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A Numerical study for improving the performance evaluation of energy consumption in wireless network

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Abstract: The performance and energy consumption of WSN were simulated in this study. This was accomplished by using NS-3, a contemporary application with open source that can be altered. The findings lead to the conclusion that an ad hoc network's energy usage directly correlates with the number of packets that are transmitted across it. We can control a network's energy consumption if we can control the number of packets that are sent across it. It is found that the number of nodes in the network affects the network traffic even when the same packet rate is maintained. Because the number of packets transferred in this scenario increases with the total number of network nodes, a larger network will experience more flooding. As an ad hoc network expands in size, more pathways between sender and receiver become possible, that leads to the conclusion that small networks have more collisions per node.

1 Introduction

Applications for wireless sensor networks (WSNs) are numerous. Mobile wireless network technology is widely employed in data collecting and transmission in a number of industries, including industry, agriculture, and the service sector. This is due to the Internet and mobile terminal technologies' rapid development. A WSN is used to measure the local humidity and temperature [1]. Applications for wireless sensor networks (WSNs) are numerous. Mobile wireless network technology is widely employed in data collecting and transmission in a number of industries, including industry, agriculture, and the service sector. This is due to the Internet and mobile terminal technologies' rapid development. Due to the fact that it is a wireless connection, the user is able to move throughout the service area while still remaining connected. Current WLANs are usually referred to as Wi-Fi as it is associated with IEEE standards [2]. This kind of network is used in public and private networks since it allows for a wireless connection.

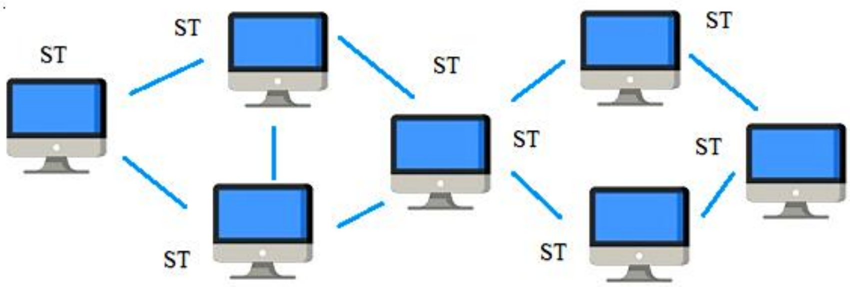

Fig. 1 BSS of Wireless network

All of the connecting devices in a WLAN network are referred to as STAs, with either be a ST (“basic station”) or an AP (“access point”). Since WLAN APs are often wireless routers that send packets to STs and can connect to other networks, not all WLANs have them. Typically, STs are portable computers or phones that transmit traffic data [3]. A Fundamental Service Set (BSS) is created when a group of STAs communicate with one another. Infrastructure BSSs and independent BSSs are two basic types of BSSs. BSSs are different from STs in that they lack APs and routing capabilities. DS (“Distribution System”) is a link between Access Points in an ESS (” Extended Service Set”), whereas an ESS is a group of connected BSSs [4].

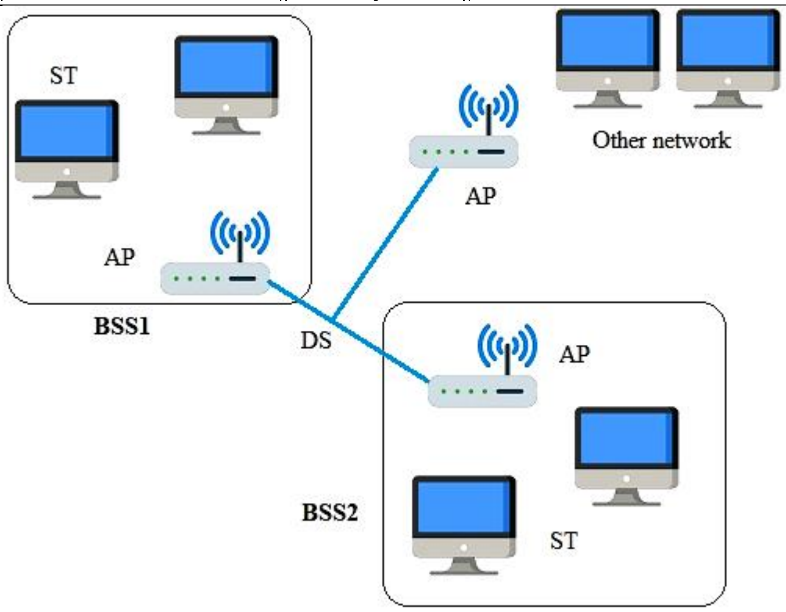

Fig. 2 ESS of Wireless Network

2 Literature Review

Liu et al. proposed an IEE-LEACH ("improved energy-efficient LEACH") by taking into account the average energy of the networks as well as the residual node energy. The proposed algorithm accounts for the optimal CHs and forbids the nodes that are closer to the base station (BS) from joining in the cluster formation in order to achieve sufficient performance. To further increase the energy efficiency of the networks, the proposed IEE-LEACH makes use of single hop, multi-hop, and hybrid communications for choosing CHs among the sensor nodes. The findings show that the proposed protocol lowers the energy usage of WSNs [5].

Khalaf et al. proposed HEESR, a new energy Efficient Routing. This study describes the real-time fixed slot assignments used in the core network design. By combining data about the precise relationship between single- and multi-way routing in wireless sensor networks, it was discovered that the transfer of data had been further decreased. The effectiveness of the WSN protocol was tested in this study by enforcing the protocol that had been accepted. Only two local measurements—the residual node energy and the separation from the base station—are employed in HEESR to choose cluster heads. The usage of just two parameters was intended to streamline the configuration procedure [6].

Nivedhitha et al. in their study used a novel protocol- DMEERP ("dynamic Multi-hop Energy Efficient Routing Protocol") to balance the energy consumption and path reliability ratio. There are three sections in it. The network model and fundamental presumptions for cluster formation and multi-hop route were made in the first section. All CH and cluster member records are stored and kept current by the Super Cluster Head (SCH). If the current cluster head fails, a new one will be obtained using the node activation and weight factor. The path reliability ratio is estimated in the second section to expedite packet routing while minimisingpacket loss. The third portion implements an energy model based on a channel capacity model. The simulation study was done using network simulator (NS 2.33) [7].

Yun et al. proposed a unique routing algorithm built on Q-learning. For finding the best path, the proposed approach uses reinforcement learning to maximize rewards at each sensor node as measured by the effectiveness of the communication energy, node residual energy and sensor-type dependent data aggregation. The authors made use of rewards that depended on the type of sensor. In the end, simulations were done to gauge the effectiveness of the suggested routing approach and contrasted it with the performance of the more established energy-aware routing algorithms. Our findings show that the suggested technique can successfully decrease the amount of data and increase the WSN's lifespan [8].

Rhim et al. considered an MH-GEER ("multi-hop graph-based approach for an energy-efficient routing") protocol in WSN to maintain the balance rate in energy distribution between clusters to extend lifespan of the networks. The clustering phase is based on distributed cluster head selection and centralized cluster construction, comparable to LEACH ("low-energy adaptive clustering hierarchy"). A dynamic multi-hop path is constructed between CH and BS during the routing phase. This technique involves investigating the level of energy in the network. When compared to the single-hop standard LEACH protocol, MH-GEER lowers energy depletion and increases the longevity and stability of the network [9].

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3 Methodology

This work aims to examine the energy consumption pattern in WSN under various scenarios. The initial component tries to increase the traffic allotted to a server. Eight nodes will be used for the simulations, but the energy model will remain the same—it has merely been placed on the additional nodes.

3.1 Tool

A publicly accessible tool for research and education, the NS3 simulator is used in this study. With its ability to analyze nearly all types of networks in-depth using the C++ programming language, NS3 was created to meet the simulation requirements of contemporary networking research. The simulation models in NS3 are realistic enough to be utilized as a real-time networkemulator [10].

3.2 Proposed protocol

The proposed protocol allows nodes to create tables next-hop locations and of neighbors, that should converge before traffic propagation can begin. As a result, the simulation will really start after 30 seconds to allow for convergence. We'll run the simulation for a total of 1000 seconds to observe what happens. Following the completion of the setting, a few traces will be connected and compared to determine the total number of packets the server generated, transferred, and received. Additionally, the process's energy usage will be contrasted.Every node in the simulation may send up to 20000 packets between 1.5 to 2.0 seconds due to the way it has been set up. The initial scenario in this experiment involved three nodes acting as client and server and sending 20,000 packets. The second project scenario uses 5 nodes and sends the same quantity of packets and third project uses 8 nodes.

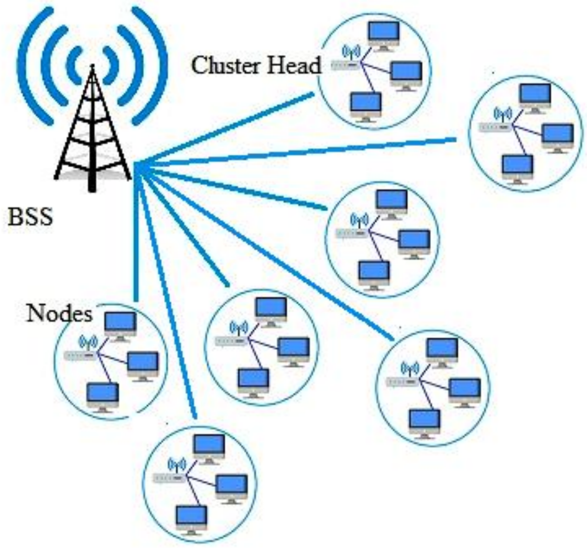

Fig. 1 Proposed Protocol

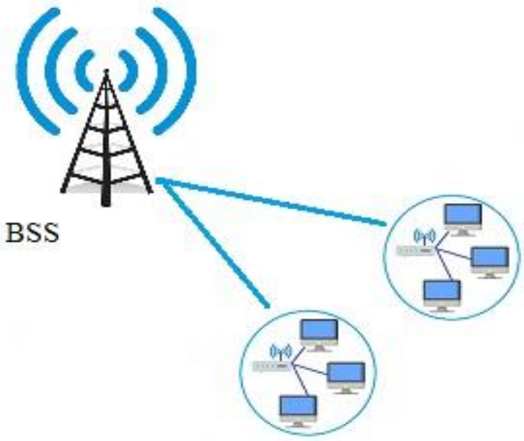

Fig. 2 case 1: 3 nodes

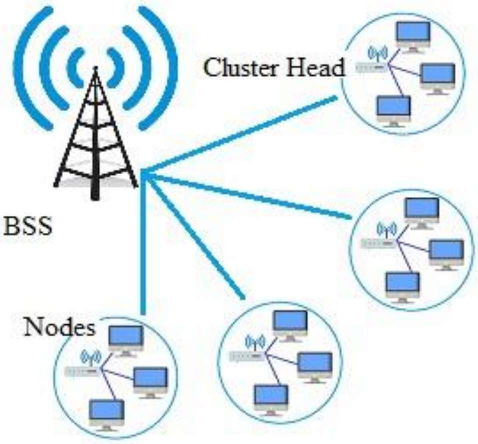

Fig. 5 case 2: 5 nodes

4 Parameter Analysis

Parameters to be measured and analyzed in this research are as follows

4.1 Energy Consumption

Energy consumption, also known as fundamental energy source and WI-FI radio energy model, is the quantity of energy needed by a node to carry out packet transmission and packet reception [11].

$$Energy\ Consumption = Energy_{initial} - Energy_{final} \quad (1)$$

The following variable will be assessed and studied in this study: - PDR ("Packet Delivery Ratio"). In this study, the package will be produced by NS3's flow monitor and will solely be examined for packet data.

4.2 Throughput

The throughput is an important characteristic on measuring resource, when implementing multiple scheduling frameworks [12]. Different scheduling frameworks employ various total system capacities. One way to calculate a system's throughput is as follows:

$$Thr = 8 \times N_{rx} / T_{sim} \quad (2)$$

Where Thr denotes the average throughput in bits per second, $N_{rx}$is number of received packets successfully; T_{sim} is simulation duration in seconds [13].

5 Results

While interval is 0.02 seconds, the resource is able to produce 20000 packets during 1000 sec simulation period as the number of generated or transmitted packets increases.

Case 1: 3 nodes

As the server simply sends acknowledgements, it is anticipated that the network's overall energy consumption will be nearly equal to that of a single node.

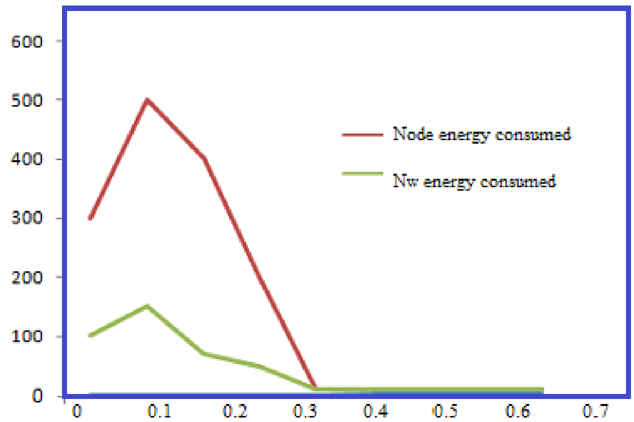

Fig. 6 Energy consumption with 3 nodes

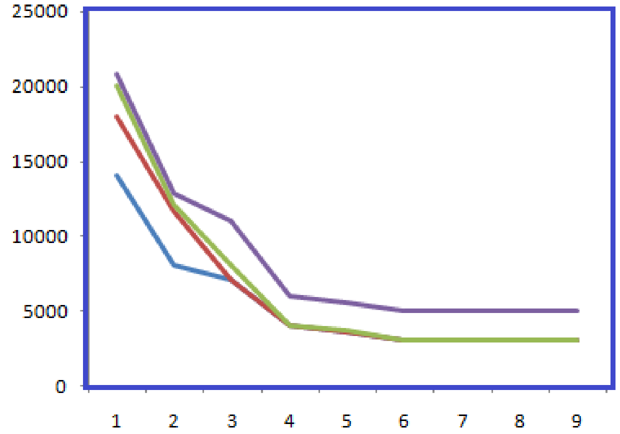

Fig. 7 Packet transmissions in case 1 with 3 nodes

Case 2: 5 nodes

There are more Mac Tx packets than there are transmitted packets. While the transmitted packets decreased to roughly 7000, the created 20,000 packets received in quite frequent intervals. This occurred as a result of the CSMA/CA method utilised in this network, which was used for collision avoidance as well as collision detection. This suggests that while all of the packets were being created, they were unable to be transmitted because the nodes had to wait for authorization.

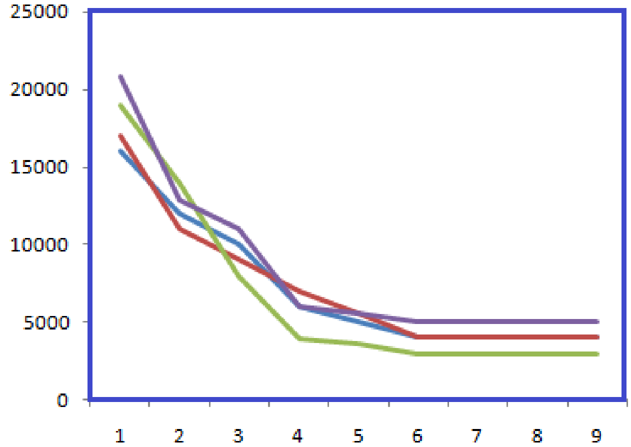

Fig. 8 Packet transmissions in case 1 with 5 nodes

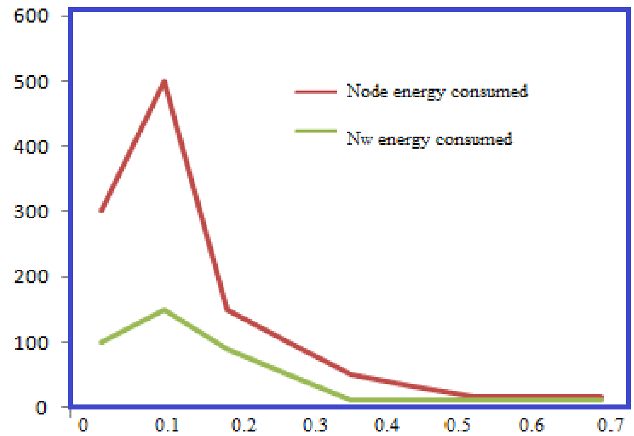

Fig. 9 Energy consumption with 5 nodes

Case 3: 8 nodes

The quantity of transferred packets affects how much energy 8 nodes use. As server receives packets from nearby nodes during packet transmission, energy consumption was same as the received packets [14].

Because of huge volume of nodes, the rate of packet drops is higher. The energy usage was exactly the same when the identical curve pattern is drawn between the packets. The nodes are stopped from increasing energy and the communicated packets. This prevents the node from disconnecting while preserving battery life, however in situations of high traffic, a node's high collision rate can cause it to appear disconnected.

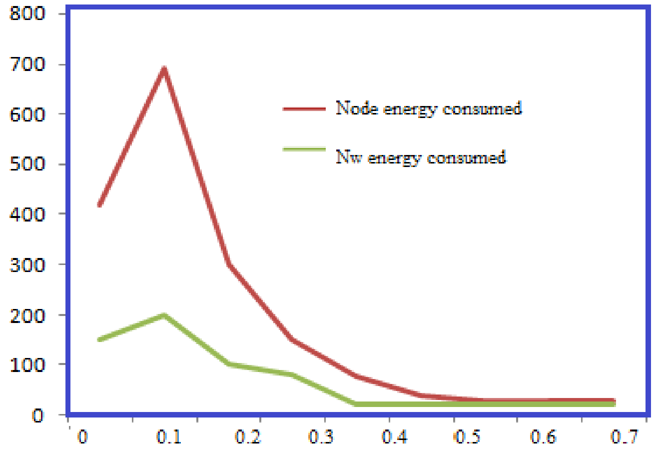

Fig. 7 Energy consumption with 8 nodes

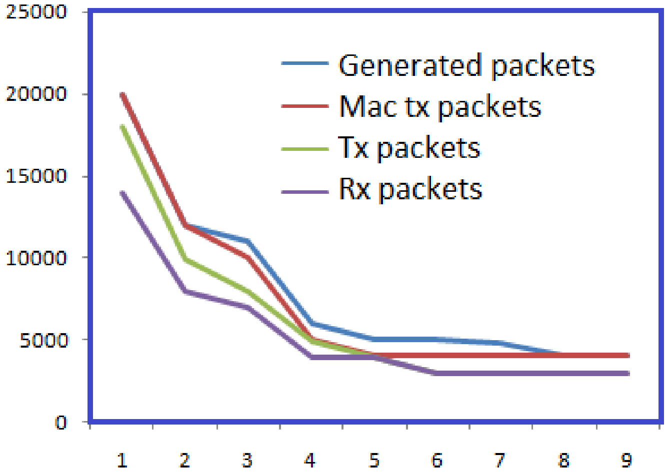

Fig. 7 Packet transmissions in case 1 with 8 nodes

6 Conclusion

In this paper, we have covered many scenarios of energy usage in ad hoc network devices in this research. According to the findings of this study, it is assumed that the quantity of packets that are transmitted through an ad hoc network directly correlates with its energy consumption. When the transmitted packets can be managed, it is also possible to regulate the energy consumed. Even when the same packet rate is maintained, it is discovered that the nodes also have impact in the network traffic. A larger network will experience more flooding because the packets sent grow with network nodes. Additionally, it is determined that small networks have more collisions per node since more pathways between sender and receiver are possible as an ad-hoc network grows in size.

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