Base Station Switching and Resource Allocation for 5G Heterogenous Networks

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Abstract: - Enhanced 4th Generation Wireless Network (4G) is called 5th Generation Wireless Network (5G) as it helps in increasing the data rate, capacity and therefore energy efficiency and spectral efficiency of 5G network, in 5G massive MIMO, multiple numbers of antennas are used to transmit the signal with same time-frequency to maximise the number of users, who can communicate with less number of channels. Energy conception is the most dangerous issue in all the generations of wireless networks such as traditional first-generation to fifth-generation because of interference, eco signals, fading, packet loss, wastage of bandwidth, remaining energy and security like malicious attacks, blocking whole attacks and wormhole attacks. This efficient research work focused energy-efficient resource allocation scheme based on the shortest job first scheduling algorithm in wireless network (SJF) for the downlink orthogonal frequency division multiple accesses (OFDMA) heterogeneous networks (HetNets) developed. To maximize the spectrum allocation efficiency for the fifth generation (5G) mobile networks, frequency reuse-1 is employed. Thus, advanced inter-cell interference coordination techniques are required to mitigate the inter-cell interference for 5G HetNets. In this paper, the energy-efficient optimization problem based on coordinated scheduling is formulated, which is a shortest path problem and link breakage is intractable to solve directly. The above proposed model was analysed using different parameters energy, bandwidth, Quality of Service (QoS) and interference.

Key-Words: - 5G Network, Energy Efficiency, Base Station, Resource Allocation, HetNets, SJF algorithm.
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1 Introduction

Mobile traffic has been increasing day by day due to the wide increase in the number of users and different uses. Since the conventional network is unable to fulfil that ever-increasing demand 5G will serve as a boon for it. As the technology is growing, the demand for it also continues to grow and traffic, interference and low data rates are also observed in the 5G networks, [1]. To meet the Quality of service (QoS) and Quality of Experience (QoE) requirements of the users, some technologies must be incorporated in 5G for its effective service; to meet the demands of the end user in a polished way. One approach to tackle these challenges could be to use a heterogeneous network concept where traditional Macro Base Stations (MBS) are deployed to provide the main coverage of the network to the users for the coverage of large areas and low-powered small base stations are present for the coverage of smaller areas as shows Figure 1 block diagram of wireless communication system.

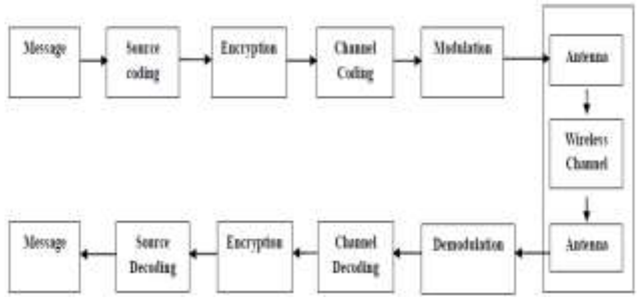

Fig. 1: Block Diagram of Wireless Communication System

Different tier systems will be present here containing small and large cells so it will provide increased bandwidth, reduced latencies and higher data rates which will overall increase the QoE and QoS experience of the user. Energy efficiency is one of the major concerns as far as 5G wireless networks are concerned. A high energy requirement increases the cost of operators and also contributes towards the emission of harmful greenhouse gases, [2], [3]. In addition to energy efficiency, there is a need to increase the spectrum efficiency of the network. Spectrum is very crucial and limited and hence utilizing it effectively is of utmost importance. Due to increased traffic, the spectrum gets overloaded and interference occurs, call drops, and low latencies, low signal-to-noise ratio are obtained will overall lead to deteriorated QoS and QoE as shown in Figure 2 block diagram of the 5G system controls plane for wireless communication.

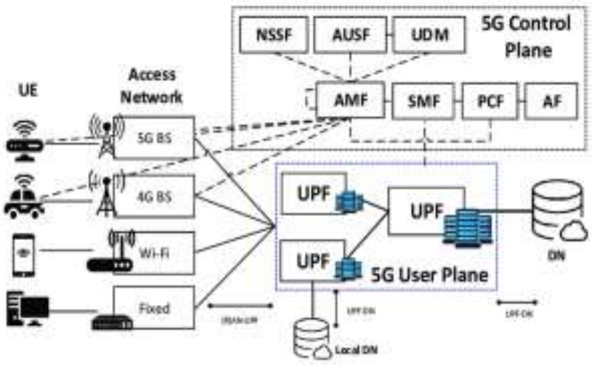

Fig. 2: 5G System Control Plane for Wireless Communication

Spectrum slicing is one of the promising ways for the better and more effective utilization of spectrum for 5G wireless technology, [4]. In the mm-Wave network many technologies such as distributed Antenna systems (DAS), mobile femtocells enabled networks, small cell networks etc. are deployed for better signal-to-interference noise ratio (SINR), reduced latencies and decreased propagation loss. However deploying a large number of small cells or microcells for the coverage and better processing connecting macro cells causes energy overload. All the cells need energy and hence energy consumption of the BS will drastically increase, [5], [6]. However, these benefits come at a price the massive BS deployment significantly increases the total energy consumption of wireless systems. For a typical LTE microcell with a cell size of 100 m and bandwidth of 5 MHz, the power consumption is ranges from 25 watts to 40 watts depending on the traffic load. To achieve the coverage of a 1500 m macrocell, more than 200 microcells need to be deployed the aggregated power of microcells can be more than 900 watts, which is comparable to a typical LTE macrocell BS with 1500 m coverage, [7], [8]. The increased energy consumption not only increases the cost of wireless operators, but also generates more greenhouse gas emissions. Thus, energy saving has become an important design objective of wireless systems in recent years. Meanwhile, energy saving needs to be achieved without sacrificing the quality of service (QoS) of users. As the 5G system is expected to provide 1000x data rates, energy efficiency (EE), typically measured by bits/Joule, also needs to be increased by 1000 times if the total energy consumption remains at its original level, [9]. BS ON-OFF switching (also known as BS sleep control) has been considered an efficient approach for both energy saving and EE improvement Figure 3 block diagram of resource allocation graph for wireless communication.

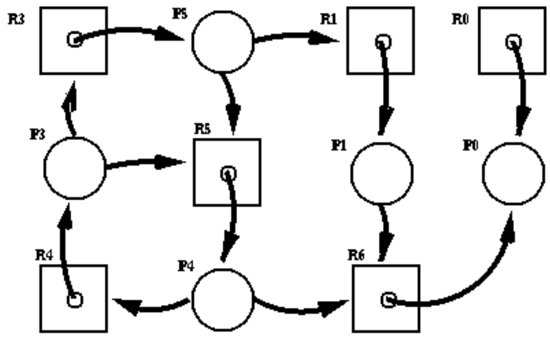

Fig. 3: Resource Allocation Graph for Wireless Communication

2 Background Work

BS ON-OFF switching (also known as BS sleep control) has been considered an efficient approach for both energy saving and EE improvement. As the traffic pattern fluctuates over both time and space, under-utilized BSs can be dynamically turned off to save energy, [10]. In 2009, China Mobile began to apply BS sleep control and the estimated reduction of energy consumption is 36 million kWh per year. Due to such great potential, considerable efforts have been devoted to the design of BS ON-OFF switching strategies in different network scenarios. However, as the 5G system is an integration of different techniques with highly heterogeneous network architecture, [11], [12], the design of BS ON-OFF switching faces special challenges in 5G systems, which can be summarized as follows. On the other hand, processing and explosively increased amount of mobile data traffic in 5G systems will also bring ever-increasing energy consumption and carbon footprint to the mobile communication industry. In particular, the whole information and communication technology (ICT) industry has been estimated to contribute to about 2% of global CO_2 emissions, to which the mobile communication industry contributes 15-20%, [13]. With increasing awareness of the potential harmful impact on the environment and the depletion of non-renewable energy sources, establishing greener mobile communication networks has become an economic issue and a big challenge for sustainable development, [14], [15]. In particular, 100 times energy efficiency improvement has been proposed as another technical challenge in the design of 5G systems, [16].

Specifically, according to some surveys on energy consumption, [17], [18],, 80% of energy consumption in mobile communication networks is due to the operation of BSs. Further, based on the results from laboratory tests done by China Mobile Communications Corporation, a BS consumes 100% energy in the state with the maximum traffic load and about 50%-60% energy in the state with zero traffic load, while the energy consumption of a BS can be reduced to 40% if it is switched off (i.e., in the sleeping state). Therefore, an effective way to achieve energy saving in mobile communication networks is to dynamically switch off BSs, especially for scenarios with low traffic load where fewer BSs can meet the traffic needs of all user equipment (UEs), [19].

A traditional BS consists of baseband unit (BBU) for a baseband signal processing and a remote radio head (RRH) for transmitting/receiving radio signals, [20]. When a traditional BS is switched off, BBU and RRH of this BS would be switched off together. In contrast, in cloud radio access networks (CRANs) which would be investigated and pursued in 5G systems, BBUs of several traditional BSs are centralized in a single location and the corresponding BBU resources are sliced via virtualization technologies, while RRHs are left at cell sites. With this kind of system architecture, the switch-off operation for RRHs and virtual BBUs could be done separately, through combination with flexible resource allocation on virtual BBUs. The energy consumption on the base station (BS) accounts for more than 50% of the total energy consumption of the cellular network. Due to the space-time characteristics of the traffic, the BS cannot allocate resources reasonably, which results in wasted energy consumption and low energy efficiency (EE), [21]. Base station ON-OFF switching in 5G wireless networks: approaches and challenges to achieve the expected 1000x data rates under the exponential growth of traffic demand, a large number of base stations (BS) or access points (AP) will be deployed in the fifth generation (5G) wireless systems, to support high data rate services and to provide seamless coverage. Although such BSs are expected to be small-scale with lower power, the aggregated energy consumption of all BSs would be remarkable, resulting in increased environmental and economic concerns, [22], [23]. However, in 5G systems with new physical layer techniques and highly heterogeneous network architecture, new challenges arise in the design of BS ON-OFF switching strategies. In this article, we begin with a discussion on the inherent technical challenges of BS ON-OFF switching. We then provide a comprehensive review of recent advances in switching mechanisms in different application scenarios. Spectrum Slicing is arising as an important notion for 5G wireless networks as it helps in increasing the data rate, capacity and therefore energy efficiency and spectral efficiency of 5G networks. In this paper, traffic modelling is done based on user density and demand. The system model for spectrum slicing is analyzed based on traffic density pattern analysis so that utilization of spectrum is based on the probability of active users in different zones i.e. urban, suburban and rural areas which has the objective of increasing spectral efficiency. Moreover, the Hidden Markov Model is used for training and preserving of Base station such that probabilistic spectrum allocation to different user densities can be achieved which aims to use the spectrum efficiently.

3 Existing Work

Till now, we have been scheduling the processes according to their arrival time (in FCFS scheduling). However, the SJF scheduling algorithm, schedules the processes according to their burst time. In SJF scheduling, the process with the lowest burst time, among the list of available processes in the ready queue, is going to be scheduled next. However, it is very difficult to predict the burst time needed for a process hence this algorithm is very difficult to implement in the system. The advantages of SJF are the maximum throughput and Minimum average waiting and turnaround time. The disadvantage of SJF is they may suffer from the problem of starvation. And also it is not implementable because the exact Burst time for a process can't be known in advance. There are different techniques available by which, the CPU burst time of the process can be determined. We will discuss them later in detail.

Since-, No Process arrives at time 0 hence; there will be an empty slot in the **Gantt chart** from time 0 to 1 (the time at which the first process arrives). According to the algorithm, the OS schedules the process which is having the lowest burst time among the available processes in the ready queue. Till now, we have only one process in the ready queue hence the scheduler will schedule this to the processor no matter what is its burst time. This will be executed for 8 units of time.

Table 1. In the following example, there are five jobs named P1, P2, P3, P4 and P5. Their arrival time and burst time are given in the table below.

PID	Arrival Time	Burst Time	Completion Time	Turn Around Time	Waiting Time
1	1	7	8	7	0
2	3	3	13	10	7
3	6	2	10	4	2
4	7	10	31	24	14
5	9	8	21	12	4

Till then we have three more processes arrived in the ready queue hence the scheduler will choose the process with the lowest burst time. Among the processes given in Table 1, P3 will be executed next since it is having the lowest burst time among all the available processes. So that's how the procedure will go in the shortest job first (SJF) scheduling algorithm.

A routing protocol is also known as a routing policy. Most Internet Protocol (IP) networks use the following routing protocols:

- ✓ Routing Information Protocol (RIP) and Interior Gateway Routing Protocol (IGRP): These provide interior gateway routing through path or distance vector protocols.
- ✓ Open Shortest Path First (OSPF): This provides interior gateway routing through link-state routing protocols.

Border Gateway Protocol (BGP) v4: This provides public Internet routing protocol through exterior gateway routing.

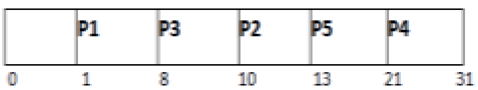

Fig. 4: SJF Ready Queues

Shortest Job First (SJF) always chooses the shortest job available as shown Figure 4. Here, we use a sort list to order the processes to the shortest. When adding a new process/ task, we need to figure out where in the list to insert.

Step 1: Sort all the processes according to their arrival time.

Step 2: Select the process with minimum arrival time as well as minimum burst time.

Step 3: After completion of the process, select from the ready queue the process which has the minimum burst time.

Step 4: Repeat thee above processes until all processes have finished their execution.

4 Problem Identification

To identify and counter network attacks it is common to employ a combination of multiple systems to prevent attacks from happening or to detect and stop ongoing attacks if they cannot be prevented initially. These systems are usually comprised of an intrusion prevention system such as a firewall as the first layer of security with intrusion detection systems representing the second layer. Consequently, an efficient routing approach may generate route failures. This paper aims to provide an unbreakable route for secured transmission by proposing the SJF scheduling-based resource allocation algorithm for overcoming the QoS parameters as delay factor, throughput, and energy conservation.

5 Proposed Work

In this section, we discussed the shortest job first scheduling algorithm for resource allocation in 5G heterogeneous networks for wireless communication, in which the process having the smallest execution time is chosen for the next execution. It significantly reduces the average waiting time for other processes awaiting execution. We propose an algorithm which can minimize the delay. It can improve process throughput by making sure that shorter jobs are executed first. The scheduling algorithm said that if turnaround time, waiting time, and burst time for each process can be reduced. This will help to increase the speed of packet delivery. Shortest Job First (SJF) scheduler with resource allocation is used to process the non-real-time data packets that are present at the same level of priority. SJF used by taking requests with the short-term time task will be prioritised first later it admits the long-term process by CPU request which reduces the time for execution if time is required is minimal helping in energy consumption also reduced to low. Calculating the average waiting time of a process is done for time allotment for each process which helps lower energy consumption. From the proposed system there must be an improvement in QoS for a secured transmission without the misbehavior of the malicious node with the scheduling algorithm as shown in Figure 5 resource allocation using SJF.

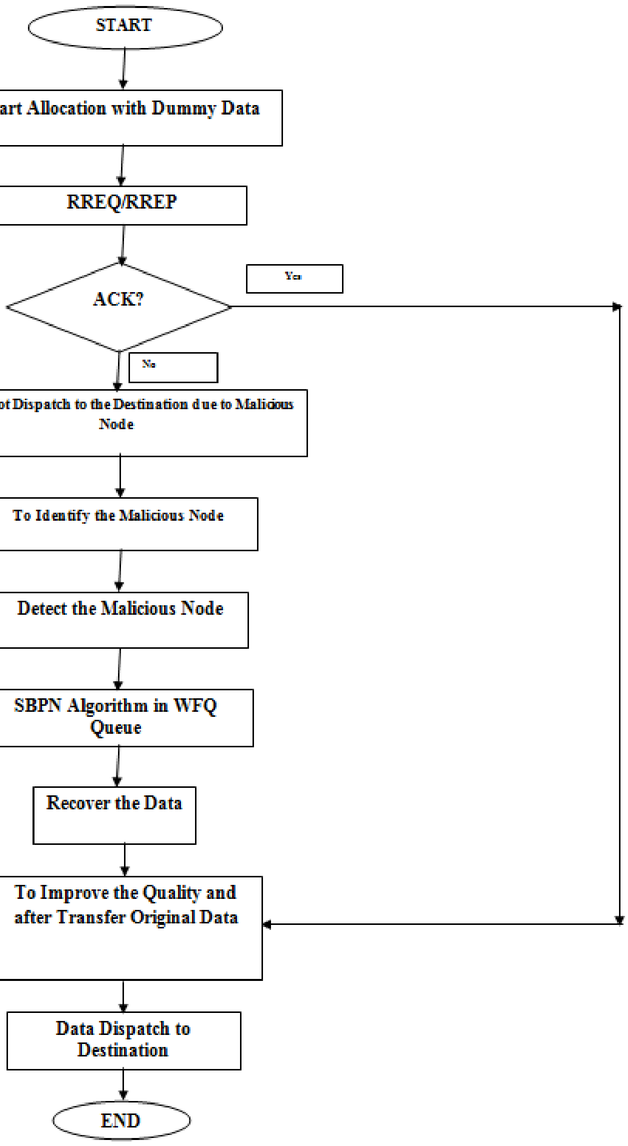

Fig. 5: Resource Allocation using SJF

Following are the basic algorithm steps used in SJF-based resource allocation:

STEP 1: Start the resource allocation from source to destination.

STEP 2: Generate the information with dummy data.

STEP 3: The route request and route replay will take place.

STEP 4: If acknowledgement comes at the particular time no malicious node is obtained to start the original data transmission.

STEP 5: If the acknowledgement does not come, the data is not dispatched to the destination due to a malicious node.

STEP 6: Now, we use the SJF-RA protocol to choose the best packet from the flow.

STEP 7: If the packet is best then directly dispatch at the destination.

STEP 8: SJF is used to send packets, which we assign weight to every flow of the network.

STEP 9: To identify and detect the malicious node to attenuate the node recover the data and improve QOS using SJF-RA.

STEP 10: To improve the quality and send the original data for transmission.

STEP 11: At last, dispatch the data to the destination.

STEP 12: End the transmission.

Flowchart (Figure 5) for Resource Allocation using SJF

To facilitate the comparison of the simulation results with the other research work, the default setting in (NS 2.34) is adopted. The maximum number of hops allowed in this configuration setting is four. Both the physical layer and the 802.11 MAC layer are included in the non-wired extension of (NS 2.34), where the total bits transmitted are calculated using only the application layer. Simulation parameters are listed below in Table 2.

Table 2. Simulation Parameters

Parameters	Values
Simulation area	800 m * 800 m
Number of nodes	90
The average speed of nodes	0-25 m/sec
Mobility model	Random waypoint
Number of packets sent	40
Transmission range	250 m
Initial energy/node	100 joules
Antenna model	Omni directional
Simulation time	500 sec
Max. no. of malicious nodes	12

6 Result and Discussion

The results have been obtained by using the NS-simulator and results show that our proposed algorithm performed better SJF-based resource allocation than the traditional resource allocation model in terms of throughput, packet delivery ratio, packet drop rate, remaining energy and interference. Energy efficiency can be described as the ratio between the total number of packets received at the destination node and the total energy spent by the network to deliver these packets. Thus the drops in energy, packet delivery ratio throughput and quality have been improved by using the shortest job first in a scheduling-based resource allocation algorithm. Evident Table 2 shows our proposed SJF-RA model performs improved packet delivery ratio, throughput and remaining energy than SJF and reduces delay and packet loss than SJF with 800 m * 800 m of topology size, when several nodes 90, our adaptive partial method achieves minimum output than other two methods. Figure 6 shows the achieved simulation results on the scheduling-based model better than others. The proposed algorithm increases no of connections and this system is capable of decreasing failed unbreakable routes between the source and the destination; it is possible to save more energy.

Table 3. Simulation results of different parameters

RP/NN	15	30	45	60	75	90
packet delivery ratio						
RA	0.89	0.82	0.75	0.68	0.61	0.54
SJF-RA	0.97	0.89	0.81	0.77	0.69	0.61
Throughput						
RA	0.24	0.29	0.34	0.39	0.44	0.49
SJF-RA	0.36	0.49	0.61	0.64	0.67	0.71
remaining energy						
RA	0.90	0.85	0.80	0.75	0.70	0.63
SJF-RA	0.98	0.95	0.93	0.89	0.87	0.84
Delay						
RA	0.12	0.19	0.26	0.33	0.42	0.49
SJF-RA	0.05	0.11	0.15	0.23	0.31	0.37
packet loss						
RA	0.12	0.18	0.24	0.28	0.33	0.38
SJF-RA	0.05	0.07	0.14	0.19	0.21	0.23
Energy-delay trade-off under different sleep modes with heterogeneous traffic requirements						
Standby only	0.33	0.36	0.40	0.44	0.45	0.47
Deep sleep only	0.27	0.31	0.36	0.38	0.39	0.41
Adaptive partial	0.23	0.27	0.32	0.34	0.35	0.37

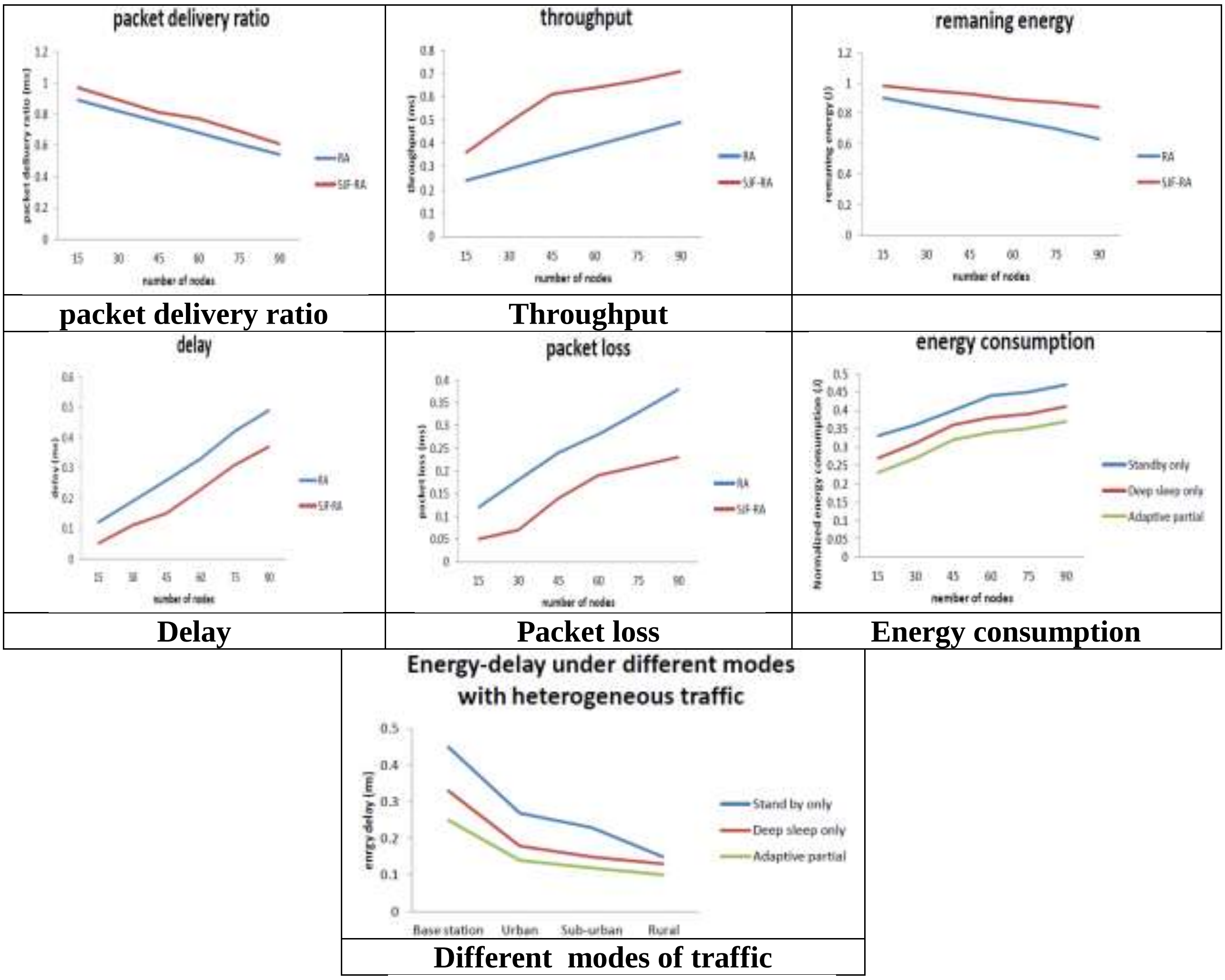

Fig. 6: Responses of various parameters

Table 4. Energy-delay trade-off under different sleep modes with heterogeneous traffic

RP/NN	Stand by only	Deep sleep only	Adaptive partial
Base station	0.45	0.33	0.25
Urban	0.27	0.18	0.14
Sub-urban	0.23	0.15	0.12
Rural	0.15	013	0.10

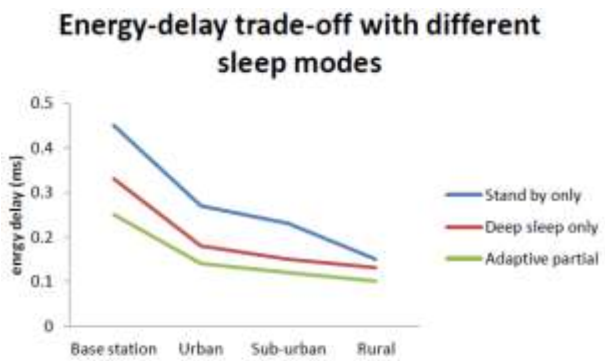

Fig. 7: Energy-delay trade-off with different sleep modes

Simulation results of energy-delay trade-off under different sleep modes with heterogeneous traffic proposed shortest job first resource allocation compared to the normal shortest job first performance as shown in figure 7 and Table 3 shows that three different sleep modes with four different areas. If any of the intermediate nodes is found to be busy or link failure, then the traffic condition of the proposed algorithm can find an alternate shortest route from the previous node itself this avoids more overhead which reduces the delay.

From all the above figures and Table 1, Table 2, Table 3, Table 4, it is clear that our proposed new design shortest job first scheduling based resource allocation and existing shortest job first scheduling schemes, show the packet deliver ratio, throughput and remaining energy increase and delay and packet loss decrease with the increase in the number of nodes from.

7 Conclusion

Finally, in this section's crisp discussion of the overall outcomes of this efficient research manuscript, it is clear that the proposed model has always been a major threat to the security in MANETs during the transmission drop (or) attack the packet, if wireless communication is done, in this research, a proposed scheduling algorithm named SJF-RA is proposed. The simulation results propose an algorithm as compared with the existing algorithm in different parameters with varying numbers of nodes through the network simulation 2. This developed model's ability to detect misbehaviour nodes improves the average packet delivery ratio by 6.7%, average throughput by 12.9% and increases the average remaining energy by 21% than existing method also solves the weakness of the existing method, to reduce the average packet drop by 7.4%, average delay 8% compared to the existing method. **There is a plan to investigate the following issues in the future however**, the same concept can be applied in satellite to reduce end-to-end delay in the route and reduce packet loss, possibilities of adopting secure quality-oriented techniques to further improve the network performance of quality.

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Conflict of Interest

I confirm that neither I nor any of my relatives nor any business with which I am associated has any personal or business interest in or potential for personal gain from any of the organizations or projects.