Optimized Node Swapping for Efficient Energy Usage in Heterogeneous Network

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Contents

Abstract Network lifetime has become a new challenge for wireless heterogeneous network because of battery base nodes or limited power nodes. To increase the network lifetime, we have to plan the new approach with an alternate solution of distribution of the load on multiple nodes in order to maintain guaranteed services. In our proposed work, we have planned to distribute the load with optimized node swapping scheme, based on energy level and distance. The node swapping will be carried out only with the optimized register neighbor nodes with their energy level and distance between them. The resulting analysis shows that the proposed work enhances the overall lifetime of the network and reduces the packet loss, which leads to an increase in the efficiency with minimum node swapping latency.

Keywords Node Swapping · Energy Efficient
Network Lifetime and Optimization

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1 Introduction

Future heterogeneous networks are based GSM/UMTS system, which merge IP-based services into the communication system for reducing packet latency. The demand for more data and Internet access has been increasing tremendously in recent years. This can be overcome by using LTE heterogeneous network. The data rate of LTE forward link is more than reverse link. The multiple access method used for downlink is different that of uplink. For downlink, it uses OFDMA and SC-FDMA for uplink transmission.

The request for more speed data rates from user is rising drastically, and standardized mobile networks will undergo different issues, while handling with data of network. These boundaries are correlated with the existing bandwidth and capability of the system. However, heterogeneous systems are combination of two or more different technologies, which enhance the data rates, efficiency and to reduce traffic problems.

Figure 1 illustrates the structure of heterogeneous network. Heterogeneous LTE network supports many applications in real-time environment. Therefore, such application consumes more power in the network. Hence, to execute time_critical_application, each node should possess more energy. The power supplied to each mobile node is very limited; therefore to enhance the power of each mobile node, the mobile node has to be swapped with other register neighbor mobile nodes.

The remainder of the paper consists of sections such as Sect. 2 representing the related papers, where we study how the previous scheme discusses on the efficient

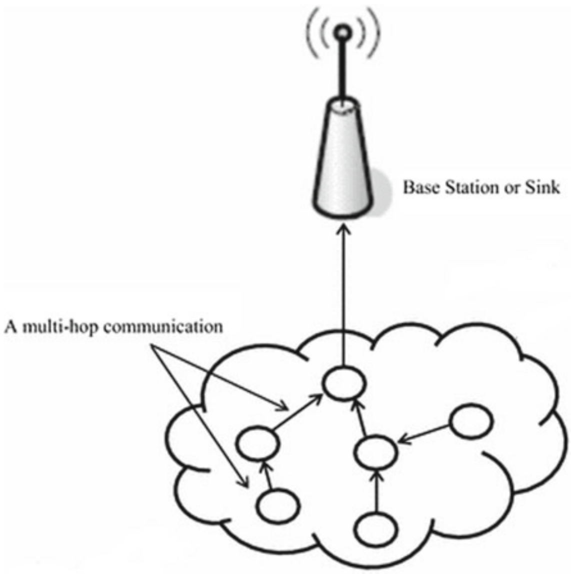


Fig. 1 Heterogeneous Network

schemes. Section 3 will explain the information of proposed work. Section 4 presents simulation platform, network configurations, performance metrics, and comparative results. Section 5 discusses the conclusion of the proposed work.

2 Related Work

Many different types of methods have been planned for enhancing lifetime of network [1]. In this paper, the method of power saving is been done by differential criteria using data mules or mobile sinks [2, 3]. In this chapter, paper explained how the power is saved using data mules approach. In data mules, the powerful mobile node visits each node of network, collects the information about mobile node, and physically takes data to sink. The purpose is to rotate the mobile node one by one to minimize the differential power consumption [4]. This paper presents how mobility of the node is controlled by means of low-power method in embedded network. This also explains the data mule approach for the mobility of the node [5]. This paper described how the power saving can be done using data reduction approach. In this approach, the mobile node reduces the amount of power in the data transmission and/or generation [6]. This also explains minimizing the power in network to improve network lifetime using the data mule approach [5]. In this chapter, it explains the data reduction method in the network. The mobile nodes consume less power during data transmit and generation [7]. Power saving is done using mobile relay approach. In the relay approach, some mobile nodes are having more power and memory to process the data [8]. This paper represents how the power is controlled in cognitive networks. It also explains how the external factors like user behavior, network load, and quality of channel are affecting the system performance. In [9], the authors are considering the factors like modulation and power control for accessing the network to reduce consumption in power for achieving efficient energy. In [10], author expressed how the channel is allocated to the requested user. To allocate the channel for users, the spectrum map concept is used. In [11], authors are explained about the resource allocation using distributed methods. This method depends on queue balance, which is converted into number of hops in the cognitive network. In [12], author presented opportunistic spectrum allocation in LTE heterogeneous network. It also explains how the algorithm controls the power for bandwidth sharing. In [13], author presented about trade-off between power efficiency, network capacity, and backhaul capacity. In [14], author done survey on D2D communication in LTE network. It also explains how the spectrum is allocated in heterogeneous network.

3 Proposed Work

In this paper, the optimization of node swapping is proposed. In the present system, swapping of node is not implemented, so consumption of power is more at the critical

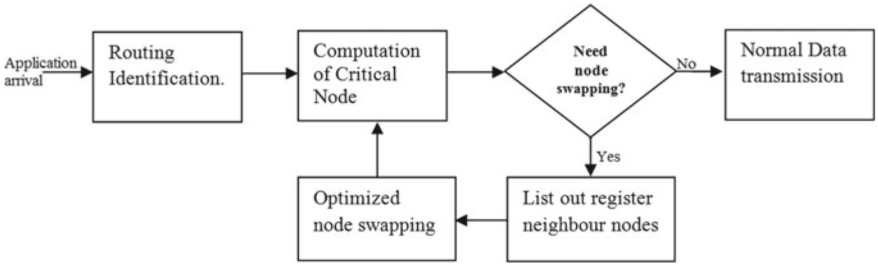


Fig. 2 Optimized Node Swapping Scheme Diagram

node. Critical node is the one which is identified prior to the sink node. In the simple swapping of the node method, it only considers for power remaining in the node. But in our proposed work, we consider the optimization of node swapping which is done. Optimization is done with respect to power constraint as well as distance or location of the neighbor node for selection of critical node.

The major issue in heterogeneous network is the power consumption for the data transmission and data generation. This will reduce the life span of system. Hence to improve the overall network lifetime, we propose the Optimized Node Swapping method, which is shown in Fig. 2.

In this proposed scheme, whenever application arrives, the network will check its source and sink node to transmit the incomingdata. At the same time, it also identifies the critical node. Critical node is the node, which is prior to the sink node. Since critical node consumes more power because of most of the data communication takes place through it. At regular instant of time, our scheme monitors the power at the critical node. If its sufficient power exists at critical node, then it continues with data transmission. If power at critical node is not sufficient, then it applies optimized node swapping approach. In the optimized node swapping method, it is not only swapping critical node with high-power neighbor register node but also it considers the distance with that of neighbor register node. This will lead to enhance the overall network lifetime as well as to reduce the latency for node swapping. Figure 3 shows the simulation flowchart and architecture.

4 Simulation and Results

Simulations:

The proposed optimized node swapping performance is implemented and tested by simulation using ns2 network simulator.

From Table 1, it is clear that different simulation parameters are considered for the proposed work scenario. It has been observed that, by continuous monitoring of the critical node, whenever power is reduced, then we execute our proposed optimized

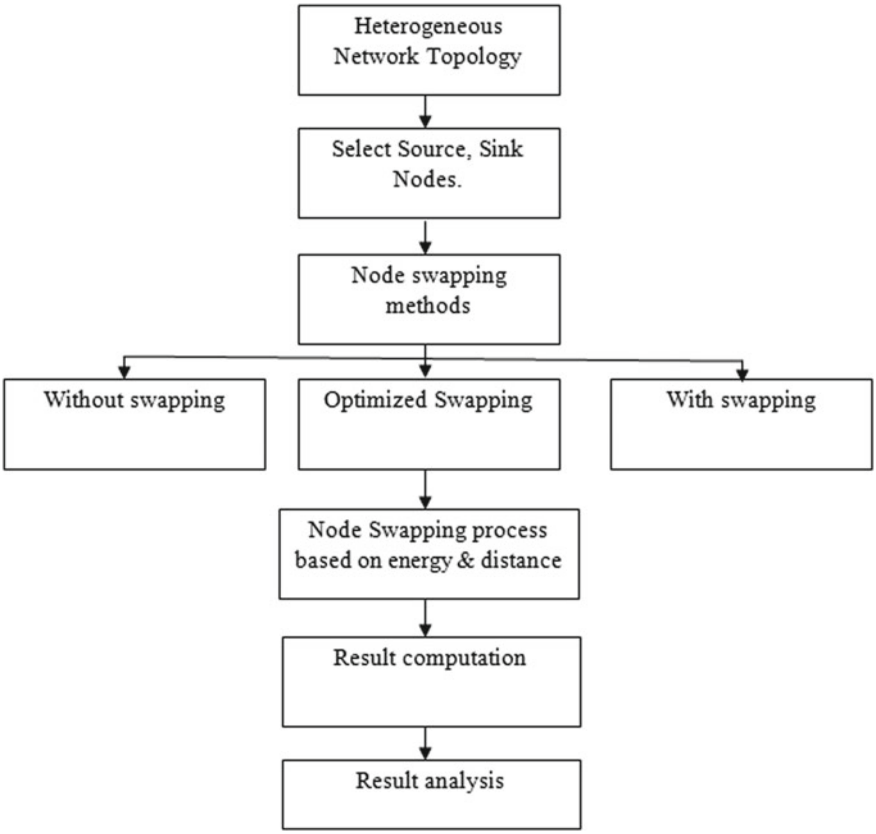


Fig. 3 Simulation flowchart and architecture

Table 1 Simulation Parameter for Evaluation

Parameter	Value
Space of simulation	300 × 300
Number of nodes	10
Wireless model	Two-way model
Antenna	Omnidirection
Model of energy	Energy model
Channel type	Wireless
Simulation time	160
Link type	Duplex-link

node swapping method. The proposed work enhances the overall lifetime of the network. Figure 4 represents the generation of heterogeneous network.

After executing the optimized node swapping method for different simulation time, the following parameters of the network are analyzed.

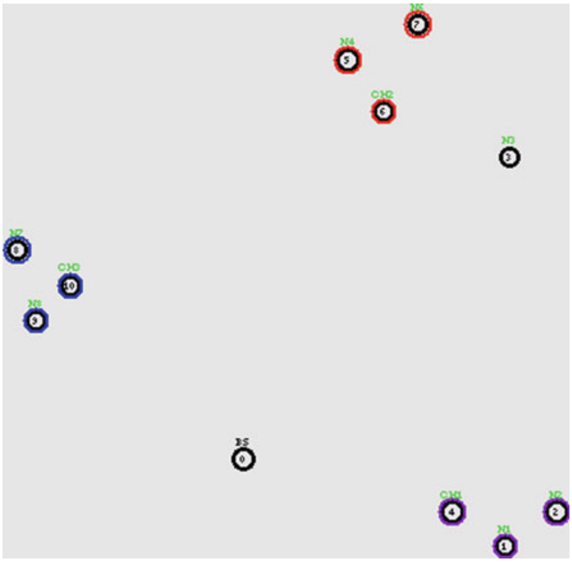


Fig. 4 Proposed Work Simulation

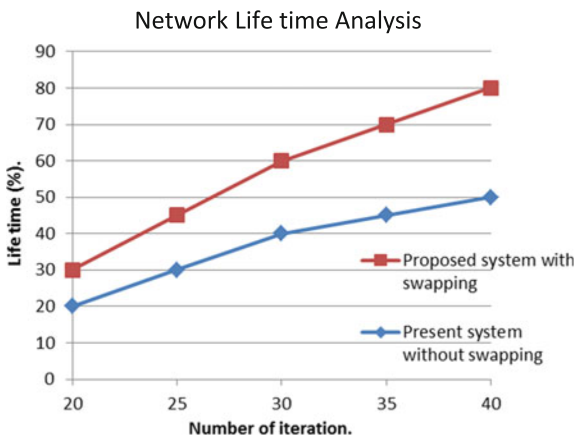


Fig. 5 Network Lifetime Analysis

- Network Lifetime Analysis.
- Data Packet Analysis.
- Energy Consumption Analysis.
- Node Swapping Latency.

Figure 5 describes the improvement in the network lifetime. In the proposed work, the optimized node swapping is executed which enhances the overall lifetime of the network.

Figure 6 represents the data packet analysis, in which the present system where node swapping not exists; therefore, packet loss is more. In the proposed system,

Fig. 6 Data Packet Analysis

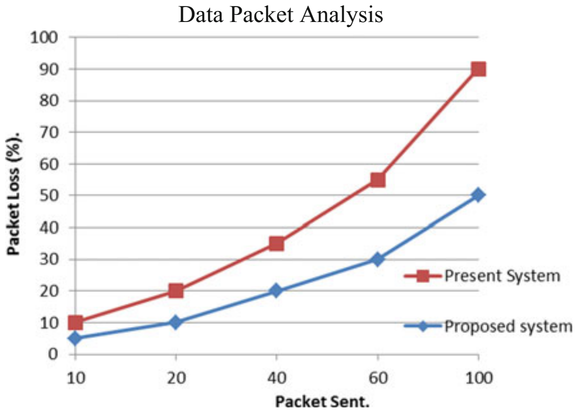
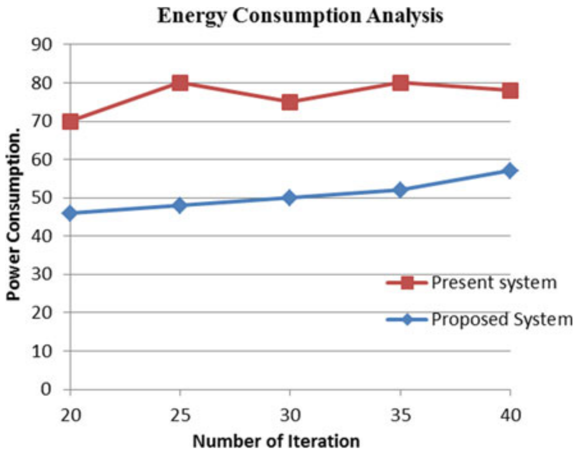


Fig. 7 Energy Consumption Analysis



because of the optimized node swapping, it reduces the packet loss and maximizes the throughput of the system.

From Fig. 7, it indicates that energy utilized for the proposed system is a smaller amount related to the present system. This is because we deploy optimized node swapping in the proposed system.

Figure 8 describes the analysis of node swapping latency. Even though it degrades the performance of the network, it is very negligible. From the graph, it is clear that node swapping time is less than 10%, which is very less.

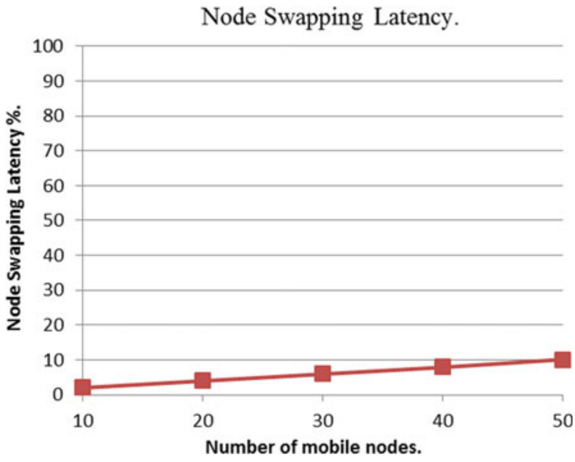


Fig. 8 Node Swapping Latency

5 Conclusion

Future heterogeneous systems are the solution to recent demand of great speed access for Internet and its related applications. Hence, they consume more power to fulfill their demands of end user. Therefore in this work, we propose new scheme called Optimized Node Swapping Scheme, which will improve the total lifespan of the system. This scheme is implemented on critical node basedon their power-level and distance. The results show that the proposed work improves the overall lifetime of the system, reduces the packet loss of the system, and increases the efficiency with minimum Node Swapping Latency.

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