A New Link Layer Protocol for Wireless Mesh Networks

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Abstract : Cooperative channel allocation and scheduling are key issues in wireless mesh networks with multiple interfaces and multiple channels. In this research work, aim to propose a load balance link layer protocol (LBLP) aiming to cooperatively manage the interfaces and channels to improve network throughput. In LBLP, an interface can work in a sending or receiving mode. For the receiving interfaces, the channel assignment is proposed considering the number, position and status of the interfaces, and a task allocation algorithm based on the Huffman tree is developed to minimize the mutual interference. A dynamic link scheduling algorithm is designed for the sending interfaces, making the trade-off between the end-to-end delay and the interface utilization. A portion of the interfaces can adjust their modes for load balancing according to the link status and the interface load. Simulation results show that the proposed LBLP can work with the existing routing protocols to improve the network throughput substantially and balance the load even when the switching delay is large**.**

***IndexTerms* - Mesh Network, Link Layer Protocol, load balance link layer protocol (LBLP), Scheduling Algorithm.**

I. INTRODUCTION

Wireless mesh networks, commonly known as MESH networks, have come a long way over the past years and their popularity is soaring. One of the main contributing factors for their growing popularity is the necessity to provide broadband access to the Internet [1][1]. This is particularly evident in areas where no appropriate cabling infrastructure is provided, or where costs of building such an infrastructure would exceed potential resulting benefits. A significant part of routing protocols in Wireless Mesh Networks (WMN) has been imported from Ad-Hoc networks (e.g. AODV and DSR protocols). These protocols are based on the simplest metrics, based on the number of hops in feasible paths, that are well-suited for the Ad-Hoc network, but are not particularly effective in MESH networks [3][4], because they do not take into account the quality of the link as well as the differences in technologies used in the networks in question. In the face of these differences and limitations, it is necessary to include in the consideration other routing metrics, specific to mesh networks, that would make any development of new routing protocols, or a modification of existing protocols, possible. Such protocols must also satisfy a number of requirements, i.e. scalability, provision of routes without loops, speed of response to possible changes in the topology of the network, security, QoS issues and optimization of energy consumption [5].

MESH networks guarantee the connectivity through a multihop wireless backbone formed by stationary routers and thus provide connectivity between mobile and stationary (landline) users and are frequently used to provide access to the Internet [6][7][8]. Wireless Mesh Networks offer many advantages such as, for example, fast and easy extension of the system, self-configuration ability, self-healing aspect, elasticity, large territorial range, better and easier area coverage (as compared to IEEE 802.11 a/b/g/n), large throughput, reliability (a failure in a single point (node) is not followed by a failure in the whole of the network) and energy conservation. Regrettably, no standard has been worked out yet and hence available solutions are most frequently incompatible with one another [9].

Lack of appropriate routing protocols suitable for mesh networks is still an important problem. Since those metrics that are known from protocols for the Ad-Hoc network cannot be applied to mesh networks, any process of designing new protocols is substantially hindered [10].

II. RELATED WORKS

Pan, Chen, et al [11] Wireless mesh networks (WMNs) are widely used to expand the current wireless network coverage. In this paper, we present a hypergraph-based channel selection method to allocate channels, which can be used to alleviate the accumulative interference from multiple weak interfering links in WMNs. Firstly, we build the ternary interference hypergraph model for all links in a WMN. Then we present a interference mitigating hypergraph game to solve the distributed channel selection problem. It is proved that the proposed game is an exact potential game with at least one Nash equilibrium (NE). Finally, a best reply (BR) based channel selection algorithm for the interference mitigating hypergraph game is presented to obtain NEs. Simulation results show that the presented channel selection method with hypergraph model has a lower global accumulate protocol interference than the existing method with binary graph model.

Shah, Peer Azmat, et al [12] A Wireless Mesh Network (WMN) can provide Internet connectivity to end users through heterogenous access network technologies. However, the mobility of mobile nodes across these access networks in WMNs results in service disruption. Existing mobility management protocols are designed for single hop networks and are centralized in nature. A Distributed IP-based Mobility Management Protocol (DIMMP) is proposed in this paper that provides seamless mobility with service continuation for mobile nodes when they roam across WMNs. Instead of relying on a centralized mobility anchor, the mobility functionality is distributed at multiple nodes in the WMN, in order to reduce the chances of potential single point of failure. The proposed protocol manages both types of mobilities i.e. intra-WMN and inter-WMN and uses a new enhanced route optimization procedure. Simulation results show that this work has contributed by improving the performance of handoff procedure with respect to handoff latency, packet loss and signalling overhead, as compared to the existing protocols.

Alic, Kemal, and Ales Svigelj [13] This paper proposes a Bearing Opportunistic Network (BON) coding procedure that operates in wireless multihop networks over multiple unicast sessions and it introduces very low overhead to the network. The BON coding is used to increase network performance in terms of a higher throughput and a lower delay. It can be seen as an independent layer in the communication stack, relying solely on information that is on the node itself. The proposed coding procedure is easy to implement and deploy. The performance evaluation of the BON coding procedure was performed in a dedicated simulation model. The comparison was made to the well-known network coding procedure COPE and the case where network coding is not used at all. Results show that BON coding increases the network goodput and decreases the delay in comparison to COPE and case where network coding is not used [16][17][18].

Wang, Gang, and Yanyuan Qin [14] Multi-beam antenna has the ability to increase the spatial reuse, extend the transmission range, improve the transmission reliability, as well as save the power consumption. Traditional Medium Access Control (MAC) protocols for wireless network largely based on the IEEE 802.11 Distributed Coordination Function (DCF) mechanism, which cannot take the advantages of these unique capabilities of multi-beam antennas. This paper surveys the MAC protocols for wireless mesh networks with multi-beam antennas. The paper first discusses some basic information in designing multi-beam antenna system and MAC protocols, and then presents the main challenges for the MAC protocols in wireless mesh networks compared with the traditional MAC protocols. A qualitative comparison of the existing MAC protocols is provided to highlight their novel features, which provides a reference for designing the new MAC protocols. To provide some insights on future research, several open issues of MAC protocols are discussed for wireless mesh networks using multi-beam antennas.

Mallikarjuna Rao, Y., M. V. Subramanyam, and K. Satya Prasad [15] Radio resource is one among the prime resources in wireless networks, which is expected to use in an efficient way especially when the mobile nodes are on move. However, providing guaranteed quality of service to the mobile nodes in the network is a challenging issue. To accomplish this, we propose 2 clustering algorithms, namely, static clustering algorithm for WMNs and dynamic clustering algorithm for WMNs. In these algorithms, we propose a new weight- based cluster head and cluster member selection process for the formation of clusters. The weight of the nodes in WMN is computed considering the parameters include the bandwidth of the node, the degree of node connectivity, and node cooperation factor. Further, we also propose enhanced quality of service enabled routing protocol for WMNs considering the delay, bandwidth, hopcount, and expected transmission count are the routing metrics. The performance of the proposed clustering algorithms and routing protocol are analyzed, and results show high throughput, high packet delivery ratio, and low communication cost compared with the existing baseline mobility management algorithms and routing protocols [19][20][21][22][23].

III. PROBLEM STATEMENT

A hypergraph-based channel selection method to allocate channels, which can be used to alleviate the accumulative interference from multiple weak interfering links in WMNs. A Distributed IP-based Mobility Management Protocol (DIMMP) is proposed that provides seamless mobility with service continuation for mobile nodes when they roam across WMNs. Bearing Opportunistic Network (BON) coding procedure that operates in wireless multihop networks over multiple unicast sessions and it introduces very low overhead to the network. Enhanced quality of service enabled routing protocol for WMNs considering the delay, bandwidth, hopcount, and expected transmission count are the routing metrics.

IV. PROPOSED METHODOLOGY

In this research work, aim to propose a load balance link layer protocol (LBLP) aiming to cooperatively manage the interfaces and channels to improve network throughput. In LBLP, an interface can work in a sending or receiving mode. For the receiving interfaces, the channel assignment is proposed considering the number, position and status of the interfaces, and a task allocation algorithm based on the Huffman tree is developed to minimize the mutual interference. A dynamic link scheduling algorithm is designed for the sending interfaces, making the trade-off between the end-to-end delay and the interface utilization. A portion of the interfaces can adjust their modes for load balancing according to the link status and the interface load. Simulation results show that the proposed LBLP can work with the existing routing protocols to improve the network throughput substantially and balance the load even when the switching delay is large.

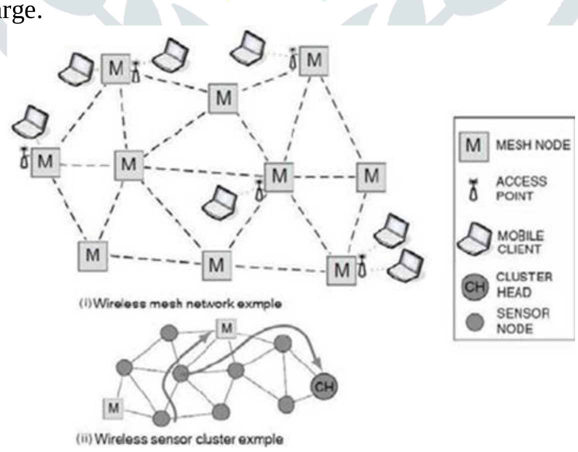

Figure 1: Architecture of Wireless Sensor and Wireless Mesh networks

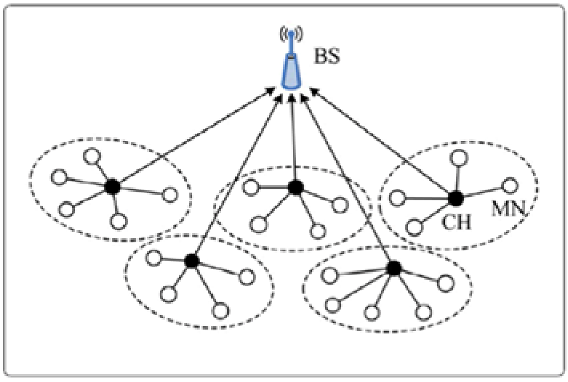

Figure 2: A Method of Cluster Formation

4.1 Cluster Formation

In this module, the formation of the cluster has done by using Cosine Similarity method. This method usually elects cluster-heads (CH) taking into consideration like Speed of the node, Power of a node, Degree Difference and Sum of distances. Designing the algorithm for the cluster formation in this module.

4.2 Node Trust Calculation

In this module, the trust value computation depends on the data that every node can associate with another node. Relevant information about other nodes has associated by examining the forwarded packets, overhead packets and received packets, given that proper reinforcements have utilized at various protocol layers. The trust between the two nodes has represented in a 3-dimensional opinion metrics (Acceptance, Rejection and Doubtful). In this module, to design the cluster head selection algorithm for calculating the trust value of the nodes in the network.

4.3 Local Cluster Formation

In this module, if the elected Cluster Head (CH) is a malicious node, then it threatens the network system connectivity. In this proposed method, (which can be identified by the above step) a node should change its Cluster Head (CH) when it becomes Malicious node to evade the overhead causing by revoking the first step of cluster formation.

4.4 Handling of Route Request by Cluster Head

A Cluster Head receives the Route Request from any node in the network. Cluster Head will check for the trust value of the node then it will find and compare with the acceptance, rejection and doubtful values. If the rejection value of a node is higher than the given rejection threshold, then that node can be discarded as the Malicious node.

4.5 Handling of Malicious Nodes

In this module, if any node determines that the next hop in the source route packet be malicious, then it attempts to attain another trustfulness of the intermediary nodes to the next jump in the same route by searching its cache or routing table for the route to the destination.

V. RESULTS AND DISCUSSION

5.1 Performance Metrics

The proposed PROTOCOL has been simulated in NS-2 software environment. 100 nodes considered as a total number of nodes, the simulation area is (250m X 250m), each initial node energy is 20000 joules, packet size is 512 bytes, the total execution time for simulation is 300 seconds, each node operating power is 10mW, 10%, and 20% are the percentages of the malicious nodes.

5.2 Performance Analysis of the proposed method with 10% and 20% Malicious Nodes

Figure 3, number of clusters formed at different ranges of malicious nodes present in the network. The increased number of clusters reduces the packet loss and end to end delay.

Figure 4 depicts the graphical representation of the average packet delivery ratio of the proposed model at 10% and 20% malicious node in the network.

Figure 5 depicts the graphical representation of the remaining energy consumption in joules of the proposed model at 10% and 20% malicious node in the network.

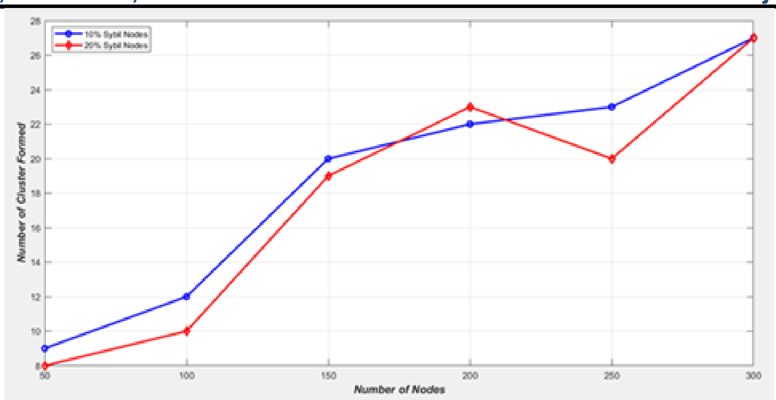

Figure 3: Graphical Representation of the Number of Clusters formed at 10% and 20% Malicious Node in the network by proposed protocol method

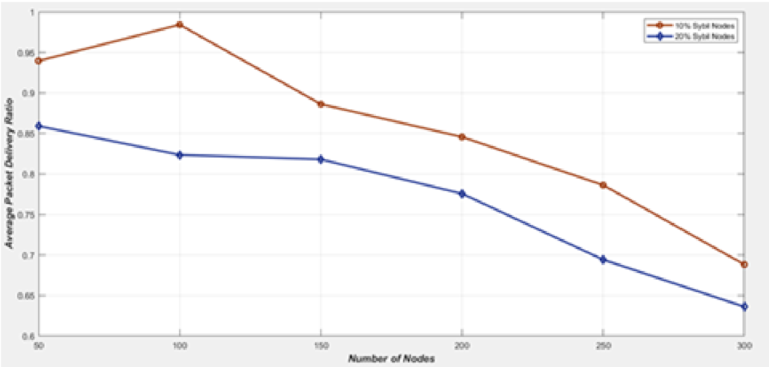

Figure 4: Graphical Representation of the average packet delivery ratio at 10% and 20% Malicious Node in the network by proposed protocol method

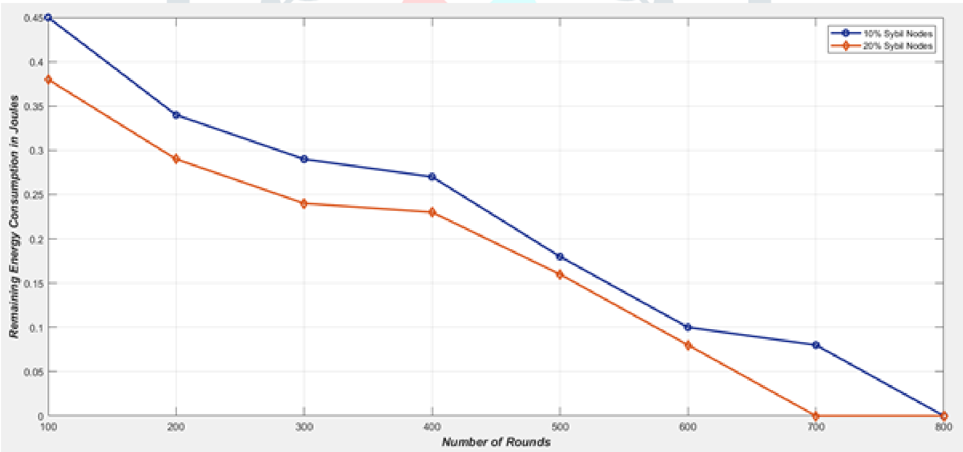

Figure 5: Remaining Energy Consumption in joules at 10% and 20% Malicious Node in the network by proposed protocol method

VI. CONCLUSION

In the research work, a novel cluster-based traffic analysis method has proposed to transmit the packet in the expansive network and the detection of the malicious node. The trust value calculation method has performed in this methodology, to know the trust of the neighboring nodes in the network. The malicious node has discarded from the network. The packet delivery ratio, detection rates are increased when the number of nodes as well as the number of malicious nodes presented in the network. The false positive rate has decreased by this method.

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