma(j, t) = \frac{\lambda(j, t)}{\mu(j.t)} \tag{1}$$

In Eq. (1) there may be some intervention to the traffic data arrived due to targeted QoS as displayed in Tab. 1.

- **Grounding Rule:** Equipment or network located with $x \in A$ is associated with served base station which gives the best signal strength,

$$e2 = arg \max_{i \in E2_i^{on}} g(i, x).H_{e2} \tag{2}$$

In Eq. (2) $E_2^{on} \subseteq E2$ is the set of active base stations at time t,$f(e2, j)$ is the hike from base station $e2$ to equipment in location j additional to travelling attenuation, coming back to fading and H_b is the imparting power of base station $e2$.

- **Channel Model:** Service rate of equipment at location j from base station $e2$ at time t is calculated as

$$c_b(j, t) = BW.\log_2(1 + SINR_{e2}(j, t)) \tag{3}$$

BW in Eq. (3) is the system bandwidth and $SINRe_2(j, t)$ is received indicator with obstruction. Noise ratio is given as $SINR$ at location j from base station $e2$ at time t that is given by

$$SINR_{e2}(j, t) = \frac{g(e2, x).H_{e2}}{\sum_{i \in E_2^{0n} - \{e2\}} g(i, x).H_{e2i} + \sigma^2} \tag{4}$$

where σ^2 refers to the noise power in Eq. (4).

Loads Organization: System load refers to the time required to specify the covered transport volume. QOS is well maintained when user traffic load and service rates are starting steps giving way to end result. The system load of base station $e2$ at time t will inch their way upwards to total traffic load which is formulated in Eq. (5),

$$p_{e2}(t) = \int_{E1_{e2}}^{1} \frac{\gamma(j, t)}{s_{e2}(j, t)} \, dj \tag{5}$$

where $E1_{e2}$ represents base station $e2$ these notations are given in Tab. 2.

Table 1: Traffic calculation based on user (time, weekdays or weekend) and resulted threshold based on request and response made

	Traffic pattern		
	No. of users	Traffic (erlangs)	Threshold
Base station 1	78	2.9676e + 03	2.9776e + 03
Base station 2	83	3.1578e + 03	2.9776e + 03
Base station 3	82	3.1198e + 03	2.9776e + 03
Request			
Sending acknowledgement from base station 1 to 3 base station			
Sending acknowledgement from base station 1 to 2 base station			
Response			
Sending acknowledgement from base station 3 to 1 base station			
Sending acknowledgement from base station 2 to 1 base station			

Table 2: Traffic management after imposing base station centralized control

	No. of users	Traffic (erlangs)
Base station 1	106	4.05196e + 03
Base station 2	56	2.15916e + 03
Base station 3	56	2.15916e + 03
Handover		
Base station 1	0	0
Base station 2	121	4.6036e + 03
Base station 3	122	4.6416e + 03
Request		
Sending acknowledgement from base station 2 to 1 base station		
Response		
Sending reply from base station 1 to 2 base station		

3.2 Problem Formulation

The proclaimed strength in wide range of base station control algorithm will be minimizing the energy accumulated for cellular networks.

$$U_{e1} = \sum_{e2 \in E2} \int_0^T E_{E2s}.e1_{e2}(t)dt \tag{6}$$

In Eq. (6) $E2_S$ Base station–energy in demand

$e1e2(t) \in \{0, 1\}$ –signal fore2 base station at time $t \in [0, t]$

$e1$–signal received for all base station during t time.

Thus, sleep mode time is calculated as follows to make it omnipotent during transmission.

Threshold $p^{th}(\leq 1)$ is for balancing trade-offs between the system resolution/dependability and effective working is given in problem formulation. For low threshold the system work load will also be less. This silent waiting state with less call drop probability ensures base stations are robust to any traffic. High threshold value results in more energy saving, but with reduced performance. Tab. 1 discusses the notation used in proposed work [1].

3.2.1 Notations Used

$E1 \subset R2$ Region represents over a period of time, $e2 \in E2$ says the index of base station, $E1_{e2} \subset E1$ base station ($e2$) gives the Coverage, $x \in E1$ are Area in consistent space, $E2^{on}t\ E2$ speaks the arrangement of active base station at time t, $\lambda(j,\ t)$ shows the traffic appearance pace of area x working in time t, $Nt1e2$ are the set of neighbouring base station's of base station $e2$, γ (j, t) is the transport volume of location x at time t, $\gamma(j,\ t) = \frac{\lambda\ (j,\ t)}{\mu(j.t)} c_b(j,\ t),\ c_b(j,\ t)$ mention the Service rate at location j from base station $e2$ at time t, $c_b(j,\ t) = BW.\log_2(1 + SINR_{e2}(j,\ t))$.

$$\min_{e1} U(e1) s.t. 0 \leq p_{e2}(t) \leq p^{th},\ \ \forall e2 \in E2,\ \ \forall t \in (0,\ t) \tag{7}$$

$\frac{1}{\mu(j.t)}$ are some average file size of location j at time t with H^{th} threshold, ES_{E1S} are operational consumption of base station as per unit time, $e1_t$ is the arrangement of base station movement in Eq. (7). This make at time t, $e1_t = \{e1(t),\ \cdots\ ,\ e1|E2|(t)\}$, p_t is the travelling attenuation at time t, $p_t = \{p_1(t),\ \cdots,\ p_{|E2|}()\}$, $P_{e2}(t)$ give the System load of base station $e2$ in t of Eq. (8),

$$p_{e2(t)} = \int_{E1_{e2}}^{t} \frac{\gamma(j,\ t)}{s_{e2}(j,\ t)}\ dj \tag{8}$$

4 Proposed Sleep Mode Algorithm

4.1 Blue Print of WGCNS

Sleep mode algorithm looks forward as more important as the peak traffic volume that balance and reduce traffic load overheads, it seems to be extreme pleasure in formalizing the sleep mode switch during peak hours as displayed in Tab. 2. The working level of WGCNS is displayed in Fig. 1. This section briefs out the use of having sleep mode option for making impale base stations to be more active. Here the newly proposed idea of having sequential algorithm, called sleep mode, in which base stations get turned on/off one by one for ensuring the QoS.

On making a single base station to sleep will fairly increase overload to neighbouring system [29,30]. Considering this elevator situation of a sleep mode to the allotted base station and less pay for $s_{e2}(x)$ to increased interval for equipment used along with base stations undergo with examination. Because of this activity the service rate $s_{e2}(x)$ will be increasing. Let us take a consideration which station can be made to sleep first. Set of neighbouring to base station $e2$ is represented as $Nt1$, so that $n\ Nt1$ which provides the best signal strength to base stations located in $x \in E1_{e2}$ as mentioned below in Eq. (9):

$$n = arg\ \max_{i \in N_{t1}} g(i,\ x).P_b\ for\ x\ \in E1_{e2} \tag{9}$$

There may be interruption between base stations due to heavy traffic after getting base station $e2$ to sleep for a while. This $e2$ can go to sleep mode when it satisfies below condition:

$$\int_{A_n}^{t} \frac{\gamma(x)}{s_n(x)} dx + \int_{A_{b\to n}}^{t} \frac{\gamma(x)}{s_n(x)} dx \ \le p^{th}, \ \ \forall_n \in N_b \tag{10}$$

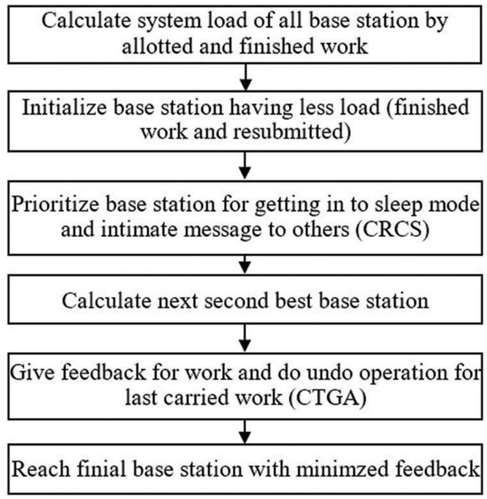

Figure 1: Working level

where $E1e2 \to n$ is the coverage of equipment who supports working of base station n to base station $e2$ in Eq. (10) which might go to sleeping condition. The unchanged travelling attenuation p_n is defined as the middle travelling attenuation for base station (n). The increased travelling attenuation is represented as $p_{b\to n}$ which gives the foreign loads $e2$ to n base station. For example, in total of 4, either base station 2 or base station 3 must go to sleep mode which in turn enhance travelling attenuation of base station 1 to be in greater scope for threshold. Thus, the network decides by self to make base station 1 or base station 4 to go for sleep mode. As base station 1 accumulates more space for traffic maintenance compared to base station 4 then chooses 1 as finally sleeping. Thus, all these type of additional work loads are represented as $p_{b\to n}$ addition to original. Hence WGCNS (1, 1):

$$H_{e2} = max_{n\in Nt1_{e2}} \left(p_n + p_{e\to n}\ \right), \ \ \forall e2 \ \in E2^{on} \tag{11}$$

In Eq. (11) Base stations $n \in Nt1_{e2}$- maximum neighbouring

This in turn occupies less spare room for traffic management on high demand. For average system load of neighbouring base station1 $1/|Nt1_{e2}| \sum_{n\in Nt_{e2}} \{p_n + p_{b\to n}\}$ increment all system load $\sum_{n\in Nt_{e2}} \{p_n - \ p_{b\to n}\}$. This proposed sleep algorithm makes least network-impact to get to sleep mode like

$$b^* = arg \ min_{e2\in E2^{on}H_{e2}} \tag{12}$$

4.2 Parameterisation of WGCNS Algorithm

4.2.1 Go to Sleep Algorithm

On matching to equation criteria in Eq. (10) which depends on location of base stations and its neighbour localization of sleep mode going base station can be fixed. This is emphasised from system information like signal strength, system load shared among base stations and equipment's at work. Thus, each and every base station long time go for a self-check whether it is to go for sleep mode or not as displayed in Fig. 2. The sleep mode protocol summary of WGCNS is depicted in Fig. 3. This completely avoid the concept of having centralized controller. This algorithm follows below three steps

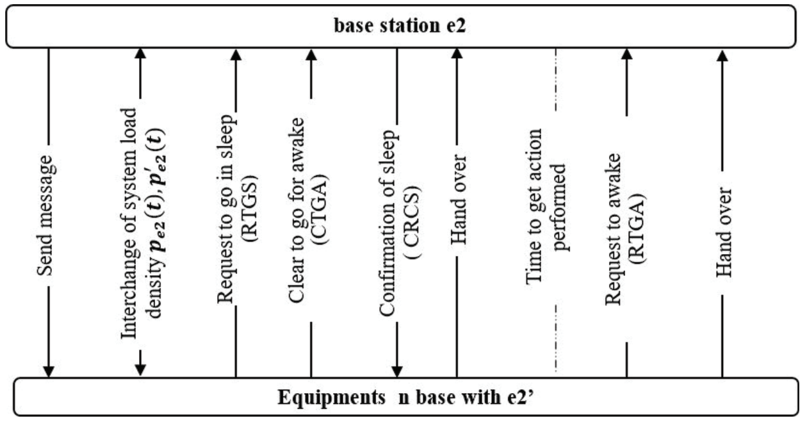

Figure 2: Sleep mode working protocol of WGCNS

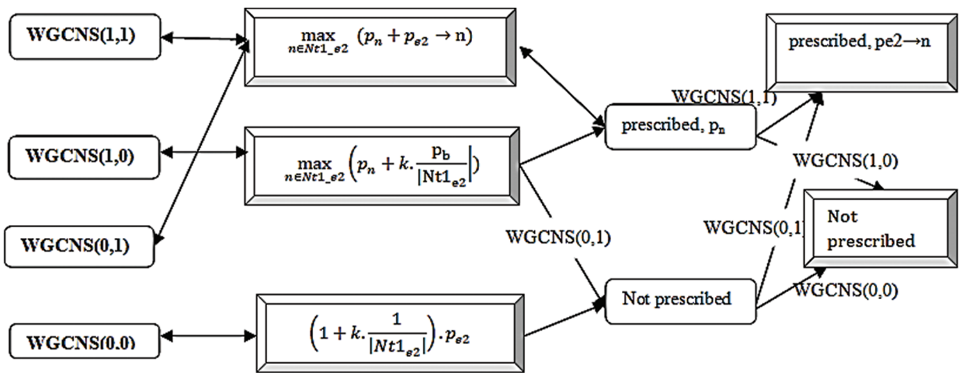

Figure 3: Sleep mode protocol summary of WGCNS

- **Initialization:** Periodical feedback information for received signal is considered mainly for initializing the base station to go in sleep conditions. When a base station goes to sleep mode then remaining users in coverage area will select the second-best base station by mentioning its identity back to equipment in use.
- **Decision Making:** Network impact for users and neighbouring base stations are given more important than any other for deciding to go for sleep mode or not. If Ge2 < ρth, then go to sleep mode for Nt1e2. To avoid such conflict, first raise broadcasting request to switching-off request to switching-off signal (RTGS). Then after only switches to sleep mode on receiving clear to switching-off (CTGA) from all its neighbouring base station. Thus, an alert from all neighbours on confirmed such as confirmation of switching-off (CRGS) is received on final.
- **Finalized Result:** Thus, base station *e*2 goes to sleep mode on receiving the signal CTGA from all neighbouring. Then the next second-best signal strength for a base station will be noted and reported as right now equipment, which looks similar like conventional hand-over where all base station makes a same decision of giving rights to second best signal received base station. This type of group hand-over is majorly concentrated for many network processes which are ongoing in research that may be used in mass transportation and this is established by controlling signal.

4.2.2 Awake from Sleep Algorithm

To awake a base station from sleep mode all its process is a reverse step of above conditions. This made when system load reaches the same value as like base station be foregoing to sleep condition. But this cannot be implemented by itself due to lack of current system load, which in turn make necessity of having neighbouring base station reply a compulsory one. On what basis a node gets to sleep will be affected with neighbouring base station.

- **Initialization:** Initial steps for sleep algorithm is processed in well co-ordnance with final steps to be received as result. After receiving CTGA from all neighbouring base station, $e2$ base station will definitely go to sleep mode. Then $e2$ records overall system load along with hand-over traffic from $e2$ to others.

Before making a base station to go for sleep mode the neighbouring base stations will share about the sleep mode status, i.e., RTGS which is same as like classical hidden terminal problem.

- **Decision Making:** On making $e2$ to go for sleep mode and then when it reaches system load matching to it, its result will thus make its neighbouring to $e2$ go to sleep mode in turn making the prior to awake by making condition as switching-on (RTGA). Thus, last sleep node to be switched on first. This is enriched as follows

If $pe2 > p_{e2b} + \in$, then forward the request to awake neighbouring base station $e2$ will be in sleep mode only.

Hence the sleep condition follows three parts as mentioned below:

- **Finalized Result:** On receiving RTGA the base station which has gone to sleep state will get back to awake. In same manner as in previous, the equipment will re-select the next base station as which has best signal strength. When the traffic pattern occupies equivalent space then automatically the sleep mode protocol will work in undo for above operation namely awake condition. The overheads raised due to feedback that overcome in following ways to avoid slowdown of transactions.

Revision in feedback received: Because of the concept adaptive modulation, equipment sends feedback for received signal strength from worked base station. After this the additional feedback like next choice of good and strong indicator associated base station identity were used to calculate the lay down for travelling attenuation which may rise some overheads. This can be reduce as mentioned below:

$$p_{e2} \rightarrow n \ \rightarrow \ k \ \cdot p_{e2} \left| Nt1_{e2} \right| \tag{13}$$

In Eq. (13) k–Represent the benefit for deployed base station and its neighbouring base station. On working with hexagonal cellular network this benefit is estimated as 1. Thus, sleep condition is redefined as follow

WGCNS(1, 0):

$$H_{e2} = max\ n \in Nt1e2\ \rho n + k \ \cdot \rho e2 \left| N\ e2 \right| \ , \ \forall e2 \in Bon \tag{14}$$

Balancing work load with neighbours: On exchange with feedback message the system work load may increase such that it will further reduce predicting system load of neighbouring. This type of execution can be done as follows:

$$n \rightarrow \rho \mathrm{e}2 \tag{15}$$

Based on approximation Eq. (15) on homogeneous distribution this gets to hold when the user traffic path is changing continuously. Thus, the network impact is redefined as Eq. (16):

WGCNS (0, 1):

$$H_{e2} = max\ n \in Nt1\ e2(\rho\ e2 + \rho\ e2 \rightarrow n),\ \forall\ e2 \in Bon \tag{16}$$

Adding Eqs. (12) and (14) here received a network effect similar to information without feedback like below Eq. (17):

WGCNS (0, 0):

$$H_{e2} = 1 + k \cdot 1\ |Nt1e2|\ \cdot\ \rho e2,\ \ \forall\ e2\ \ \in Bon \tag{17}$$

Algorithm: Network Impact External Internal From Np

- **Other Issues:** For making a node to go in sleep condition, exchange message like RTGS, CTGA and CRGS is necessary [1]. These message exchanges prevent multiple base stations switched off at the same time ensuring QoS. System goes inefficient during message exchange on same time. For example, E1 and E2 base stations send an RTGS to same neighbouring E3 simultaneously then, E3 responses CTGA to E2. But E2 doesn't go to sleep mode by the other neighbouring base station which is not connected with E1. Hence E1 and E2 cannot go to sleep condition, hence the conclusion is made that the network is asynchronous. To avoid this overhead, the system need to go for synchronous operation that prevents collision of message exchange during RTGS in waiting or multi-step for CTGA. Because of high variation to system load repeated sleep condition working may happen. To avoid such things happening hysteresis margin is used. Then threshold is rewritten as follows: $p_{th} \rightarrow p_{th} - \frac{\Delta_h}{2}$ for sleep mode

$$p_{re_{ji}} \rightarrow p_{re_{ji}} + \frac{\Delta_h}{2},\quad \text{for awake mode} \tag{18}$$

When amount of energy saved decreases by the lower threshold as in Eq. (18) there may be reduced Sleep and Awake conditions that in-turn considers the trade-off made.

4.2.3 *First-Order Analysis*

The process of calculating energy saved using above mentioned parameters may go challenging as base station deployment are dynamical during sleep condition declaration.

$$p(t) = v.\cos\left(\frac{2\pi}{T}\right) + M \tag{19}$$

mean $-m$ and variance –v for WGCNS (0, 0)

Thus, energy saving ratio based on Eq. (19) is given by the equation,

$$c = 1 - \int_0^T \frac{e1_{e2}(t)dt}{|E2|.T} \tag{20}$$

where $|E2|$ is the total number of base station t. Now consider that the average base sleep condition to account with its duration. Energy saving ratio is given in equation Eq. (18) say how long sleep condition works for a base station. Thus, it is represented as t^{on} for $e2$ and t^{off} for $e2$ for sleep time and awake time. Considering sinusoidal work in Eq. (20) for given traffic the result received is,

$$C = \frac{1}{T} \ .[\ t_{e2}^{on} - \ t_{e2}^{off}] \tag{21}$$

δ- Time gap with $(1 - k/|N_{e2}|)$

If there were more base station then this value will decrease. Hence, the peak traffic load is at time ton in Eq. (21), $e2$ will be in sleep mode. Thus, to ensure QOS the rules are followed as like below Eq. (22):

$$C = \frac{1}{T} \ .[\ 2.t_{e2}^{on} - \ T - \ \delta] \tag{22}$$

For cosine inverse, t on $e2$ is calculated as t on

$$p(t_{e2}^{on}).\left(1 + E\left\{\frac{k}{|Nt1_{e2}|}\right\}\right) = p^{th} \tag{23}$$

where $Y = E\{k/|N_{e2}|\}$.

Thus based on Eq. (23) energy saving ratio will be like

$$t_{e2}^{on} = T - \frac{T}{2\pi} e1 \cos\left(\frac{\frac{1}{v}.p^{th} - \frac{M}{v}\ (1 + X)}{1 + X}\right) \tag{24}$$

On redefining Eq. (24) the Taylor series will become

$$\mathrm{C} = 1 - \frac{1}{\pi} \mathrm{e1} \cos\left(\frac{\frac{1}{\mathrm{v}}.\mathrm{p}^{\mathrm{th}} - \frac{\mathrm{M}}{\mathrm{V}}(1 + \mathrm{X})}{1 + \mathrm{X}}\right) - \frac{\delta}{\mathrm{T}} \tag{25}$$

Eq. (25), gives the result for maximum energy saved even when traffic parameters are low values but the number of neighbouring base station is high. In urban commercial areas during night time that too in weekend the traffic will be less. Thus, δ and X are dynamical parameters while sleep or awake process.

5 Results and Discussion

On doing the stimulation with real 5G network topology holding 20 base stations in the area of 5 × 5 km, to avoid edge effects, Wrap-around technology is followed. A traffic load will be homogeneous but with varied traffic arrival rate. Increased traffic arrival rate, for base station with p^{th} will make the system load = 1 with threshold value p^{th} as 0. Making sleep condition to start with value 0.5 with system reliability for real travelling attenuation the resultant will be equal to 1 when traffic gets to peak. Considering the transmitted volume and service life of traffic structure for selected base station is given as Pi = 18W and EBS = 860W other parameters like channel propagation model are followed as per 3GPP release 15 in urban macro model. Fig. 4 depicts the traffic loads shared to neighbouring grounding during sleep or live mode for three 3 base station intially. Fig. 5 represents the graph between frequency and power spcrtral density of the system. Fig. 6 represents the energy in demand for varied traffic path having travelling attenuation ranging from 0 to 1. Here WGCNS (1, 1) with full feedback information consumes utmost 9% more energy for the entire system load. Thus, a distributed protocol with linear complexity is in result.

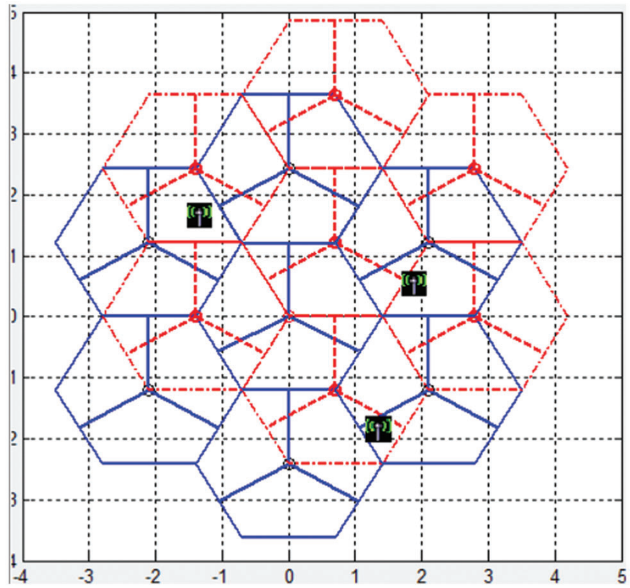

Figure 4: Traffic loads shared to neighbouring grounding during sleep or awake mode

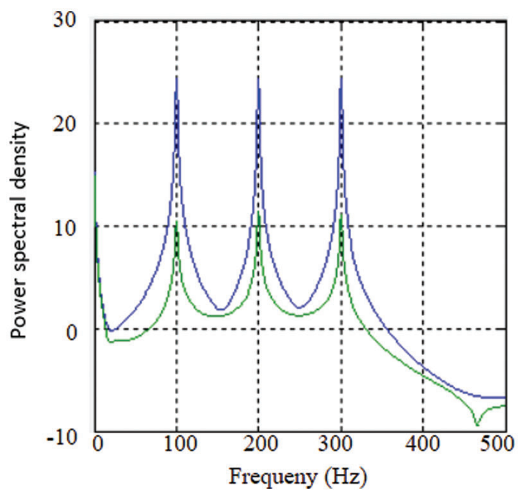

Figure 5: Impact of traffic management and implementation of sleep algorithm

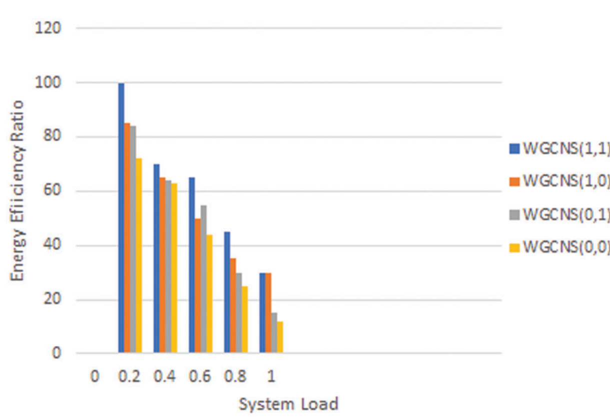

Figure 6: Energy saved ratio impact of traffic management and sleep algorithm

When feedback is like partial system load is smaller than the system functions too which is comparatively good, due to performance gap the system load will be 1. There is 3−6% of performance difference with WGCNS (0, 1), WGCNS (1, 0) and WGCNS (0, 0) as displayed in Fig. 6. Traffic benefit k is used in WGCNS (1, 0) and WGCNS (0, 0), which is 1 with our simulation to show strong signal during traffic load moving from base station to neighbouring. Thus 55% energy is saved in weekdays and 80% during weekend with performance gap less than 10%. On assuming the traffic loads will be 12% in peak and 35% in weekdays and 45% in weekends thus declared the above result. In Fig. 7 When Δh increases from 0.01 to 0.30 going for blocking of base station reaches sleep or awake point because ther is variation in system load based on time but may result in small loss of energy saving.

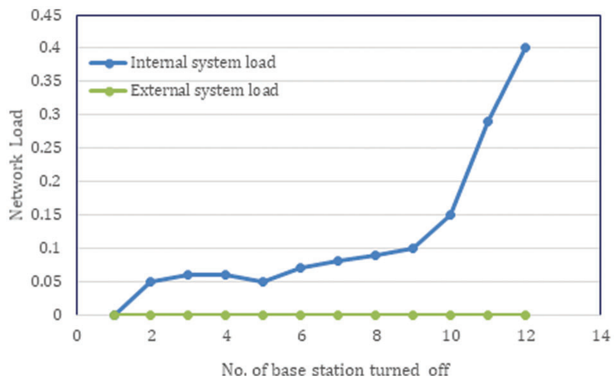

Figure 7: Balancing system overloads

Energy saving with working in sleep, considering the travelling attenuation that depends on the inner and outer work along with distance between base station and its neighbour are displayed in Fig. 8. When the system load is 0.04 the working base station is turned off one by one by the SLEEP algorithm. Average system load of base station going to sleep mode will have values less with neighbouring base stations. Thus, base station with low internal and external system load is getting to sleep first. Thus, proved was the internal factor of the sleep base station is having more network impact than the external factor of neighbouring base station with high system loads. When the density of active base station decreases then the distance increases between base stations. So, the average values of sleep station will be less compared to its neighbour with following interruption: making a base station to sleep-in high-density area will result in least collision occurrence for the network compared to base station with less density as displayed in Fig. 9.

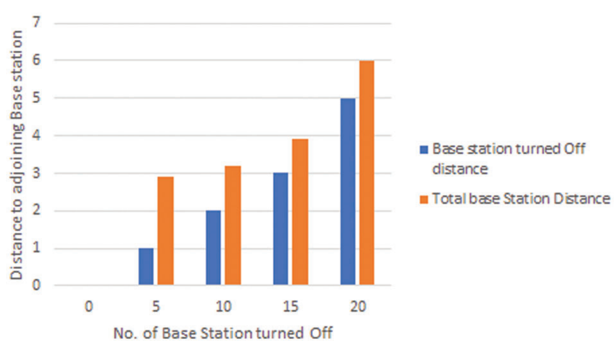

Figure 8: Distance coverage of adjoining base stations

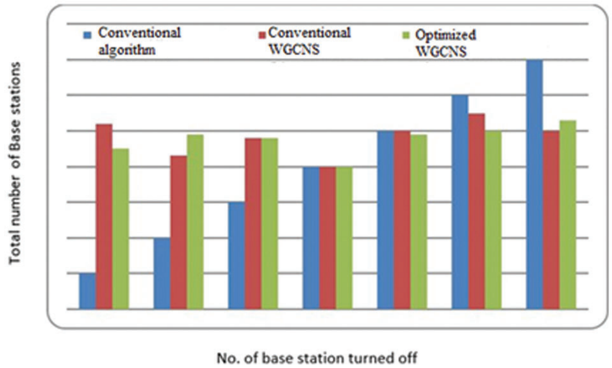

Figure 9: Number of switching off base station to total number of base station

5.1 Number of Switching off Base Station

Anyhow average number of neighbouring base stations remains same through sleep algorithm. Due to coverage increase with base station the density is reduced either way which may get reduced when there is more overheads and interference in the network.

6 Conclusion

In this system, the focus is for base station going to sleep to enforce traffic clearance and energy saving in 5G wireless cellular networks. The proposed algorithm using WGCNS provides more valuables for network-impact in all its sleep scheduling. Sleep mode for base station is considered for three constraints, namely, ease of implementation, computational complexity and signalling between the base stations, which deal in distributed way so that the network operator can apply this methodology in non-standalone implementation of 5G network. The main contribution is first-order analysis where energy in demand dependent on the transmission range mean (M) and variance (υ) for all the active base station. The proposed algorithm using WGCNS states results in energy conservation up to 80%.

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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