AACO Based MRMC technique in Wireless Mesh Network

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***Abstract*— A wireless Mesh network consists of three main components: nodes, gateways, and software. The spatially distributed measurement nodes interface with sensors to monitor assets or their environment. In this research work the optimized MRMC protocol in WMNs is implemented on the basis of AACO optimization scheme. AACO is used to provide a reciprocal path for every link in case of its failure. In this method mutation operator, is used and the new mutation rate is generated by the self-adaptive approach The proposed approach helps to reduce the load and drops in the network, so using the proposed methodology the QOS parameters such as packet delivery ratio, throughput, overheads, average end-to-end delay, average energy consumption are quite improved as shown in the result section. The improvement of 16% is shown between the existing and proposed approach in above defined features.**

***Keywords*— WMNs, MRMC, ACO, AACO**

I. INTRODUCTION

A wireless network enables people to communicate and access applications and information without wires. This provides freedom of movement and the ability to extend applications to different parts of a building, city, or nearly anywhere in the world. For example, people at home researching on the Internet can do so in a quiet area away from noisy children or in front of the television with the entire family nearby. Wireless networks allow people to interact with e-mail or browse the Internet from a location that they prefer.

A wireless mesh network (WMN) is a mesh network created through the connection of wireless access points installed at each network user's locale. Each network user is also a provider, forwarding data to the next node. The networking infrastructure is decentralized and simplified because each node need only transmit as far as the next node. Wireless mesh networking could allow people living in remote areas and small businesses operating in rural neighborhoods to connect their networks together for affordable Internet connections.

In a full mesh topology, every node communicates with every other node, not just back and forth to a central router. In another variation, called a partial mesh network, nodes communicate with all nearby nodes, but not distant nodes. All communications are between the clients and the access point servers. The client/server relationship is the basis for this technology.

II. CHANNEL ALLOCATION

Channel Allocation means to allocate the available channels to the cells in a cellular system. When a user wants to make a call request then by using channel allocation strategies their requests are fulfilled. Channel Allocation Strategies are designed in such a way that there is efficient use of frequencies, time slots and bandwidth.

Types of Channel Allocation Strategies:

These are Fixed, Dynamic, and Hybrid Channel Allocation as explained as following below.

Fixed Channel Allocation (FCA)

Fixed Channel Allocation is a strategy in which fixed number of channels or voice channels are allocated to the cells. Once the channels are allocated to the specific cells then they cannot be changed. In FCA channels are allocated in a manner that maximize Frequency reuse.

Dynamic Channel Allocation (DCA)

Dynamic Channel allocation is a strategy in which channels are not permanently allocated to the cells. When a User makes a call request then Base Station (BS) send that request to the Mobile Station Center (MSC) for the allocation of channels or voice channels. This way the likelihood of blocking calls is reduced. As traffic increases more channels are assigned and vice-versa.

Hybrid Channel Allocation (HCA)

Hybrid Channel Allocation is a combination of both Fixed Channel Allocation (FCA) and Dynamic Channel Allocation (DCA). The total number of channels or voice channels are divided into fixed and dynamic set. When a user make a call then first fixed set of channels are utilized but if all the fixed sets are busy then dynamic sets are used. The main purpose of HCA is to work efficiently under heavy traffic and to maintain a minimum S/I.

III. RELATED WORK

In this section, we have a tendency to summarize and discuss connected authentication ways employed in follow or projected within the literature to boost positive identification authentication on the net and gift their limits.

U Chaudhry, Nazia Ahmad and Roshdy HM Hafez [7] proposed certain techniques such as Topology-controlled interference-aware Channel-assignment Algorithm for MRMC WMNs. Further, they designed shortest path tree graph consisting 36 nodes network and used two-way interference-range edge coloring and called the improved algorithm as

Enhanced TICA, which improves fairness among flows in the network. The performance of the TICA scheme completely outperforms CCA scheme in terms of network throughput. Also, they have shown and verified enhancements made to TICA.

Jemm-Wei Lin, Shian-Min Lin [8] depicted that it is severely important that we must assign appropriate IEEE 802.11 channels in the radio interfaces of the wireless routers so that the interference can be reduced among the routers. There are two types of channels i.e. non-overlapping and partially overlapping. Most of the existing channel assignment algorithms in WMN use non-overlapping channels. There are only three non-overlapping channels in IEEE 802.11 b/g, and while performing channel assignment we can assign same channel to the other nodes too. They presented a new distributed channel assignment approach in which the arrangement of the channel assignment sequence among nodes is in inverted order to the path forwarding weights of nodes. The simulation result showed that their approach is better in terms of interference cost, throughput, delay and virtual transmission.

Tehuang Liu and Wanjiun Liao [9] proposed an on-demand bandwidth-constrained routing protocol for multi-radio multi-rate multi-channel WMNs with IEEE 802.11 DCF MAC protocol. Their protocol is based upon distributed threshold-triggered bandwidth estimation scheme implemented at each node for estimating the free to use bandwidth on each associated channel. They further proposed a routing metric that maintains a balance between the cost and bandwidth of the path. The network simulation scenarios (ns2) were conducted for evaluation performance of the proposed routing protocol and were successful in discovering paths that meet the end-to-end bandwidth requirements of flows, protect existing flows from QoS violations, exploit the capacity gain due to multiple channels and incurs low message overhead.

T. O. Olwal, B. J. van Wyk and K. Djouani [10] presented a dynamic power control for MRMC WMNs, a new technique named PMMUP (power selection MRMC unification protocol) is used which co-ordinates local power optimizations at the radios of a node. They also compared the outputs between different techniques. However, after simulation, MMIPA has better throughput yield but PMMUP transmits packets without transmit power control.

Vinay Kapse and Ms. U.N. Shrawankar [11] introduced interference-aware cluster based channel assignment scheme to minimize interference from the nearby mesh nodes and maximize the throughput. They introduced a channel assignment technique allocates channels that do not interfere with other channels in two hop distances. Though by using this technique all of the resources cannot be used but will increase throughput and minimize the interference. The simulation using NS-3 results showed that their technique is far much better than BFSCA and Distributed Greedy CA. The results also depicted that the average queue length is less, aggregate throughput, packet loss and aggregate delay is better than the two compared techniques.

Wen-Lin Yang, Wei-Tsung Huang [12] used two heuristic algorithms (Multi-channel multicast, Load-based Greedy) that can efficiently construct multicast tree and solve the interference problem referred as MR^2. The trees are then processed by load-based DFS and load-based BFS channel assignment procedure that allocates interference-free channels to the links. Further, performance and delay comparisons are also made for the multicast trees generated by the approximation algorithms. The result reveals that, in terms of the number of serviced subscriber is better in LMCM algorithm, where as the other has better performance and less delay with maximum interface.

Aziz U Chaudhry, Nazia Ahmad and Roshdy HM Hafez [13] determined the minimum number of non-overlapping frequency channels which are required for interference-free channels so that the maximum throughput can be achieved and the fairness of the network is maintained. To accomplish this, $select\ x\ for\ less\ than\ x$ Topology Controlled Algorithm is introduced for building the connectivity graph over the traditionally Maximum Power (MP) based. The results reflected that TCA based approach is beyond better than MP in terms of channel required as well as links to channel ratio non-degrees. The TCA is well because, both network connectivity as well as neighborhood mesh nodes is controlled by this approach. This leads to less overall transmitted power and better spatial channel reuse that results in achieving maximum throughput and fairness among the network.

A.P. Subramanian, Himanshu Gupta, Samir R. Das and Jing Cao [14] introduced centralized and distributed algorithms for channel assignment to overcome the interference at the mesh nodes. For the evaluation of the quality of the network they have developed a semi-definite and linear program formulation for optimization problem (NP-hard) to obtain lower bounds on overall network interference. The ns-2 simulation for 11-node mesh-network resulted in improved network efficiency and throughput with minimized interference.

IV. EXISTING SCHEME

The objective of Channel Assignment techniques is to reduce the interference across the mesh nodes during transmission. Many new techniques have been introduced to overcome this issue so that the connectivity of network remains intact. So far, Topology controlled Channel Assignment techniques has been successful in removing the abnormalities in the network. Focus is based on minimizing the interference at radio nodes and maximizing the network throughput so that the fairness of the network is maintained. Further, different scenarios will be created and new methodologies will be developed during the emulation and simulation phases to achieve the objective.

1. Low Transmission links and channels: MRMC technique does not provide any kind of alternative path so if link get down then source didn’t have any other path with which source can send packets.

2. Data Loss occurred: Due to unavailability of alternative path data losses occurred.
3. Low data transfer Rate: Due to data loss the data transmission rate gets reduced which in turns reduce throughput.
4. Low Throughput: MRMC gave low throughput as data drops are high.

V. PROPOSED WORK

Implementation of proposed MR-MC in WMNs protocol is done by simulation or designing of WSN using software MATLAB. For designing and simulation process 100 nodes are taken against 3000 number of rounds. In this research the scalability of the proposed protocol is tested by implementing the approach on various number of nodes i.e. 20, 40, 60, 80, 100. To find out the results of various metrics, the average value of every metrics in every set of nodes is calculated and plotted in graph. For eg, to calculate the delay along with the scalability of this approach in various set of nodes as defined above, the resultant graph of 20 nodes is generated and then the average value of that graph is calculated and plot on the 20 nodes for delay. To perform algorithms the values of initial energy is taken as 0.5J and value of energy dissipation for transmission an reception of packet is 50*0.000000001J and 50*0.000000001J. If there is a need of amplification of signal then there is a dissipation of 0.0013*0.000000000001J amount of energy. In last the energy dissipation for aggregation of data packets is 5*0.000000001J. Using the proposed approach the energy dissipation is less due to the optimization scheme. With the help of optimization scheme an alternative path is formed so that the packets can always have a route from which it can reach destination. Using this process the packet drop will be reduced. Due to it there will be fewer packets in the network so low congestion and low load will be in the network. Due to the low congestion time taken for a packet from source to destination will be less, results in low delay. In this fashion all the metrics for all set of nodes are calculated as shown in the graphs below.

VI. SIMULATION ENVIRONMENT

During preliminary study it has been studied that, there are a number of parameters that are to be assumed before the simulation like Frame Duration, frequency Bandwidth, Mode of transmission, network size etc. The area taken into consideration is 100*100m. For the implementation of coverage techniques in WSN, simulation parameters used are shown in Table 4.1.

Table 4.1: Simulation Parameters for MRMC Protocol

Simulation parameters	Value
Frame duration	1ms
Frequency bandwidth	25MHZ
Mode of transmission	TDD
Packet size	5kb
Simulation grid size	100m*100m
Rounds	3000
Initial Energy	0.5J
Energy for transmission	50*0.000000001J
Energy for reception	50*0.000000001J
Energy for Amplification	0.0013*0.000000000001J
Energy for Data Aggregation	5*0.000000001J

Performance Metrics

Performance metrics are the parameters on the basis of which we analyze the performance of the network. The performance metrics that are to be used are packet delivery ratio, average end-to-end delay, overheads, throughput, average energy consumption which are discussed below.

Packet Delivery Ratio: The first metric is PDR, which is defined as the number of packets successfully received Prx, to the number of packets transmitted Ptx. As shown in equation 1.

$$PDR = Prx/Ptx \qquad (1)$$

Where Prx is packets received and Ptx is packets transmitted

Average End-to-end Delay: It is the average time between a packet being created and being delivered to the sink. The average delay in a TDMA multi-hop based protocol depends greatly on the order of the allocated time slots of the forwarding nodes.

Overhead: Overhead is a major factor in designing routing protocols for mobile sensor networks since more no. of packets can cause congestion, which will limit the throughput of data. There are generally two types of overhead; packet overhead and control overhead. Packet overhead is the ratio of non-data bits to data bits in a data packet. Control overhead is the ratio of bits in control packets to bits in data packets. Control packets are often used to negotiate channel access, discover routes or share topology information.

Throughput: Throughput is defined as the number of data bits successfully delivered to the sink in predefined time.

Average Energy Consumption: It is the energy consumed in transmitting and receiving the message packets in a mobile wireless sensor network.

VII. RESULTS

In this research various performance metrics are improved by using the optimization schemes that is ant colony optimization and adaptive ant colony optimization. The effect on various QoS parameters such as Packet Delivery Ratio, Overheads, Average End-to-End Delay, Throughput, Average Energy Consumption have been observed by varying the no. of nodes i.e. 20, 40, 60, 80 and 100 nodes by taking same number of rounds. Firstly by taking the 20 number of nodes the values are plotted against packet delivery ratio. Then the average mean of ten values are taken and we get one value. The whole process is repeated for 40,60,80,100 no. of nodes. Similarly the values are plotted against throughput, overhead, average energy consumption and average end-to-end delay. The values are plotted by using both ACO and AACO optimization techniques.

OVERHEAD:

Figure 3 compares the overhead in MRMC, ACO-MRMC, AACO-MRMC. The result is plotted against the overhead bitts and number of varying nodes. From the graph it may be defined that the average value of overheads in MRMC is most i.e. 1.1 whereas in case of ACO-MRMC it is slightly less than that of MRMC i.e. 0.9 and in case of AACO-MRMC it is quite better and it is 0.8. According to this figure the proposed results shows 27% improvement in overheads. As the packet drop is reduced due to new path generation the packet delivery ratio is improved; all the packets are delivered in time as the result of which overhead is reduced in AACO-MRMC.

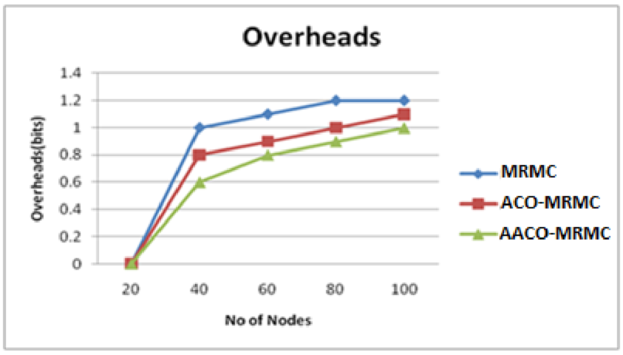

Figure 3: Comparison of Overhead in MRMC, ACO-MRMC, AACO-MRMC

Throughput:

Figure 4 represented the relation between MRMC, ACO-MRMC, AACO-MRMC. AACO-MRMC shows better results as compared to the existing protocol and the other one. From the graph it may be defined that the average value of throughput in MRMC is least i.e. 1000 bits whereas in case of ACO-MRMC it is slightly more than that of MRMC i.e. 1100 bits and in case of AACO-MRMC it is quite better and it is 1200 bits. According to this figure the proposed results shows 20% improvement in throughput. As the packets will take the reciprocal path more no. of packets will reach to the destination without any loss; which means maximum number of data bits will reach successfully to the sink hence throughput of AACO-MRMC is improved than the other two.

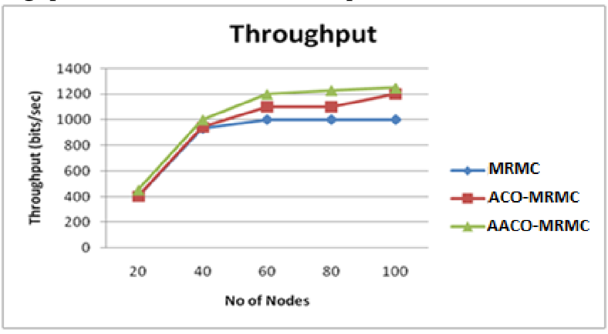

Figure 4: Comparison of Throughput in MRMC, ACO-MRMC, AACO-MRMC

Average Energy Consumption:

Figure 5 shows that there is less energy consumption in AACO-MRMC. From the graph it may be defined that the average value of Average Energy consumption in MRMC is most i.e. 0.0015 joule whereas in case of ACO-MRMC it is slightly less than that of MRMC i.e. 0.0013 joule and in case of AACO-MRMC it is quite better and it is 0.001 joule. According to this figure the proposed results shows 12.5% improvement in average energy consumption. As the packet drop is less; the re-transmission attempts for sending the message to receiver are less. So as a result of which there is less energy dissipation and hence there is less energy consumption in optimized scheme as compared to the existing protocol.

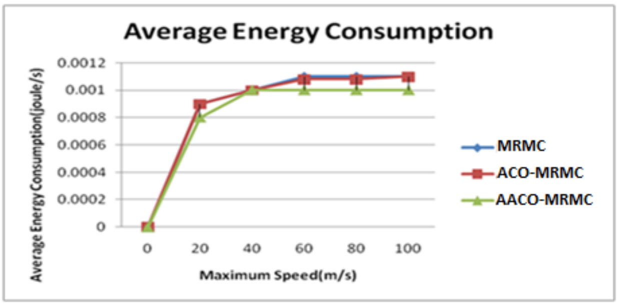

Figure 5: Average Energy Consumption in MRMC, ACO-MRMC, AACO-MRMC

Tabular comparison of existing protocol parameters and protocol with optimization scheme is shown in Table 2. the values of all the performance metrics packet deliver ratio, overhead, throughput, average end-to-end delay, average energy consumption is shown in the following table against the number varying nodes that is 20, 40, 60, 80, 100 nodes.

Table 2: Comparative study for AACO-MRMC, ACO-MRMC and MRMC

Technique / Parameters	Existing	ACO-MRMC	AACO-MRMC
Overheads	1.1	0.8	0.6
Throughput(bits/sec)	1000	1100	1200
Average energy consumption(joule)	.0011	.0011	.0013

VIII. CONCLUSION

A wireless Mesh network consists of three main components: nodes, gateways, and software. The spatially distributed measurement nodes interface with sensors to monitor assets or their environment. In this research work the optimized MRMC protocol in WMNs is implemented on the basis of AACO optimization scheme. AACO is used to provide a reciprocal path for every link in case of its failure. In this method mutation operator, is used and the new mutation rate is generated by the self-adaptive approach The proposed approach helps to reduce the load and drops in the network, so using the proposed methodology the QOS parameters such as packet delivery ratio, throughput, overheads, average end-to-end delay, average energy consumption are quite improved as shown in the result section. The improvement of 16% is shown between the existing and proposed approach in above defined features.

In the future scope the scalability of the approach can be improved so that quality parameters cannot be reduced. Any other algorithm can also be used in order to improve the QoS parameters if it shows better results than this proposed work.

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