International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 6s
DOI: https://doi.org/10.17762/ijritcc.v11i6s.6948
Article Received: 29 March 2023 Revised: 18 May 2023 Accepted: 26 May 2023

Design of Multi-Layer Protocol Architecture using Hybrid Optimal Link State Routing (HOLSR) Protocol for CR Networks

T. Venkatakrishnamoorthy[1], Bachu Srinivas[2], M. Dharani[3], S. Vamsee Krishna[4], Y Dasaratha Rami Reddy[5], P Supriya[6]

[1]Associate Professor, Dept. of Electronics and Communication Engineering,
Sasi Institute of Technology & Engineering,
Tadepalligudem, Andhrapradesh, India.
Krishna454@sasi.ac.in
[2]Marri Laxman Reddy Institute of Technology and Management,
Dundigal, Hyderabad, Telangana.
E-mail:bachusrinivas@gmail.com
[3]Associate Professor, Dept. of Electronics and Communication Engineering
School of Engineering, Mohan Babu University,Tirupati,
Tirupathi, Andhrapradesh, India.
E-mail: dharani.m@vidyanikethan.edu
[4]Assistant Professor, Dept. of Electronics and Communication Engineering
Koneru lakshmaiah educational foundation,
Vaddeswaram, Andhrapradesh
E-mail: vamseekrishna@kluniversity.in
[5]Dept. of Conputer Science and Engineering
BVSR Engineering College,
Chimakurthy, Andhrapradesh, India
E-mail: vamseekrishna@kluniversity.in
[6]Assistant Professor, Dept. of Computer Science and Engineering
Koneru lakshmaiah educational foundation,
Vaddeswaram, Andhrapradesh
E-mail: psupriya@kluniversity.in

Abstract— There is a lack of spectrum due to the rising demand for sensing device communication and the inefficient use of the existing available spectrum. Through opportunistic access to licenced bands, which does not obstruct the primary sensory users (PU), it is feasible to enhance the inefficient use of the current sensor device frequency spectrum. Cognitive settings are a demanding environment in which to carry out tasks like sensor network routing and spectrum access since it is difficult to access channels due to the presence of PUs. The basic goal of the routing problem in sensor networks is to establish and maintain wireless sensor multihop paths between cognitive sensor nodes. The frequency to be used as well as the number of hops at each sensor node along the path must be determined for this assignment. In order to improve performance while using less energy, scientists suggested a unique adaptive cross-layer optimisation subcarrier distribution technique with the HOLSR protocol for wireless sensor nodes. Throughput and energy consumption parameters are used to analyse the sensor network architecture protocol that has been developed. The energy usage of the sensor nodes in the network has increased by 50%. The performance of the proposed HOLSR algorithm is assessed using the simulation results, and the results are contrasted with those of a conventional multicarrier (MC) system in terms of bit error rate and throughput.

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

I. INTRODUCTION

Proactive, reactive, and hybrid routing protocols are the three main types. Table-driven routing is proactive routing in which all network node routing data is kept in a single database [1]. The classification of routing protocols is shown in Figure 1. When a new route is created or an old one is altered, the routing table is updated. Managing preferred route data is not a part of reactive or on-demand routing. Any node that wishes to broadcast data must first perform route detection and route maintenance in order to ensure efficient packet transfer. By modifying the routing protocols depending on the network parameters of residual energy, Received Signal Strength Indicator, queue size, and bandwidth [2], energy-efficient routing can be accomplished. These changes can improve throughput, packet delivery ratio, energy consumption, and delay. This study attempts to evaluate existing cross-layer protocols in order to give answers for the design problems that cognitive mobile ad hoc networks and cognitive wireless sensor networks are now facing. Users in cognitive mobile ad hoc networks are anticipated to be cognitively capable and make decisions based on their observations of the environment [3–7]. Users in cognitive mobile ad hoc networks act as data routers as well. As a result, energy efficiency is taken into account at every stage of the design protocol for cognitive mobile ad hoc networks. Cognitive wireless sensor networks make advantage of cognitive abilities to deal with the ISM band's spectrum scarcity. A sensor network is made up of small, inexpensive, and low-power sensor nodes. These nodes both collect and send data. When developing protocols for sensor networks, energy economy is essential because, once deployed, there is comparatively little human engagement.

II. BACKGROUND

Data is sent between layers in a multi-layer system to increase adaptability and make the best use of network resources. In a cross-layer design, each layer is distinguished by a small number of crucial parameters and control knobs. Other levels use the parameters to determine the best adaptation rules for their control knobs given the state of the network. Cross-layer design is frequently presented as an optimisation problem with inputs and constraints from different layers. By resolving the optimisation problem, the optimal values for the control knobs in the layers are obtained. Multi-layer architecture is intriguing in wireless networks for the reasons listed below. First, the traditional architectural design process narrows the search space for the optimal adaptation despite its high effectiveness in wireline networks.In contrast to wireline networks, where resources are plentiful, the necessity to explore a broader optimization space, encompassing several layers to make the most of a few resources, is compelling in wireless networks. Second, wireline networks are considered when designing the current protocol stack. It might not be appropriate for wireless networks that are fundamentally different in many ways. For instance, the idea of a "link" has completely changed. The distance and transmit power between two nodes significantly affect their connectivity.

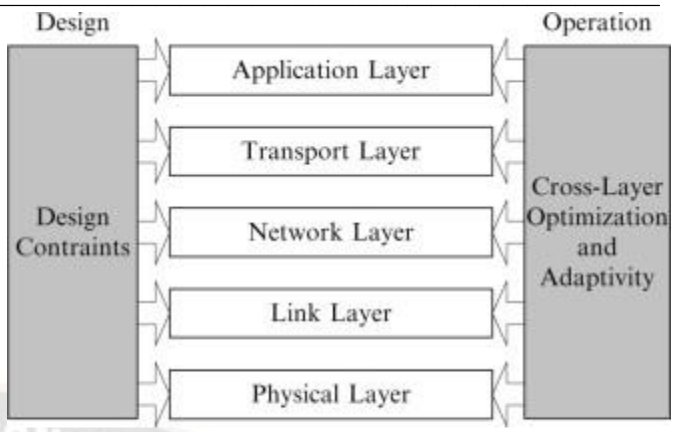

Figure 2: cross-layer architecture

Data is sent between layers in a multi-layer system to increase adaptability and make the best use of network resources. In a cross-layer design, each layer is distinguished by a small number of crucial parameters and control knobs. Other levels use the parameters to determine the best adaptation rules for their control knobs given the state of the network. Cross-layer design is frequently presented as an optimisation problem with inputs and constraints from different layers. By resolving the optimisation problem, the optimal values for the control knobs in the layers are obtained.Cross-layer architecture is intriguing in wireless networks for the reasons listed below. First, the traditional architectural design process narrows the search space for the optimal adaptation despite its high effectiveness in wireline networks.[8]

Multi-layer optimisation, which defines a general idea of communication between layers by taking into account specific intelligent interactions between them, can improve network performance [12–15]. Its goal is to enhance system performance overall by fusing the capabilities of several network levels. The usual technique can only pinpoint part of the potential cross-layer interactions in the context of the OSI tiered model. The cross-layer optimisation framework enables the user to modify the physical layer's transmission power after learning the RSS value of a node's nearest neighbour. Based on the simulated transmission power, the node will continuously alter the physical layer range that it can transmit. The network layer receives this information from the physical layer so that it can make more informed routing decisions. A key advantage of this design is data sharing between the physical and application levels.

III. METHODOLOGY

The link state algorithm serves as the foundation for the protocol, ensuring its dependability. The routes are ready for use the moment it is decided that they are necessary due to the proactive nature of the system. Any link that a network has formed with its nearby nodes will be broadcast under a pure link status protocol. The OLSR protocol is an extension of a fundamental

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link-state protocol for MANETs. The protocol is built such that additional control traffic beyond the messages normally scheduled to be sent out does not occur from link failures and link additions. [16]. The Network's routes to each destination are stored in the protocol. Because this protocol was created with high-density networks in mind, it performs effectively even in settings with a lot of open space. The protocol may carry out its duties without a central server or any other centralised component because it is decentralised. The protocol can manage the occasional packet loss caused by collisions or other transmission issues, which are common occurrences in radio networks, because each node only sends its control messages infrequently. The information cannot be reordered at the receiving end due to the inclusion of a sequence number of the most recent information in each control message; hence, the older information is perceived as more recent.

According to the HOLSR protocol, routing is carried out hop-by-hop, which means that each node utilises the most recent information to decide which hop a packet should take after finishing its current one. Data packets are successfully transmitted to a moving node as a result. As a result, the protocol permits node mobility, which may be monitored with the help of local control messages [17]. The speed at which these messages are exchanged directly affects how precisely this monitoring operates. A Multipoint Relay (MPR) node selection optimisation approach is used to create the optimal link-state routing protocol. This scenario employs a hybrid GSO-GA technique for optimisation. Utilising the HOLSR protocol considerably reduces the network's control overhead by allowing only certain neighbour nodes to forward control packets. The link state protocol can avoid flooding of this control traffic and, as a result, improve performance by declaring only a subset of links with its neighbors—those being the multipoint relay sectors—and by using only the chosen nodes, referred to as multipoint relays, to spread its messages in the Network. Only the multipoint relays connected to a node will convey any broadcast messages sent to that node. With this approach, fewer retransmissions are needed during a flooding or broadcasting procedure. Figure 3 illustrates how the protocol and its components perform their intended functions together.

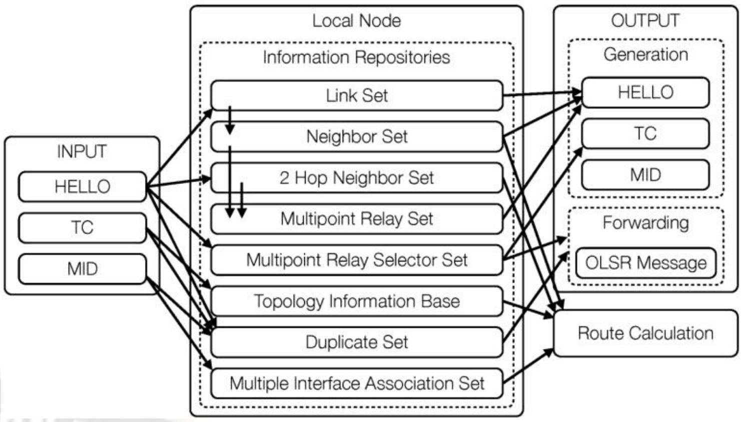

Figure 3: Architecture of the proposed modified Optimal Link State Routing (HOLSR) Protocol

The HOLSR protocol reduces the network's control overhead by only allowing certain neighbour nodes to forward control packets. To transport data packets from the source to the destination, the MPR nodes, a subset of the neighbour nodes selected by each source to access all the two-hop neighbours, act as forwarders. Searching for untapped frequency ranges (CR) is one of the best strategies to improve channel efficiency. By efficiently allocating spectrum, the HOLSR routing system reduces routing delays. Only proper channel allocation techniques, which OLSR routing must implement, can identify the subsequent optimal hop with a quicker link transmission time. Next, we outline the suggested method's high-level block diagram and show how the complete procedure works.

By altering the transmission power of the different nodes, the main goal is to lower the energy required to keep the Network linked. Such circumstances are referred to as "Power Assignment Issues." A second category of connected problems is referred to as Networks. Lifetime issues arise if the initial battery power supply of the nodes varies from node to node and if the objective is to maintain a connectivity constraint in the Network for as long as is practical. In contrast to traditional networks, ad hoc networks rely on cross-layering power regulation at the MAC and Network layers rather than a central server or network backbone to share data wirelessly. Each node acts as a relay for data transmission in a wireless network. Since batteries power the majority of nodes, reducing power usage is essential. The best options for power distribution in a wireless environment can be found in transmission power assignment algorithms. Because wireless networks are broadcast, they are constrained by interference and capacity constraints.

IV. RESULTS

In contrast, CL-throughput DTPCPs grow in step with the rate at which packets are generated, reach a maximum, and stabilize at a fixed value. Throughput grows linearly and reaches a

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maximum at a high packet creation rate since fewer packets compete for transmission at low rates.

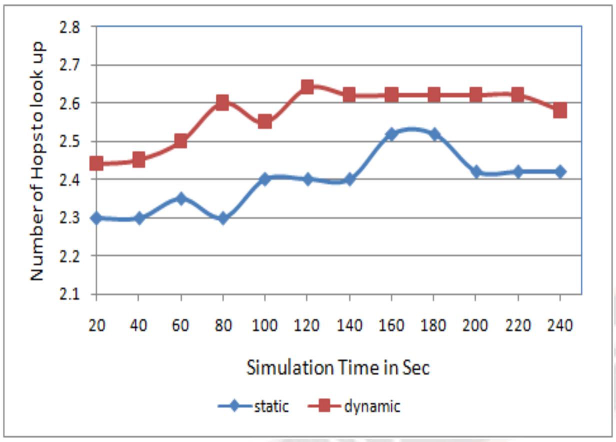

Figure 4: Number of Hotspot look up

The figure 4 depicts the change in number of hotspots look up over a time interval in the static and dynamic mode. The time increases proportionately the hotspots also varies. Among the two methods dynamic method takes more number of handoff initiations.

The energy consumption for the proposed protocol of HOLSR is measured with respect to the network load generated per second. Among the static and dynamic methods, the energy consumption is more for the dynamic method when the load increases and which is shown in figure 6. The average response to the notifications versus the number of nodes is represented in the figure 6. If the number of nodes are increases proportionately the average query response from the nodes also varies.

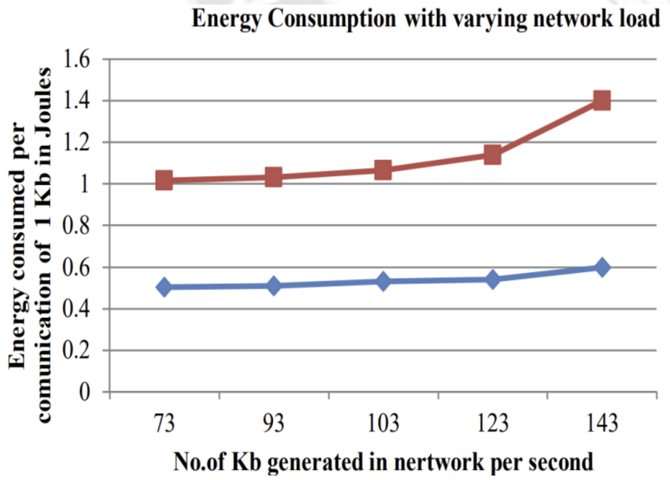

Figure 5: Energy consumed per communication

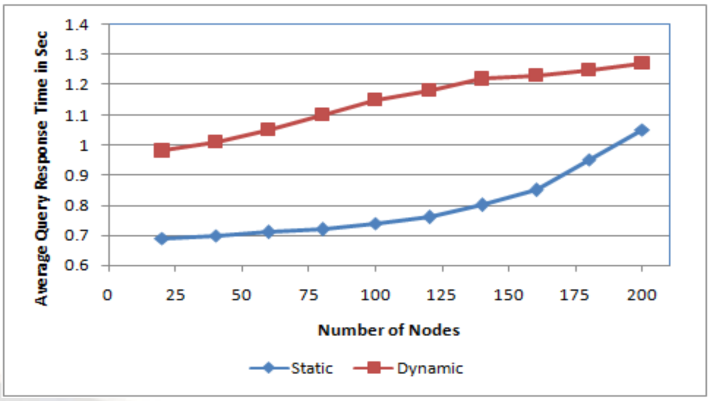

Figure 6: Average query response

From the figure it is observed that the number of nodes increases the average query response is also increases for both static and dynamic methods. When compare with the dynamic method, the static method gives better average query response for the proposed HOLSR protocol.

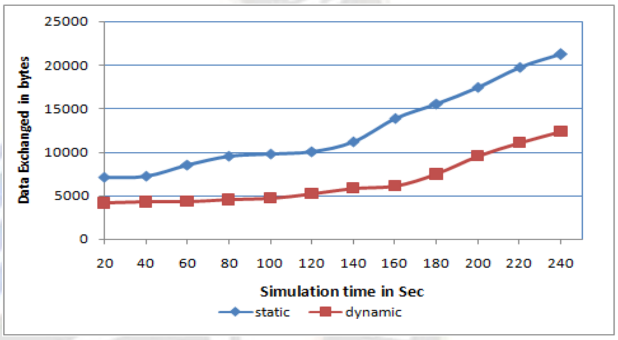

Figure 7: Data Exchanged information

The data exchange from node to node versus time is measured and plotted in figure 7. The dynamic method gives linear response when the data is exchange from node to node with respect to time. But the static model gives non linear response when the data is exchanged from node to node with respect to time. The proposed protocol gives almost 50% better data exchange for the static method than the existing dynamic method.

V. RESULTS

The HOLSR protocol is used for estimation of the performance of the data exchange between nodes and energy consumption in the cognitive radio networks. The proposed protocol is tested on the both cases like dynamic and static modes. The performance also analyzed between both the modes and identified the protocol is well suited for the static mode operations. In the case of energy consumed per communication, the static model HOLSR protocol gives 50% better than dynamic model.

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