DESIGN OF CROSS LAYER PROTOCOL ARCHITECTURE USING MODIFIED OPTIMAL LINK STATE ROUTING (MOLSR) PROTOCOL

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Abstract

The increased demand for communication capacity combined with inefficient utilization of the spectrum that is currently available has led to a shortage of spectrum. An improvement in the inefficient utilization of the current spectrum is possible through the use of opportunistic access to licensed bands, which does not interfere with the primary users. The existence of primary users makes it difficult to access channels, which makes cognitive environments a complex setting in which to perform tasks like routing and spectrum access. The task of creating and maintaining wireless multihop pathways between cognitive nodes is the primary focus of the routing problem in cognitive networks. This task involves determining both the frequency that will be utilised and the hop count at each node along the path. Within the scope of this work, we present a cross-layer optimization technique with the goal of achieving the aforementioned goal. We suggested using an adaptive cross-layer optimised subcarrier distribution technique for WSN so that it could give optimal performance while also consuming a low amount of energy. In order to achieve this goal, a technique known as the Modified Optimal Link State Routing (MOLSR) Protocol was put into place. A fair scheduling algorithm and proportional algorithms are described here to assign the subcarriers to the sensors in accordance with the conditions of their respective channels. In order to draw conclusions about the performance of the proposed MOLSR algorithm, the results of the simulation are analysed, and the findings are compared to those of a typical multicarrier (MC) system in terms of both bit error rate and throughput. To begin, the congestion-aware routing algorithm is put into action in order to modify the data rate of each individual node in accordance with the current queue state and the Received Signal Strength Indicator (RSSI). We are also able to draw the conclusion that the proposed protocol is an extremely energy-efficient system for carrying out optimal stable multipath routing with relatively minimal congestion in the network while the data is being transmitted.

Keywords: Modified Optimal Link State Routing (MOLSR) ,Received Signal Strength Indicator(RSSI), multicarrier (MC)

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1. INTRODUCTION

The three primary categories of routing protocols are proactive routing, reactive routing, and hybrid routing. Table driven routing is a proactive kind of routing in which the routing information for all network nodes is stored in a central database [1]. Figure 1 depicts the categorization of routing protocols. When there is a new route or a change to an existing one, the routing table is updated. Reactive routing, also known as on-demand routing, does not include the management of preferred route information. To ensure efficient packet transmission, any node that wants to broadcast data must first engage in route detection and route maintenance. Energy-efficient routing is achieved by adapting the routing protocols based on the network parameters of residual energy, Received Signal Strength Indicator, queue size, and bandwidth [2]. Throughput, packet delivery ratio, energy usage, and latency can all be enhanced by making these sorts of adjustments.

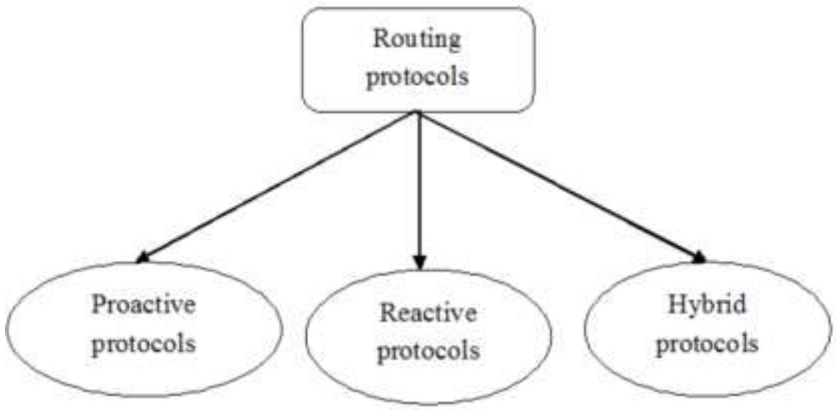

Figure 1: Types of routing protocols

The purpose of this study is to analyze the design issues faced by cognitive mobile ad hoc networks and cognitive wireless sensor networks, and to provide solutions based on an evaluation of existing cross layer protocols. In cognitive mobile ad hoc networks, users are expected to have cognitive abilities and make decisions about what to do based on their own observations in the area [3-7]. In cognitive mobile ad hoc networks, users also serve as a sort of data router. As a result, the design protocol for cognitive mobile ad hoc networks takes energy efficiency into account at every step. Because of the spectrum shortage in the ISM band, cognitive wireless sensor networks employ cognitive skills to address this problem. Little, low-cost, and low-power, sensor nodes are the building blocks of a sensor network. These nodes both gather information and transmit it. Energy efficiency is especially important when building protocols for sensor networks since once implemented, there is relatively little human contact.

2. BACKGROUND

Protocol layers are assumed to be layered levels of abstraction in packet-based network designs, with each layer's header including metadata relevant to that layer's control of packet delivery. The Open System Interconnection (OSI) network model is widely used for classifying and modeling the cross-layer architecture features of networks and services, as shown in Figure 2. Following the standardization of the ISO/OSI model in 1984, a 7-layer protocol stack was established, with each layer defining the requirements for a specific feature of the network and offering services to the higher layers [8-11]. The modularity function is a crucial feature of the OSI model. The architecture restricts direct contact between layers that aren't physically contiguous, with each layer implementing a different service. There is efficient two-way communication between adjacent layers thanks to the use of common interfaces. Alternately, protocols can be developed in a way that goes against the reference architecture by allowing interactions and state information to pass between layers that aren't directly connected. To improve performance, cross-layer designers build protocols that let different layers share their respective states with one another. When compared to the OSI model's layered structure, the cross-layer protocol stack's emphasis on information sharing gives each layer a more complete understanding of the network's restrictions and features.

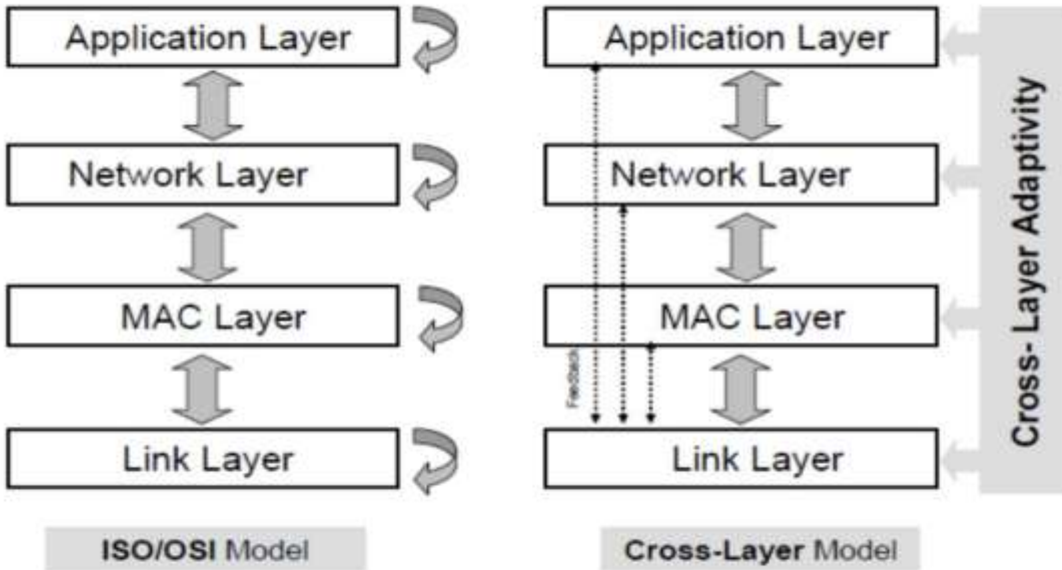

Figure 2: Classifying and modeling the cross-layer architecture features of networks and services

Hierarchical frameworks are used in the cooperative design and integration of networking protocols. Cross-layer design is commonly referred to as both a broad framework for designing protocols and a means of identifying protocols that follow this methodology.
Improvements in network performance can be achieved through cross-layer optimization, which specifies a broad idea of communication between layers by taking into account certain intelligent interactions between them [12-15]. Its purpose is to improve overall system performance by integrating the features of several network layers. In the case of the OSI layered model, the conventional technique can only identify some of the possible cross-layer interactions. After learning a node's nearest neighbor's RSS value, the cross-layer optimization framework enables the user to adjust the physical layer's transmission power. The physical layer range that node can propagate will be constantly adjusted based on the modeled transmission power. This is due to the fact that the distance a signal travels is directly proportional to the strength of the signal in that direction. The physical layer communicates this data to the network layer so the latter can make smarter routing decisions. The ability to share data between the physical and application layers is a significant benefit of this architecture (MAC and network layer).

3. METHODOLOGY

The reliability of the protocol is ensured on account of the fact that it is founded on the link state algorithm. Because of the proactive nature of the system, the routes are prepared for usage the minute that it is determined that they are required. A pure link status protocol will broadcast each and every link that a network has established with its neighboring nodes. An improvement on a basic link state protocol for MANETs, the OLSR protocol is an extension of that protocol. Link failures and link additions do not result in any additional control traffic beyond the messages that are routinely scheduled to be sent out because of the way the protocol is designed. Because the protocol remembers all of the network's paths to their respective destinations, it is useful in situations in which a large number of nodes are exchanging data and the pairings of sending and receiving nodes are constantly changing [16]. This is because the protocol is able to remember all of the network's paths to their respective destinations. This protocol was developed with high-density networks in mind; as a result, it functions quite well even in surroundings with a large amount of space. Because it is decentralized, the protocol does not require a central server or any other kind of centralized component in order to carry out its functions. Because each node only sends its control messages on a periodic basis, the protocol can handle the occasional loss of packets that may occur as a result of collisions or other transmission difficulties, both of which are common occurrences in radio networks. Because a sequence number of the most current information is included in each control message, it is impossible for the information to be reordered at the receiving end in such a way that the older information is seen as more recent.

The OLSR protocol executes routing on a hop-by-hop basis, which means that each node uses the most upto-date information that is available to determine which hop a packet should travel after it has completed its current one. As a result, data packets are successfully delivered to a node that is moving. As a consequence of this, the protocol enables the mobility of nodes, which may be followed through the use of local control messages [17]. The precision of this monitoring is directly related to the pace at which these messages are transmitted. The best link state routing protocol is developed by adopting an optimization method for picking Multi Point Relay (MPR) nodes. For the purpose of optimization, this scenario makes use of a hybrid GSO-GA approach. Because only specific neighbor nodes are allowed to forward the network's control packets when using the OLSR protocol, the control overhead of the network is significantly reduced. By declaring only a subset of links with its neighbors — those being the multipoint relay sectors — and by employing only the selected nodes, referred to as multipoint relays, to spread its messages in the network, the link state protocol is able to avoid flooding of this control traffic and, as a result, improve performance. Any broadcast message that is issued to a node will only be transmitted by the multipoint relays that are associated with that node. This strategy significantly reduces the amount of retransmissions that are required during a flooding or broadcasting procedure. Figure 3 illustrates how the protocol and all of its components work together to perform their intended functions.

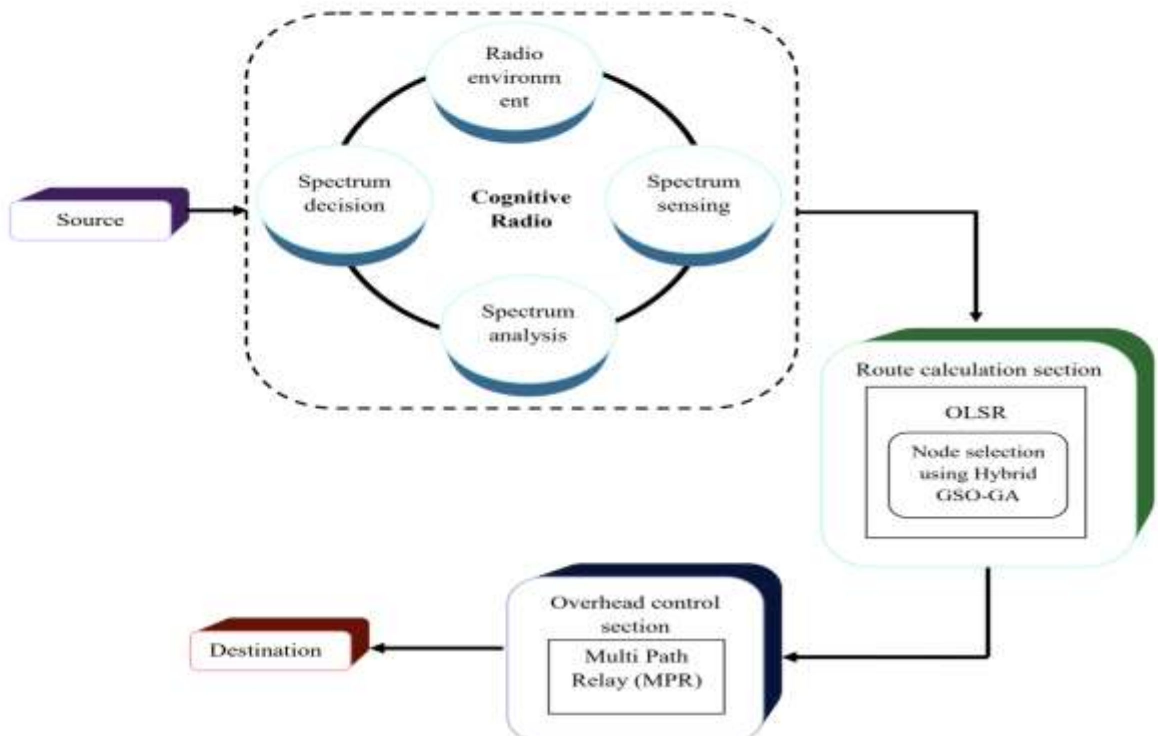

Figure 3: Architecture of the proposed modified Optimal Link State Routing (MOLSR) Protocol

With the OLSR protocol, only certain neighbour nodes forward the network's control packets, thus cutting down on the network's control overhead. The MPR nodes, which are a subset of the neighbour nodes chosen by each source to access all the two-hop neighbours, operate as forwarders to send data packets from the source to the destination. One of the most effective ways to increase channel efficiency is to look for untapped frequency ranges (CR). The OLSR routing system helps cut down on routing delays by effectively managing spectrum allocation. The next optimal hop with a faster link transmission time can only be found with the use of appropriate channel allocation mechanisms, which OLSR routing must implement. Next, we present a high-level block diagram of the proposed method and illustrate the entire process of the suggested approach.

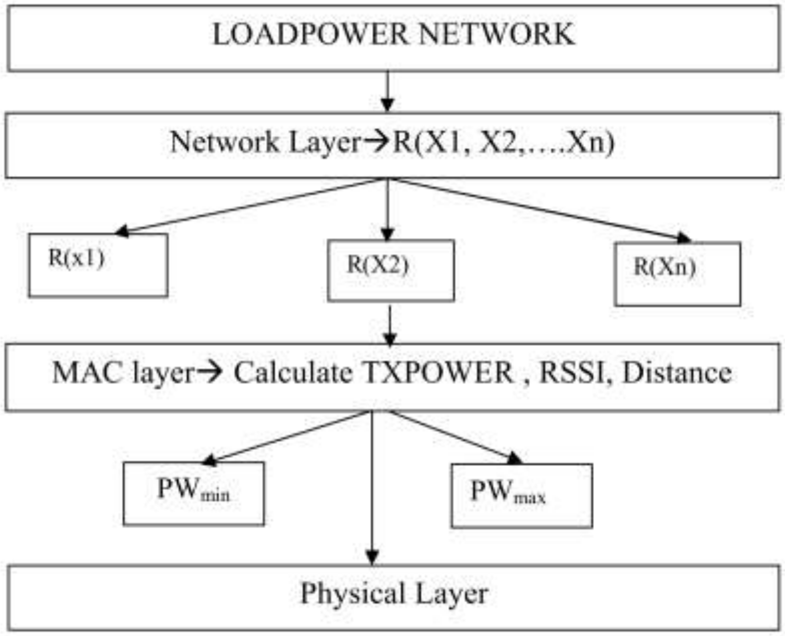

Figure 4: Proposed power assignment flowchart

The primary objective is to reduce the amount of energy needed to keep the network connected by modifying the transmission power of the individual nodes. We refer to situations like this as "Power Assignment Issues." There is a second class of connected issues, known as Network If the nodes' initial battery power supply varies from node to node, and if the goal is to keep a connectivity constraint in place for as long as feasible in the network, then lifetime difficulties occur. Ad hoc networks are a collection of nodes that may exchange data wirelessly but don't rely on a central server or network backbone; instead, they rely on cross-layering of power control at the MAC and Network layers. In an ad hoc network, nodes rely on other nodes to act as relays, taking the packets on their way to their final destinations. In a wireless network, each node serves as a relay for data transmission. It is crucial to consider how to reduce power consumption, as most nodes rely on batteries. When it comes to allocating power in a wireless setting, the most optimal solutions can be found in transmission power assignment algorithms. Ad hoc networks are restricted by interference and capacity issues due of the broadcast nature of the wireless medium.

4. RESULTS

In contrast, CL-throughput DTPCP's grows in step with the rate at which packets are generated, reaches a maximum, and then stabilizes at a fixed value. Throughput grows linearly and reaches a maximum at high packet creation rate since fewer packets are competing for the transmission at low rates.

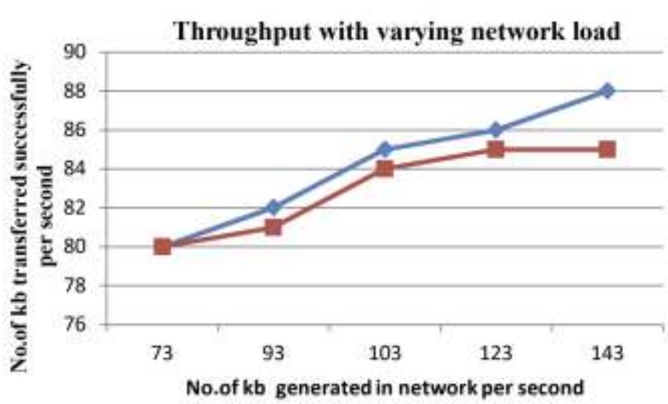

Figure 5: plot for throughput with varying network load

The figure depicts the change in energy required to successfully transmit 1kb of data as the rate of packet production increases. Results from computer simulations reveal that the average energy needed to transmit 1 kilobyte of data successfully is significantly lower When the transmit power is lowered, the number of delaying nodes drops, and more data may be sent per joule.

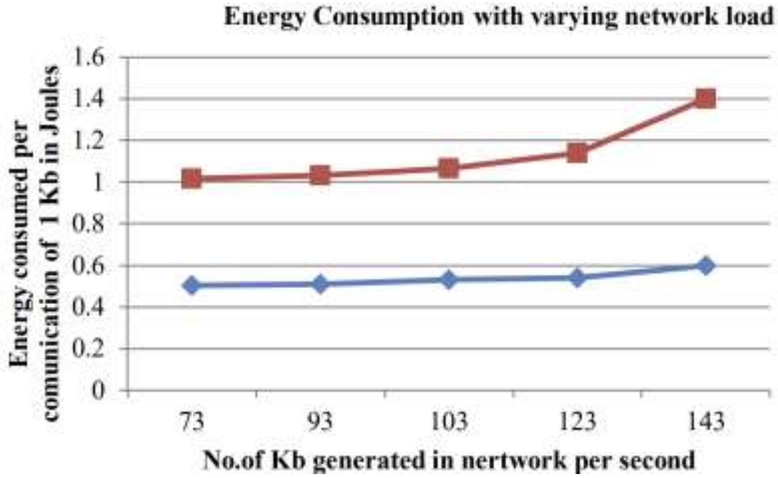

Figure 6: Plot for energy consumption with varying network load

Changes in the total number of cognitive nodes in the network are also used to measure how well the suggested method performs. The number of principal users is assumed to be 10 in this case. Almost the same percentage of errors is shown in the figure 7 regardless of the cognitive user loads. Therefore, the algorithm's efficacy is unaffected by the degree to which a cognitive network is thick or sparse. As a result, there are no cognitively enabled users in the disabled area.

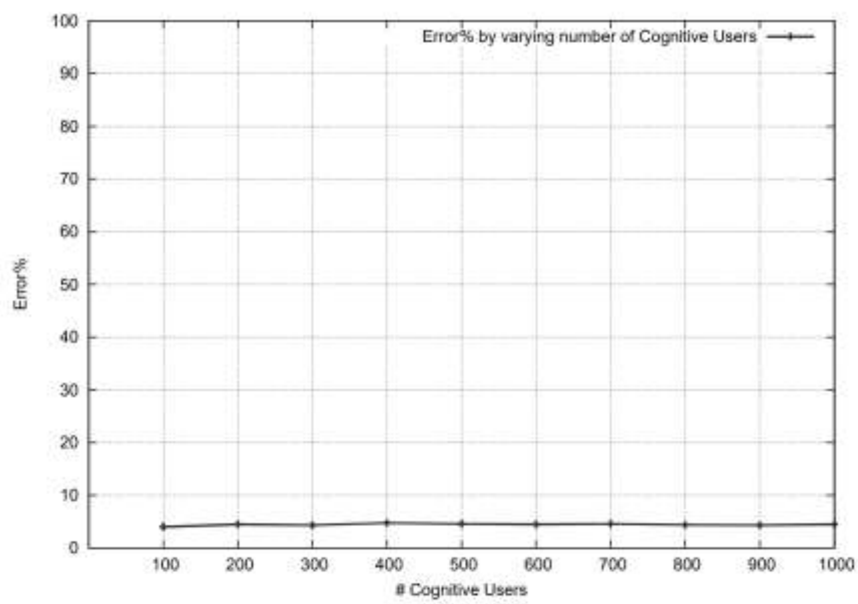

Figure 7: error percentage based on no of cognitive users

Now we can test how well the proposed method works by adjusting the size of the network. The ratio of primary to cognitive users in this case study is 1 to 10. The figure demonstrates that the error rate decreases as network size increases while the number of primary users remains constant. In this case, there are no cognitively enabled users in the impaired area.

Adding more cognitive users to the network does not change the suggested algorithm's performance. But if the number of primary users is very large, the mistake rate will rise. When spectrum usage by primary users is high, it is not prudent to consider that spectrum for cognitive users. Spectrum that is heavily utilized by primary users should not be considered for cognitive users. Because of this, the suggested method can be used in areas with low main user spectrum use.

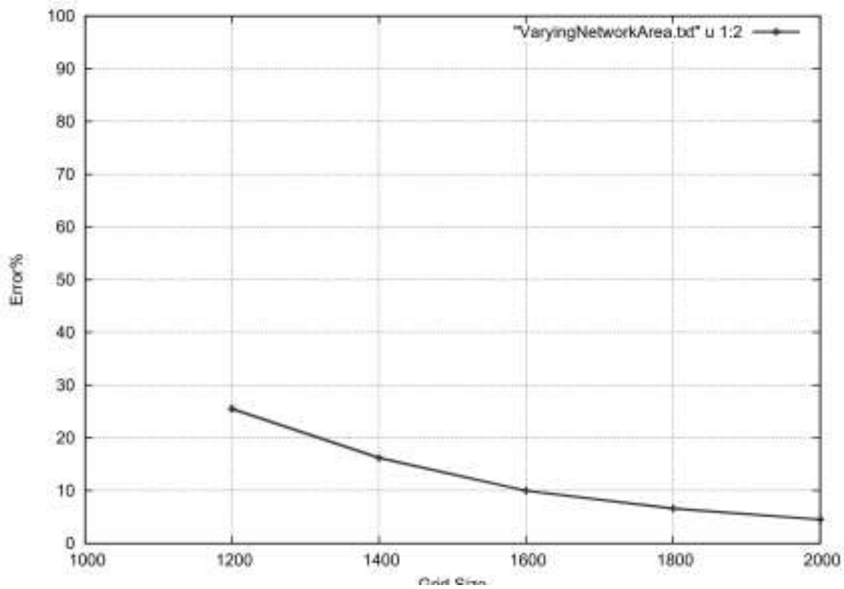

Figure 8: error percentage based on network area

5. CONCLUSION

In this study, we suggest a recharging technique in addition to two ideas that make use of cross-layer design. Bit error rate, packet delivery ratio, energy consumption, and throughput were used to evaluate the performance of the cross-layer design approaches. Reception voltage, harvested energy, residual energy, and throughput were used to quantify CLD performance with charging strategies. To investigate the regimens' efficacy, simulations were run. By combining physical layer, media access control (MAC), and transport layer parameters, our proposed cross-layer optimized multicarrier protocol achieves greater network efficiency. As a cutoff for both battery life and storage capacity, we settled on a number. Research on the node's status is conducted by inspecting MAC layer parameters. These criteria are used to determine which nodes qualify. There are two allocation techniques used to distribute the available subcarriers to the appropriate nodes. To test the efficacy of the suggested algorithm, a simulator was developed. It is clear that the proposed MOLSR method uses 35.78 percent less energy than the standard multicarrier approach. The average round-trip delay is also seen to be 32% lower than the typical multicarrier system. An increase in throughput of 25% was measured between the MOLSR and the conventional multicarrier system. The proposed algorithm uses a leveling and sectoring method to determine who the primary users are and then determines where to deactivate the network interface in order to prevent the primary users from accessing the network. The proposed approach yields respectable simulation results. Particularly, in all cases, the number of cognitive users with incorrect permissions to access the system is zero, indicating that there is no way for the system to interface with the primary users.

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