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Resource Allocation for Multi-user Multi-Traffic Class in UWB MANET

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Abstract- In this paper we propose to design a Resource allocation for Multi-user Multi-Traffic technique for UWB ad hoc networks as an extension work to MAC protocol for UWB MANET, which combines the DEX Protocol with DU-MAC protocol. Initially the incoming traffic is classified according to their QoS requirements. The packets with strict QoS constraints (like real-time video or voice) are stored in a special queue and other packets are stored in a normal queue. Then resource allocation is done according to packet reception rate (PRR) and queue size. Our work in the paper includes an algorithm for classification of packets, mechanisms for resource allocation for multi-user environment besides estimation of probability of error rate. Our extensive simulations revealed that the proposed approach outperforms existing one in terms of average packet delivery ratio, average end-to-end-delay, packet drop, overhead.

Keywords- *UWB MANET, Scheduling, Multi-user*

1. Introduction

1.1 MANET

Mobile Ad Hoc network (MANET) is a wireless network which made up of collection of mobile nodes connected by wireless links called mobile ad hoc networks that dynamically form a network with no infrastructure or centralized administration such as base stations or access points or centralized administration [1]. MANET is a self-configuring system of mobile routers linked by wireless links which consequently combine to form an arbitrary topology. The mobility of the routers are provided randomly and organized themselves arbitrarily. MANET has various potential applications, such as emergency search-rescue operations, meeting events, conferences, and battlefield communication between moving vehicles and/or soldiers [2] [3].

Issues:

- Error-prone channel state
- Hidden problem
- Exposed terminals
- Bandwidth-constrained, variable capacity links
- Energy-constrained operation
- Security Issues

1.2. Scheduling in UWB

Ultra-wide band (UWB) is an emerging radio technology or wireless network. According to the FCC, an ultra-wideband transmission has a bandwidth that is larger than 25% of the carrier frequency [4]. Wireless network design deals with the issues of scheduling at the link layer and relaying of data packets (routing) at the network layer. At the link layer, the resources to be allocated are access to the wireless medium and the power of transmission [5] [6].

1.3 Resource Allocation and Scheduling in UWB MANET

The maximum acceptable UWB transmission power is restricted to a very small value, since UWB exchanges the same frequency band with other existing wireless communication systems .Consequently, short-distance communications or mobile ad-hoc networks (MANETs) are the main uses considered. MANETs do not require any infrastructure, a feature which allows for instant deployment and rerouting of traffic around failed or congested nodes [3]

Since in MANETs it is unnecessary to deploy base stations, the cost of a MANET system is expected to be considerably lower than the corresponding cost of a cellular infrastructure. Furthermore, fault-tolerance of this type of networks is also significantly improved. MANETS can be reconfigured to adapt its operation in diverse network environments [7].

1.4 Problem Identification

In our previous work, we have proposed a MAC protocol for UWB MANET which combines the DEX Protocol with DU-MAC protocol. For the exclusive regions (ER) calculation, this paper uses a blind discovery mechanism. By combination of these techniques, this paper finds a good solution for MAC protocol that has a low access delay. DEX protocol uses RTS and CTS frames and two protocols. A TXOP protocol is used for enhancement of the service. This paper has shorter access delays of neighboring users because of shorter time 'T' to transmit data/ACK. The proposed technique in this paper is able to consider node mobility. It has also shorter access delays of neighboring users because of shorter time 'T' to transmit data/ACK. In this paper, the value of the path loss exponent is accurately measured or estimated, so the value of D may not be optimal and paper, it needs to reduce the power consumption.

The remainder of the paper is structured as follows. Section 2 provides review of literature. Section 3 presents the proposed solution. Section 4 provides simulation results while section 5 concludes the paper.

2. Related work

P.Sangeetha and Dr.R.Mala [8] have proposed a cross-layer design that aware of UWB wireless channel conditions, time slot allocations at the Medium access control (MAC) layer, and MPEG-4 video at the APP layer. Therefore two cooperative sensing appliances, namely, AND and OR, are evaluated in terms of probability of detection, probability of false alarm, and then necessary sensing period. Furthermore, the impact of sensing scheduling to the MPEG-4 video transmission over wireless cognitive UWB networks were observed. In addition to this, the packet reception rate based resource allocation scheme explain the channel condition, target PRR, and queue status.

Dongsheng Ning et al [9] have introduced an UWB-based MAC protocol for wireless multimedia networks termed as UWB-based Receiver originated by MAC protocol with Packet aggregation and Selective retransmission (URMPS). The receiver initiated request, packet aggregation and selective retransmission are used to decrease the synchronization acquisition time and overhead. The combination of mutually exclusive area and time-hopping (TH) code is used to mitigate the interference caused by concurrent transmissions of multiple nodes. The problems of long acquisition time ,large overhead and high collision probability have been addressed most when designing such MAC protocols.

Tommaso Melodia, and Ian F. Akyildiz[10] have proposed a cross-layer communication design based on the time-hopping impulse radio ultra wideband technology. The objective is to provide flexibly QoS to heterogeneous applications in WMSNs, by leveraging and controlling interactions between different layers of the protocol stack according to applications requirements. WMSNs need the sensor network paradigm to be re-thought for the need for mechanisms to deliver multimedia content with a pre-defined level of quality of service (QoS)

Kuang-Hao Liu et al [6] have formulated an optimal scheduling problem for ultra wideband (UWB) networks like utility maximization problem, considering heterogeneous traffic characteristics and the fairness constraint, which was an NP-hard problem. The stochastic optimization problem by a metaheuristic, called the exclusive-region-based global search algorithm that avoid trapping into local optima with reasonable efficiency , complexity, and convergence speed. In addition ,the scheduling algorithm supports heterogeneous applications and guarantee the intra class and interclass fairness among competing flows. The utility function, defined as the user satisfaction level with respect to the allocated bandwidth, takes the link distance as the input parameter that may be noisy due to ranging errors.

Kuang-Hao Liu et al [11] have explored the unique characteristics of UWB communications from which a sufficient condition for scheduling concurrent transmissions in UWB networks. Thus the concurrent transmissions could be improved the network throughput if all senders were outside the exclusive regions of other flows. Hence the optimal scheduling problem for peer-to-peer concurrent transmissions in a WPAN was NP-hard, the induced computation load for solving the problem may not be minimum requirement to the network coordinator, commonly a normal UWB device with limited computational power. MANET issues and challenges explored in [12] and [13] also can help in relating with the work of this paper which is aimed at proposing a solution for resource allocation for Multi-user Multi-Traffic class in UWB MANET.

3. Proposed Solution

3.1 Overview

In this extension work, we propose to devise a Resource allocation for Multi-user Multi-Traffic technique for UWB ad hoc networks. Initially the incoming traffic is classified according to their QoS requirements. The packets with strict QoS constraints (like real-time vide or voice) are stored in a special queue and other packets are stored in a normal queue [9]. Then resource allocation is done according to packet reception rate (PRR) and queue size [8].

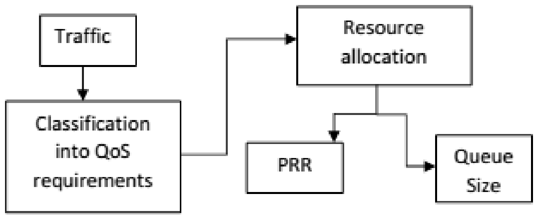

Fig 1: Block diagram

3.2 Classification of packets

Algorithm

1. Initially the incoming traffic is classified according to their QoS requirements.
2. After receiving packets the node initially classifies the data packets according to certain rules and stores them into the buffer queues.
3. The classification is performed according to the destination address and the QoS requirements of data.
4. Two queues are assigned for the packets, one queue is used to store the packets with QoS requirements and another queue is used to store the data packets without QoS requirements.
5. When the node finds out that packets without clear real-time requirements, the classification would be conducted only according to the destination address contained in data packets.
6. So that the packets with the same destination address will be buffered to the queue without QoS requirements.
7. If the packets are with the real-time requirements, the packets will be buffered to the corresponding queue with QoS requirements according to the destination address and QoS requirements.

3.3 Resource allocation

The resource allocation is done according to packet reception rate (PRR) and queue size. In PRR based resource allocation, optimal time slots are allocated to the users in terms of the estimated Probability of Error rate (PER) depending on the user class and its queue size. (ie) Priority is given for the users in the special queue and slots are allocated according to the channel condition and queue size.

3.3.1 Estimation of Probability of Error rate (PER) :

The probability of error in a packet of size K can be represented as,

$$PER_1(K) = 1 - (1 - BER)^K \quad (1)$$

The PER after n-retry is given by,

$$PER_2(K) = \left[1 - (1 - BER)^K\right]^n \quad (2)$$

3.3.2 Resource allocation for Multi-user Multi-Traffic technique:

In order to know the target PRR (PRR_T) and the instantaneous PRR (PRR_i) of each user *i*, the optimal time slot allocation is computed. The resource allocation is computed for each super frame.

Let L be the super frame size, the PRR based resource allocation is given by,

PRR_{T1}, PRR_{T2}, PRR_1, PRR_2, L

Let N1 and N2 be the Channel time allocation for user 1 and user 2,

$$N1 = \frac{L*(1-PRR_2)}{(a*(1-PRR_1)+(1-PRR_2))} \quad (3)$$

$$N2 = \frac{L*(1-PRR_1)}{(a*(1-PRR_1)+(1-PRR_2))} \quad (4)$$

Finally the resource allocation for the multi user case is given by,

$$MU_i = \frac{L+Q[Z]}{1+\sum_{j=0}^{j=MU} PER_i / PER_{j,j\neq i}} \quad (5)$$

where Q[Z] – Queue Size.

All users will be assigned optimal time slot in accordance to their own channel condition as well as other users channel conditions.

4. Simulation Results

4.1 Simulation Parameters

We use NS2 to simulate our proposed Resource Allocation for Multi-user Multi-Traffic (RAMM). We use the IEEE 802.11MANETs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage. In our simulation, the number of nodes is varied as 30,50,70,90 and 110. The area size is 1250 meter x 1250 meter square region for 50 seconds simulation time. The simulated traffic is Constant Bit Rate (CBR) and Exponential (Exp).

Our simulation settings and parameters are summarized in table 1

Table 1: Simulation parameters

No. of Nodes	30,50,70,90 and 110
Area	1250 X 1250
MAC	802.11
Simulation Time	50 sec
Traffic Source	CBR and EXP
Rate	100Kb
Propagation	TwoRayGround
Antenna	OmniAntenna

4.2 Performance Metrics

We evaluate performance of the new protocol mainly according to the following parameters. We compare the CLA protocol with our proposed RAMM protocol.

Average Packet Delivery Ratio*:* It is the ratio of the number of packets received successfully and the total number of packets transmitted.

Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Overhead: It is the number of router packets transmitted during the transmission.

Packet Drop*:* It is the number of packets dropped during the data transmission

4.3 Results & Analysis

The simulation results are presented in the next section.

A. Based on Nodes (CBR)

In our experiment we are varying the number of nodes as 30,50,70,90 and 110 for CBR traffic.

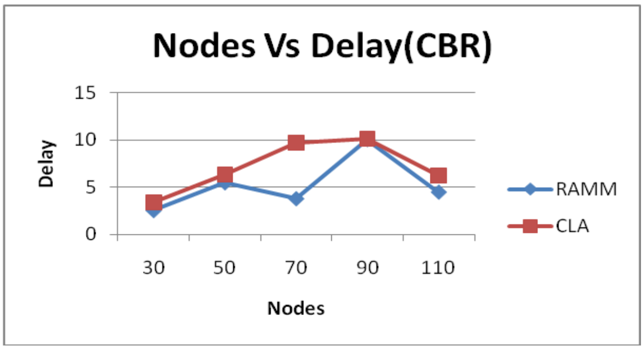

Fig 2: Nodes Vs Delay

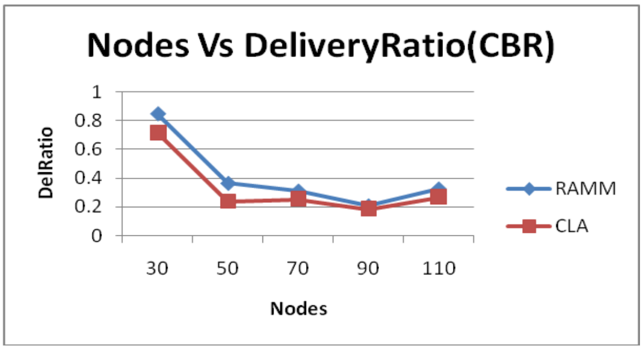

Fig 3: Nodes Vs Delivery Ratio

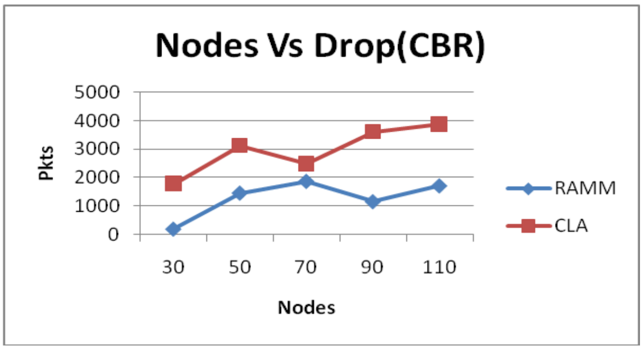

Fig 4: Nodes Vs Drop

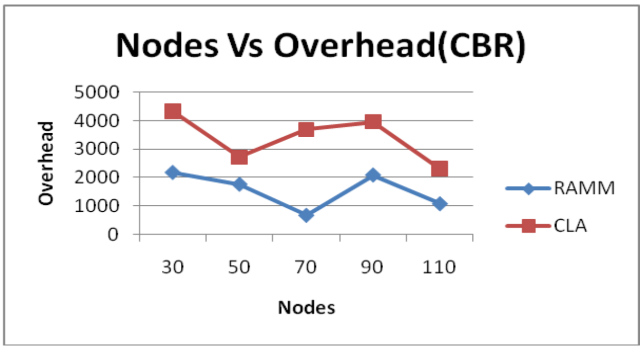

Fig 5: Nodes Vs Overhead

Figures 2 to 5 show the results of delay, delivery ratio, packet drop and overhead by varying the number of nodes from 30 to 110 for the CBR traffic in RAMM and CLA protocols. When comparing the performance of the two protocols, we infer that RAMM outperforms CLA by 26% in terms of delay, 19% in terms of delivery ratio, 58% in terms of packet drop and 53% in terms of overhead.

B. Based on Nodes (EXP)

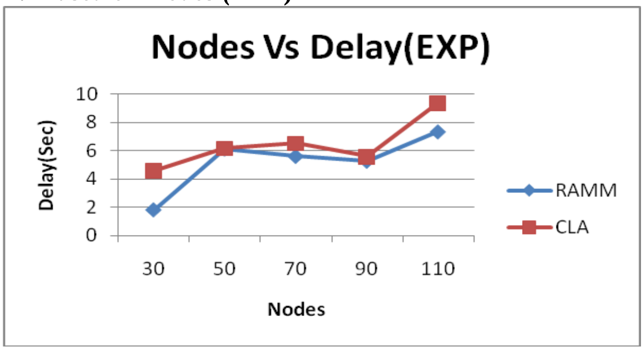

Fig 6: Nodes Vs Delay

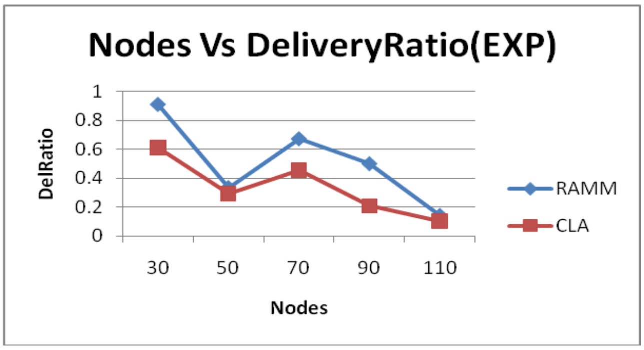

Fig 7: Nodes Vs Delivery Ratio

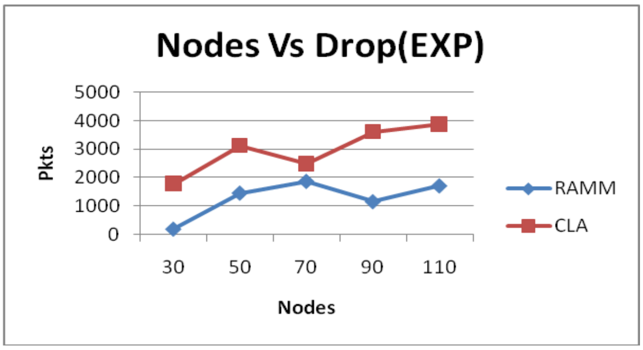

Fig 8: Nodes Vs Drop

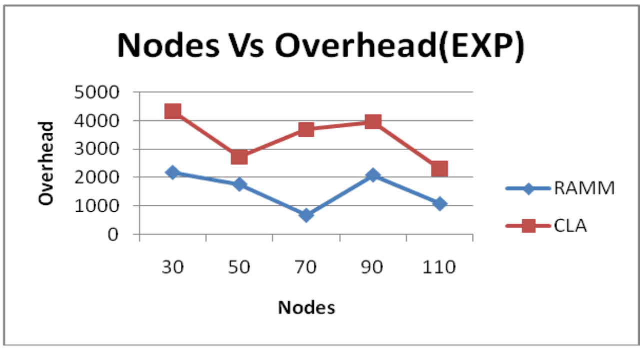

Fig 9: Nodes Vs Overhead

Figures 6 to 9 show the results of delay, delivery ratio, packet drop and overhead by varying the number of nodes from 30 to 110 for the CBR traffic in RAMM and CLA protocols. When comparing the performance of the two protocols, we infer that RAMM outperforms CLA by 21% in terms of delay, 33% in terms of delivery ratio, 58% in terms of packet drop and 53% in terms of overhead.

5. Conclusion

In this paper we designed a Resource allocation for Multi-user Multi-Traffic technique for UWB ad hoc networks as an extension work to MAC protocol for UWB MANET which combines the DEX Protocol with DU-MAC protocol. Initially the incoming traffic is classified according to their QoS requirements. The packets with strict QoS constraints (like real-time video or voice) are stored in a special queue and other packets are stored in a normal queue. Then resource allocation is done according to packet reception rate (PRR) and queue size. The simulation results revealed improved performance in terms of packet delivery ratio, delay, packet drop and overhead. By performing good result and determining regions reserved for communications in UWB channels we further insert received signal strength indicator for future work.

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