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Delay Optimization in Cognitive Radio Network Using DORP Protocol

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Abstract

In Wireless Sensor Network during routing of packets, energy loss may occur which leads to dropping of packets. This loss of packets is caused due to collision and interference in the channel. To overcome this issue a routing protocol is developed to improve the routing performance of the hob by hop wireless mesh network greedy forwarding in sensor network in terms of latency through minimum hop count, energy and quality link. The protocol used is DORP protocol. Through cognitive sensing an efficient routing is carried out. We evaluate DORP for collision in the physical layer with symbol level simulation, and evaluate its network level representation, by comparing it with broadcast CSMA/CA protocol. The advantage is that the delay obtained through the schemes of cognitive network by sensing and routing is comparative to the network range.

Keywords

Wireless sensor network, mesh network, cognitive nodes, DORP, hidden terminal problem.

Introduction

Wireless communication is one of the rapidly changing area whose changes have immediate impact on the individuals and society. Day by day new technology improvement is occurring in the area of communication and information. Today the users of wireless communication are aware about their environment and components nearby. As more people make use of wireless network they are in need of efficient resource to obtain more data. Mobile and cellular technology has thriving effects on human. Of the available resources Frequency spectrum is considered to be the scarcest resource. In the past people only make use of fixed spectrum to utilise wireless network. Due to this many spectrum remains unused leading to wastage of large band of spectrum. To overcome this efficient utilisation of spectrum is required. At present Cognitive network is one of the optimal solution to overcome spectrum scarcity [1].

Cognitive Network is used to utilise the spectrum available efficiently. They make use of the unlicensed spectrum. The main principle of cognition is to sense the wireless path automatically and cognition radios have the capability to make decision on their own without human intervention. They utilise the secondary spectrum available in a band efficiently. The cognitive

sensing has the capability to find the available path automatically and schedule the packets in the available path. Cognitive network consists of two users, primary and secondary users. The primary users utilise the licensed spectrum while the secondary users make use of unlicensed spectrum. The secondary users utilise the spectrum without interfering the primary users.

The main challenge in designing the cognitive network is to allocate the spectrum dynamically. The cognitive network can be cross layered with any network like wireless mesh network, adhoc network etc. The selecting of spectrum in from the available band is challenging. A proper spectrum sensing method is used to allocate the available spectrum and routing algorithm is used to transmit the packet effectively. The sensing and routing should be carried out by efficient algorithm [2].

Delay optimization is a major problem while routing the packets. It is dependent on the load balance, channel frequency etc. In this paper, research is carried out to reduce the delay while transmitting packets. The delay in the cognitive mesh network is compared to that of wireless sensor network. The hidden terminal problem is also overcome by randomly deploying the nodes in a network using DORP protocol. By solving this problem all nodes can communicate with others efficiently.

Related Work

In cognitive radio network the sensing of spectrum must be carried out efficiently so that unutilised spectrum is used effectively. The issues during sensing is overcome by various protocols. The resources are also allocated so that coordination between primary and secondary occurs and interference is avoided.

Yuan Yuan et al. [3] discussed a method to formalise the spectrum allocation problem in cognitive network, time-spectrum blocks model was presented for reservation of spectrum. B-SMART, a distributed and practical spectrum allocation scheme was proposed in order to realize dynamic and fine-timescale allocation. They make the maximum utilisation of bandwidth available and can adapt to any traffic flow in the channel. In this overhead of the channel is not considered while transmitting smaller data packet. Interference problem between the primary and secondary user may occur.

In order to avoid interference between primary and secondary users *Qing Zhao et al.* [4] proposed a protocol Partially Observable Markov Decision Process (POMDP) that allows the secondary users to autonomously find the spectrum on the available channel. They also reduce the hidden terminal problems. The overall spectrum efficiency considering both the primary and secondary users decreases when maximum collisionis large. In this paper, in a wireless mesh network communication is carried out using cognitive sensing. The mesh node senses the medium prior to each communication and identify the available band for transmitting data.

Jie Jia et al. [5] emphasised about congestion avoidance in cognitive network. This issue occurs due to two main problems, interference and collision. The aim is to reduce the interference and to improve the throughput. The issue is overcome by genetic algorithm in which the bandwidth is optimized so that channel allocation is carried out effectively. The disadvantage is that by increasing the channels the congestion becomes more. So more leads on channels must be controlled.

The delay in cognitive network is considered to improve the transmission. *Hung Tran et al. [6]* overcome the delay in cognitive network using the queuing analysis. In this point to point and point to multipoint communication network is observed and verified. By observing it is concluded that best channel is selected for transmission under certain conditions like channel capacity, load balance etc. Analytical framework is designed to infer the QOS trade off and challenges in interference is deducted.

In the existing work Amr A. El-Sherif et al. [7] designed a cognitive mesh network. In this the allocation of resources and routing of packets is carried out jointly. The design of network is divided into optimal and sub-optimal solution. The designed framework is tested for performance. In this secondary users utilise channel in ideal condition. The Queuing theory and Lagrangian dual problem solution method is developed. In this the main aim is to reduce the delay. The end to end delay is minimized using dual problem solution. Anyhow the hidden terminal problem is an issue. In our paper, the breaking of mesh topology is carried out and all nodes participate in communication.

Proposed Work

A joint design of routing and resource allocation scheme is carried out in Cognitive Radio based Wireless Mesh Network(WMN) to reduce delay of the secondary users. In this an optimal strategy is used for channel sensing and allocating. It is based on prime dual frame work and then the problem is divided into sub optimal problem so that routing is carried out. The end to end delay is obtained by joit routing and allocating.In this only static nodes are considered and probability of primary idle channel is maximized. More over the problem of hidden terminal occurs.So the DORP protocol breaking the mesh topology is designed and random deployment is carried out.

In this work, the packet transmission in wireless sensor network nodes is first designed. In WSN, broadcast delay and loss of energy occurs. So to overcome the losses and delay, the nodes form a mesh topology in which nodes have the capability of cognitive sensing. Through cognitive sensing effective transmission of the packets occur. They provide efficient communication to the network. The communication of both WSN and using Cognitive sensing is examined using simulation and the graph obtained is compared with each other in terms of delay, total loss and channel frequency.

Modules

The modules used to carry out this work is listed below,

- Deployment of WSN communication
- Mesh network using cognitive nodes
- Random routing of nodes

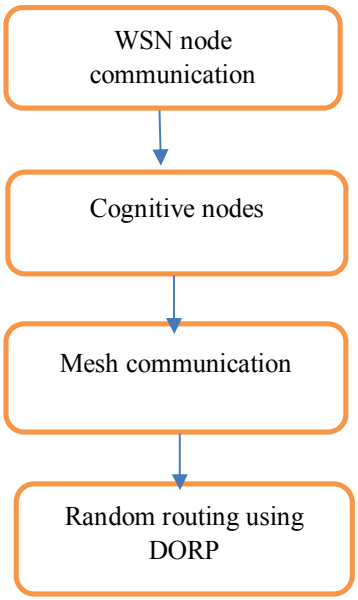

Fig.1: Architecture Diagram

Deployment of WSN communication:

The nodes are deployed randomly in the wireless sensor network. The communication is carried out using the Destination Sequenced Distance Vector Routing (DSDV) algorithm. It is coined from the concepts of Bellman Ford Algorithm with definite improvements. It is a proactive protocol in which the routing table is updated periodically with the information of destination and the nodes to reach destination. The formation of loops is avoided using the sequence number. They are also used to avoid dropping and retransmission of same packets. If a change occurs then the routing table is updated prior change. During simulation using DSDV, the packets are dropped due to traffic and it cannot accommodate heavy transmission. Moreover continuous updating of routing table is tiring and large delay occurs. To overcome the losses cognitive sensing nodes are used.

Mesh network using Cognitive nodes:

A wireless mesh network is designed to carry out communication effectively. In this, the mesh node has the capacity of cognitive sensing through which the available spectrum isidentified dynamically. The selection of transmitting packets is based on frames which is divided on basis of time. The cognitive node is selected on the basis of sensing capacity of node which is able to accept the request of all other nodes. The cognitive node sends the packet only if the available spectrum is idle.

A directed graph G (V, E) is used to form a mesh network in which the nodes are represented by each vertex. The cognitive nodes in the network has the same transmission range and the node consists of two edges. Based on primary spectrum the availability for secondary nodes is obtained. In mesh node for sensing of idle nodes during transmission is carried out using

Recursive Algorithm. They sense based on space priority and partial input buffer sharing. If cognitive node is not near idle node then the nearest cognitive sensing node is selected based on distance. The cognitive node then transfers the packets in the network by sensing the unused spectrum and allocate the channel for transmission.

Random Routing of nodes:

In this in order to avoid the hidden terminal problem in which the hidden nodes can communicate with other nodes. Only the nodes near cognitive nodes cam communicate in mesh network. So the breaking of mesh is carried out. Then the nodes are deployed randomly so that any node can communicate with cognitive sensing nodes. So DORP protocol is used for routing. This protocol combines all the metrics like delay, losses etc. In this the cumulative delay between the end nodes is calculated. The delay in each route is determined by combining the path delay and node delay.

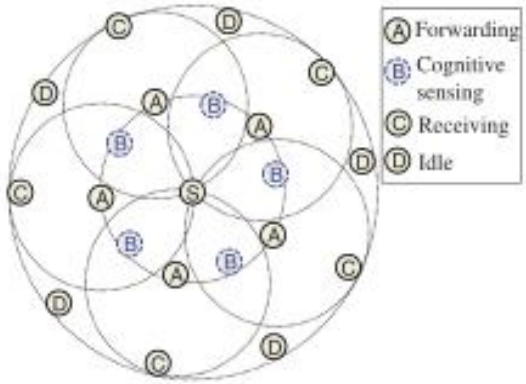

Fig 2: Random deployment of nodes

Then the graph is obtained by simulating the WSN and mesh network. The graph is examined and compared with each other. The graph indicates the metrics like delay, channel frequency, total loss.

Conclusion

In this paper, the various issues while routing and sensing of spectrum band where investigated. The collision occurring during deployment of nodes is overcome using DORP protocol. The interference and coordination problem is also avoided. The existing CR mesh network is used. The random routing without mesh topology using DORP protocol is proposed and compared with existing technique. The expected result is minimized energy, lower cumulative and latency of the proposed design. The issues related Hidden node problem is also overcome. The broadcast efficiency is improved.

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