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Throughput Performance of ALOHA and CSMA MAC Protocol in Power for Wireless Ad Hoc Networks

R. Manikandan
Dept.of Computer Science & Engg
Annamalai University,
Chidambaram
e-mail: rmkmanikandan {at} yahoo.co.uk

K. Selvakumar
Dept.of Computer Science & Engg
Annamalai University,
Chidambaram.

***Abstract*— Power conservation and throughput management is a major issue in Mobile Ad Hoc Networks. In the design of wireless ad hoc networks, various techniques are applied to efficiently allocate the scarce resources available for the communication links and the power control and throughput management is not related to any particular layer in the layered design communication protocol design. But most of the power control and throughput management mechanisms are working in MAC layer. An adaptive CSMA medium access control (MAC) protocol is proposed to consider a spatial network model in which nodes are randomly distributed in space, and address the problem of interference, power control, and throughput improvement through CSMA MAC layer design. Power control and throughput improvement is a critical issue to implement Mobile Ad Hoc networks. The proposed method present a novel power control protocol, and improve the aggregate throughput of the network for its possible application in Mobile Ad Hoc networks.**

Keywords—component; formatting; style; styling; insert *(key words)*

I. Introduction

Since the devices used in an ad hoc network are mostly battery powered, power conservation is a major issue of such networks. The following principles may serve as general guidelines for power conservation in MAC protocols. First, collisions, a cause of expensive retransmissions should be avoided as far as possible. Second, the nodes should be kept in standby mode or sleep mode whenever possible. Third, instead of using the maximum power, the transmitter should use a lower power that is enough for the receiver node to receive the transmission.

In this context we mentioned above, the MAC protocols can be classified into two: Power management protocols (using alternative sleep and wake up modes for nodes) and power control protocols (variation in transmit power). The nodes in the ad hoc network remain in one of the three possible states: active, idle or sleep. Power consumption in sleep state is less compared to other two states. So we keep some of the nodes those are not participating in data transmission in sleep mode. In a network power is consumed during computation and transmission of packet, but computation power is negligible as compared to transmission power cost. Hence efforts are made to control the transmission power by incorporating different power control mechanisms.

In this thesis we have designed a MAC protocol for reducing the power consumed by each and every node. This protocol also increases the aggregate throughput of the network. The power control approach discussed above is used for the design of the protocol. For improving the throughput, we should improve the spatial reuse of the network. We achieved this by make some modifications in the VCS scheme used in IEEE 802.11. Improving the spatial reuse allows more nodes to send frames at a time and which will increase the overall throughput of the network.

II. Problem Definition

A. About the problem

Since nodes in an ad hoc network are limited battery powered, power management is an important issue in such networks. Battery power is a precious resource that should be used effectively in order to avoid the early termination of nodes. Power management deals with the process of managing resources by means of controlling the battery discharge, adjusting the transmission power, and scheduling of power sources so as to increase the life time of nodes in the ad hoc networks. Battery management, transmission power management and system power management are three major methods to increase the life time of nodes.

The main reasons for power management in ad hoc networks are the following:

Limited Energy Reserve: The main reason for the development of ad hoc networks is to provide a communication infrastructure in environments where the setting up of fixed infrastructure is impossible. Ad hoc networks have very limited power resources. The increasing gap between the power consumption requirements and power availability adds to the importance of energy management. Difficulties in Replacing Batteries: In some situations, it is very difficult to replace or recharge batteries. Power conservation is essential in such situations.

Lack of Central Coordination: The lack of central coordination necessitates some of the intermediate node to act as relay nodes. If the proportion of relay traffic is more, it may lead to a faster depletion of power source.

Constraints on the Battery Source: Batteries will increase the size of the mobile nodes. If we reduce the size of the battery, it will results in less capacity. So in addition to reducing the size of the battery, energy management techniques are necessary.

Selection of Optimal Transmission Power: The transmission power determines the reachability of the nodes. With an increase in transmission power, the battery charge also will increase. So it is necessary to select an optimum transmission power for effectively utilize the battery power.

Channel Utilization: The frequency reuse will increase with the reduction in transmission power. Power control is required to maintain the required SIR at receiver and to increase the channel reusability.

B. Objective

- To improve the performance of wireless Ad Hoc networks through Adaptive MAC layer design using CSMA protocol
- To implement the energy efficient MAC Protocol Design
- To Improve the throughput of Wireless Ad Hoc Networks
- To correct the reception of packets and thus the analysis is performed in terms of outage probability

III. RELATED WORKS

The performance of the ALOHA and CSMA MAC protocols are analyzed in spatially distributed wireless networks. The main system objective is correct reception of packets, and thus the analysis is performed in terms of outage probability. In our network model, packets belonging to specific transmitters arrive randomly in space and time according to a 3-D Poisson point process, and are then transmitted to their intended destinations using a fully-distributed MAC protocol. A packet transmission is considered successful if the received SINR is above a predefined threshold for the duration of the packet. Accurate bounds on the outage probabilities are derived as a function of the transmitter density, the number of backoffs and retransmissions, and in the case of CSMA, also the sensing threshold. The analytical expressions are validated with simulation results. For continuous-time transmissions, CSMA with receiver sensing (which involves adding a feedback channel to the conventional CSMA protocol) is shown to yield the best performance. Moreover, the sensing threshold of CSMA is optimized. It is shown that introducing sensing for lower densities (i.e., in sparse networks) is not beneficial, while for higher densities (i.e., in dense networks), using an optimized sensing threshold provides significant gain. [1].

The performance of unslotted ALOHA and CSMA are analyzed in spatially distributed wireless networks. Users/packets arrive randomly in space and time according to a Poisson process, and are thereby transmitted to their intended destinations using a fully-distributed MAC protocol (either ALOHA or CSMA). An SINR-based model is considered, and a packet transmission is successful if the received SINR is above a threshold value for the duration of the packet. Accurate bounds to the probability of outage, which is a function of the density of transmissions, are developed for both MAC protocols. These bounds are used to evaluate the performances of ALOHA and CSMA, and to gain insight into the design of general MAC protocols for ad hoc networks. Moreover, CSMA with receiver- sensing is proposed to improve the performance of CSMA. [2].

Outage probabilities and single-hop throughput are two important performance metrics that have been evaluated for certain specific types of wireless networks. However, there is a lack of comprehensive results for larger classes of networks, and there is no systematic approach that permits the convenient comparison of the performance of networks with different geometries and levels of randomness. The uncertainty cube is introduced to categorize the uncertainty present in a network. The three axes of the cube represent the three main potential sources of uncertainty in interference-limited networks: the node distribution, the channel gains (fading), and the channel access scheme (set of transmitting nodes). For the performance analysis, a new parameter, the so-called spatial contention, is defined. It measures the slope of the outage probability in an ALOHA network as a function of the transmit probability p at p = 0. Outage is defined as the event that the signal-to-interference ratio (SIR) is below a certain threshold in a given time slot. It is shown that the spatial contention is sufficient to characterize outage and throughput in large classes of wireless networks, corresponding to different positions on the uncertainty cube. Existing results are placed in this framework, and new ones are derived. Further, interpreting the outage probability as the SIR distribution, the ergodic capacity of unit-distance links is determined and compared to the throughput achievable for fixed (yet optimized) transmission rates. [3].

The upper and lower bounds on the transmission capacity of spread-spectrum (SS) wireless ad hoc networks are derived. We define transmission capacity as the product of the maximum density of successful transmissions multiplied by their data rate, given an outage constraint. Assuming that the nodes are randomly distributed in space according to a Poisson point process, we derive upper and lower bounds for frequency hopping (FH-CDMA) and direct sequence (DS-CDMA) SS networks, which incorporate traditional modulation types (no spreading) as a special case. These bounds cleanly summarize how ad hoc network capacity is affected by the outage probability, spreading factor, transmission power, target signal-to-noise ratio (SNR), and other system parameters. Using these bounds, it can be shown that FH-CDMA obtains a higher transmission capacity than DS-CDMA on the order of $M^{1-2}\alpha/$, where M is the spreading factor and $\alpha>2$ is the path loss exponent. A tangential contribution is an (apparently) novel technique for obtaining tight bounds on tail probabilities of additive functionals of homogeneous Poisson point processes. [6].

A MAC protocol for mobile ad hoc networks that uses power control for the RTS/CTS and DATA frame transmissions in order to improve energy and capacity utilization efficiency. Unlike IEEE 802.11, in our scheme the RTS frames are not sent using the maximum transmission power to silence neighboring nodes, and the CTS frames do not silence all receiving nodes to the same degree. In contrast, the transmission power of the RTS frames follows a slow start principle, while the CTS frames, which are sent at maximum transmission power, prevent the neighboring nodes from transmitting their DATA frames with power more than a computed threshold, while allowing them to transmit at power levels less than that threshold. This is done by including in the RTS and the CTS frames additional information, such as the power of the transmissions, and the interference tolerance of the nodes. Moreover the DATA frames are sent at the minimum required transmission power increased by a small margin to ensure connectivity with the intended receiver, so as to cause minimal interference to neighboring nodes and allow for future interference to be added to the receiver of the DATA frames. The power to be used by the transmitter is computed by the recipient of the RTS frame and is included in the CTS frame. It is expected that a network with such a power management scheme would achieve a better throughput performance and more power savings than a network without such a scheme. [7].

Mobile ad-hoc networking involves peer-to-peer communication in a network with a dynamically changing topology. Achieving energy efficient communication in such a network is more challenging than in cellular networks since there is no centralized arbiter such as a base station that can administer power management. We propose and evaluate a power control loop, similar to those commonly found in cellular CDMA networks, for ad-hoc wireless networks. We use a comprehensive simulation infrastructure consisting of group mobility, group communication and terrain blockage models. A major focus of research in ad-hoc wireless networking is to reduce energy consumption because the wireless devices are envisioned to have small batteries and be incapable of energy scavenging. We show that this power control loop reduces energy consumption per transmitted byte by 10-20%. Furthermore, we show that it increases overall throughput by 15%. [8].

PARO, a power-aware routing optimization that helps to minimize the transmission power needed to forward packets between wireless devices in ad hoc networks. Using PARO, one or more intermediate nodes called "redirectors" elects to forward packets on behalf of source-destination pairs thus reducing the aggregate transmission power consumed by wireless devices. PARO is applicable to a number of networking environments including sensor networks, home networks and mobile ad hoc networks. In this paper, we present the detailed design of PARO and evaluate the protocol using simulation and experimentation. We show through simulation that PARO is capable of outperforming traditional broadcast-based routing protocols (e.g., MANET routing protocols) due to its power conserving point-to-point on-demand design. We discuss some initial experiences from an early implementation of the protocol in an experimental wireless testbed using off-the-shelf radio technology. [12].

IV. System Analyses

A. Existing System

In the design of wireless ad hoc networks, various techniques are applied to efficiently allocate the scarce resources available for the communication links. Using an appropriate medium access control (MAC) protocol is one such technique. Taking into account the system's quality of service (QoS) requirements, a MAC protocol for ad hoc networks shares the medium and the available resources in a distributed manner, and allows for efficient interference management.

In this method, consider a spatial network model in which nodes are randomly distributed in space, and we address the problem of interference through MAC layer design. The ALOHA and CSMA MAC protocols are employed for communication, and the success rate of packet transmissions is investigated.

The performance of the ALOHA and CSMA MAC protocols are analyzed in spatially distributed wireless networks. The main system objective is correct reception of packets, and thus the analysis is performed in terms of outage probability. In this network model, packets belonging to specific transmitters arrive randomly in space and time according to a 3-D Poisson point process, and are then transmitted to their intended destinations using a fully-distributed MAC protocol.

B. Proposed System

Power conservation is a major issue in Mobile Ad Hoc Networks, as most of the nodes are battery powered. Power control is not related to any particular layer, since power conservation methods can be applied on all layers. But most of the power control mechanisms are working in MAC layer. The adaptive MAC protocol design is proposed to Control Power and Throughput for wireless Ad-Hoc network.

The primary aim of the proposed method is to control the overall power consumption and the then improve the throughput of the network. Thus proposed protocol method includes two phases; in the first phase, reduce the power consumption and in the second phase improves the aggregate throughput of the network. The proposed method is based on the IEEE 802.11 CSMA MAC protocol. In this approach, IEEE 802.11 CSMA added with an additional field to the RTS and CTS control packets (PRTS in RTS packet to indicate the power used to send RTS packet and PData in the CTS packet to indicate the power with which sender can send DATA packet) for the design purpose.

For reducing the power consumption we used the following method: sends the RTS packet with maximum or default power. The receiver after receiving the RTS packet calculate the data transmission power PData using the received power Pr , RTS transmission power PRTS and the receiving threshold Rth. After calculating the PData that power is assigned to the PData field of the CTS frame and then the CTS frame will send with the same power PData. Then after receiving the CTS frame the sender will send the DATA frame using the power PData and the receiver will send the ACK packet with the same power.

Next is to improve the throughput of the network. For this purpose, added the virtual carrier sensing mechanism. In this approach, uses a NAVR with NAV to make the VCS scheme suitable for MAC protocol. It makes more nodes to send packets at a time and thus improves the spatial reusability. The improvement in spatial reusability increases the aggregate throughput of the network.

V. DESIGN AND IMPLEMENTATION

A. System Architecture

Nodes in an ad hoc network share a common broadcast channel. Since the bandwidth available for communication in such networks is limited, access to this shared medium should be controlled in such a manner that all nodes receive a fair share of the available bandwidth. A different set of protocols is required for controlling the access to shared medium in ad hoc networks, because they need to address unique issues such as mobility, limited bandwidth, hidden and exposed terminal problems etc.The structural diagram of the ad-hoc node model and the adaptive CSMA MAC module is given below.

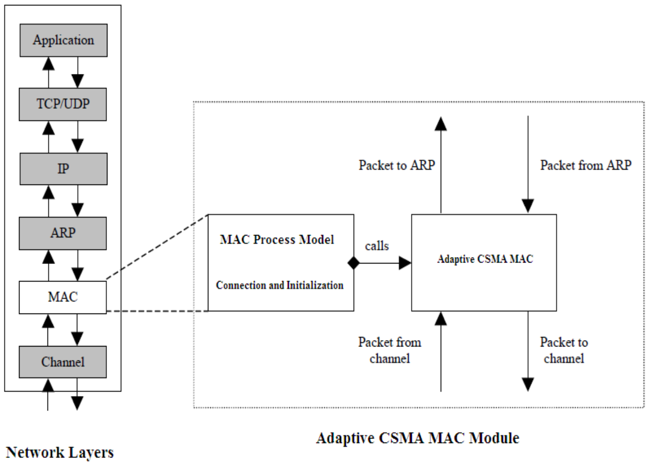

Figure 1 . Node Model Architecture

The MAC module consists of a generic MAC process model and the MAC process model. The MAC is designed to interact with the IP/ARP module and also possible for it to be integrated into a self-implemented higher module. The generic MAC process model invokes a MAC protocol process model to control the packet flow in the medium. The generic MAC process model to call the MAC protocol models is to enable us to reuse part of the MAC model and to allow the users to select different protocols from the network model rather than from the node model.

B. Module Descriptions

The modules which are to be implemented in this project are given below.

B.1 Analysis and design of Wireless ad hoc network

A wireless ad-hoc network is a decentralized type of wireless Network. The network is ad hoc because it does not rely on a preexisting infrastructure. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. In addition to the classic routing, ad hoc networks can use flooding for forwarding the data.

B.2 Cooperative diversity in wireless Ad hoc Networks

Cooperative diversity is a novel technique proposed for conveying information in wireless ad hoc networks, where closely located single-antenna network nodes cooperatively transmit and/or receive by forming virtual antenna arrays. For its building blocks, the relay channel and the two-transmitter, two-receiver cooperative channel, we survey the latest advances made in determining the theoretical capacity bounds and describe the best practical code designs reported so far. Since communication over a wireless channel is limited by interference, fading, multipath, path loss, and shadowing, the main design challenge lies in devising communication methodologies in a decentralized network to overcome these limitations. An additional design issue has to do with the high dynamics of an ad hoc network, where nodes frequently join and leave the network.

B.3 Implementation of MAC (CSMA-MAC) protocol

Due to the poor performance of unslotted ALOHA, a new MAC protocol, termed Carrier-Sensing Multiple Access (CSMA), was proposed more than 30 years ago. By introducing channel sensing and the ability to back off from transmissions, the performance of wireless networks was greatly improved. Moreover, several modifications were proposed in order to overcome the inherent hidden and exposed node problems of CSMA. By allowing some kind of communication between the TX and its RX, throughput improvement was achieved. And extended the work to consider point-to-point wireless ad hoc networks and we evaluate the OP performance of CSMA.

In this design, a packet is backed off if the measured or estimated (depending on whether the RX or TX are sensing) SINR is below the sensing threshold, $\beta sens$, at the beginning of its transmission. Up to a maximum of M times, the packet then waits a random time before the channel is sensed again and a new decision is made. Once initiated, but received in error at its RX, the packet is retransmitted. This is repeated N times before the packet is dropped.

B.4 Outage Probability of CSMA

The total OP of CSMA may be expressed as

$$P_{out}(CSMA) = P^M{}_b+(1-P^M{}_b)P_{rt1}\, P^N{}_{rt} \;;$$

and the density of packets attempting to access the channel is

$$\lambda_{csma}(P_b,P_{rt1},P_{rt}) = \lambda[(1-P^M{}_b/1-P_b) + (1-P^M{}_b)P_{rt1}(1-P^N{}_{rt}/1-P_{rt})];$$

Where P_{rt1} is the probability that an activated packet is received erroneously at its first transmission attempt and must be retransmitted, and P_{rt} is the probability of error in the retransmission attempts.

Due to the backoff property of CSMA, and since packets tagged for retransmission do not perform new channel sensing, multiply λ_{csma} by $(1 - P_b)$ to find the density of active packets:

$$\lambda_{active}(P_b,P_{rt1},P_{rt}) = \lambda(1-P^M{}_b+(1-P^M{}_b)P_{rt1}(1-P_{rt}{}^N/1-P_{rt}));$$

B.5 CSMA with Transmitter Sensing

In the conventional CSMA protocol, which is employed in many of today's network standards, such as IEEE 802.11 and 802.16, the TX is the backoff decision maker. That is, when a new packet arrives, the TX immediately measures the aggregate interference power. If this is greater than it $({}_\rho R^{-\alpha}/\beta - \eta)$, backs off, otherwise, it starts transmitting.

$P_b \approx \tilde{P}_b$ is the backoff probability, and is found as the solution to,

$$\tilde{P}_b = 1-e^{-\lambda}(1- \tilde{P}_b{}^M + (1- \tilde{P}_b{}^M)\tilde{P}_{rt1}(1- \tilde{P}^N{}_{rt1}/1-P_{rt})\pi s^2$$

$P_{rt} \approx \tilde{P}_b + (1 - \tilde{P}_b)\, \tilde{P}^{TX}{}_{during}$ is the probability that an activated packet is received erroneously in a retransmission attempt, with) $\tilde{P}_{during}$ being the probability that the error occurs at some $t \in (0, T\,)$,

$$\tilde{P}^{TX}{}_{during} = 1-e^{-\int s_{s-R}\, \lambda_{csma[2\pi-2\cos^{-1}(r^2+R^2-s^2/2Rr)]r\, dr}}$$

$$P_{rt1} \approx \tilde{P}_{rx|transmit} + (1- \tilde{P}_{rx|transmit})\, \tilde{P}^{TX}{}_{during}$$

is the probability that an activated packet is received erroneously at the first transmission attempt, $\tilde{P}_{rx|transmit}$ with being the probability that the RX is in outage upon the packet arrival, given its TX decides to transmit,

$$\tilde{P}_{rx|transmit}=\tilde{P}_b[1-1/\,\pi s^2(2s^2\cos^{-1}(R/2s)-Rs\sqrt{(1-R^2/4s^2)})]$$

B.6 CSMA with Receiver Sensing

With the objective of improving the performance of CSMA, introduced a novel protocol, termed CSMARX. In this protocol, the RX senses the channel and subsequently determines whether or not the packet transmission should be initiated. The communication between the TX and RX is assumed to occur over a separate 1 bit control channel, and the delay introduced by the feedback is assumed to be small and insignificant compared to the packet length.

$P_b \approx \tilde{P}_b$ is the backoff probability and $P_{rt} \approx P_b + (1-P_b)\, P^{RX}{}_{during}$ is the probability that an activated packet is received erroneously some time during its transmission and must thus be retransmitted,

$$\tilde{P}^{TX}{}_{during} = 1-e(-\int^s{}_s-R\int^{2\pi-v(r)}{}_{v(r)}\, \lambda_{csma}P(active|r,\varphi)rd\varphi dr)$$

$P(active|r,\varphi) = 1-1/\pi \;\cos^{-1}\; (r^2+2R^2-s^2-2Rr\cos\varphi/2R\sqrt{r^2+R^2-2Rr\cos\varphi}),$

$V(r) = \cos^{-1} (r^2+2Rs - s^2/2Rr).$

B.7 Optimizing the Sensing Threshold

Our objective is to optimize the sensing threshold, $\beta sens$, of CSMA in its various incarnations, in order to minimize the OP. In the analysis thus far, design used a constant sensing threshold, namely $\beta sens = \beta req = \beta = 0$ dB. In this design, we take into account variations in $\beta sens$. For the sake of readability of the formulas, we denote $ssens$ by s. Initially, we assume that βreq stays constant, while $\beta sens$ varies. Next-C, set $\beta sens = \beta req$, and allow both the thresholds to vary.

B.8 Optimizing Transmitter Sensing Threshold

When s varies, it results in changes in the area of $B(TX0, s)$. This impacts Pb, $Prt1$, and Prt, as seen below,

$$\tilde{P}^{TX}_{during} = \begin{cases} 1-e^{-\lambda csma}[\int^{R-s}_{0} 2\pi r dr + \int^{s}_{req\ R-s} [2\pi - 2\cos^{-1}(r^2+R^2-s^2/2Rr)]rdr] & ; s<R \\ 1-e^{-\lambda csma} \int^{s}_{req\ s-R} [2\pi - 2\cos^{-1}(r^2+R^2-s^2/2Rr)]rdr & ; R<=s<R+s_{req} \\ 0 & ; otherwise \end{cases}$$

$$\tilde{P}_{rx|transmit} = \begin{cases} P_{rx} - P_{rx}s^2/\pi s^2_{req} \cos^{-1} (R^2+s^2-s^2_{req}/2Rs) - P_{rx} 1/\pi \cos^{-1} (R^2-s^2_{req}-s^2/2Rs_{req}) + P_{rx}/2\pi s^2_{req} \sqrt{(s+s_{req}-R)(s-s_{req}+R)(-s+s_{req}+R)(s+s_{req}+R)}; & s<R+s_{req} \\ 0 & ; otherwise \end{cases}$$

$\tilde{P}_b \approx P_b$ and $\tilde{P}_{rx} = 1 - e^{-\pi\lambda active\ s2_{req}}$ is the approximate probability that the RX is in outage upon arrival in each retransmission attempt with $\lambda active$.

$P_{rt} \approx \tilde{P}_{rx} + (1- \tilde{P}_{rx}) \tilde{P}^{TX}_{during}$ is the probability that an activated packet is received erroneously in a retransmission attempt, with $\tilde{P}_{during}$ being the probability that the error occurs at some $t \in (0, T)$.

$P_{rt1} \approx P_{rx|transmit} + (1-P_{rx|transmit})$ is probability that the first transmission is erroneous, with $P_{rx|transmit}$ being the probability that the RX is in outage at the start of the packet.

Optimizing the sensing threshold in CSMATX yields an optimal tradeoff between the hidden and exposed node problems. An increase in one problem (by changing s) leads to a decrease in the other, and vice versa.

B.9 Optimizing Receiver Sensing Threshold

To improve the performance of CSMARX by optimizing the receiver sensing threshold.

$P_b \approx \tilde{P}_b$, $\tilde{P}_{rx}$, $\tilde{P}_{rt} \approx \tilde{P}_{rx} + (1- \tilde{P}_{rx}) \tilde{P}^{TX}_{during}$ is the probability that an activated packet is received erroneously in a retransmission attempt, with being the probability that the error occurs at some $t \in (0, T)$.

$Z(r) = \cos^{-1}(r^2-2Rs-s^2/2Rr)$,

$P_{rt1} \approx \tilde{P}_{rx|transmit} + (1- \tilde{P}_{rx|transmit}) \tilde{P}^{RX}_{during}$ is the probability that the first transmission attempt is erroneous, with $\tilde{P}_{rx|transmit}$ being the probability that the RX is in outage at the start of the packet;

$$\tilde{P}_{rx|transmit} = \begin{cases} P_{rx}[1-s^2/s^2_{req}] & ; s< sreq \\ 0 & ; otherwise \end{cases}$$

Our simulation results indicate that the optimal sensing threshold in CSMARX is $\beta sens = \beta req$ (equivalent to $ssens = sreq$). To understand this, consider w.l.o.g. the case of $(M,N) = (1, 0)$,

$$\tilde{P}_{total} = \tilde{P}_{out}(CSMA_{RX}) = \begin{cases} \tilde{P}_{rx} + (1- \tilde{P}_{rx}) \tilde{P}^{RX}_{during} & ;s<s_{req} \\ \tilde{P}_b + (1- \tilde{P}_b) \tilde{P}^{RX}_{during} & ; otherwise \end{cases}$$

B.10 Dependence of OP on the Required SINR Threshold

In this module, assumes that both the sensing threshold and the required SINR threshold are varying, while at the same time remaining equal, i.e., $\beta sens = \beta req = \beta$ (equivalently $ssens = sreq = s$).

The approximate probability that the RX is in outage at the start of its first transmission attempt, is:

$$\tilde{P}_{rx|transmit} = \begin{cases} P_{rx} & ;s<R/2 \\ P_{rx} [1- 2/\pi\cos^{-1}(R/2s) + R/\pi s\sqrt{1-(R/2s)^2}] & ; otherwise \end{cases}$$

The approximate probability that a packet goes into outage at some $t \in (0, T)$ is now given below,

$$\tilde{P}^{TX}_{during} = \begin{cases} 1-e^{-\lambda csma\ \pi s2} & ; s<R/2 \\ 1-e^{-\lambda csma}[\int^{R-s}_{0} 2\pi r\, dr + \int^{s}_{R-s} [2\pi - 2\cos^{-1} (r^2+R^2s^2/2Rr)]rdr] & ;R/2<s<R \\ 1-e^{-\lambda csma} \int^{s}_{s-R} [2\pi - 2\cos^{-1} (r^2+R^2-s^2/2Rr)]rdr & ; otherwise \end{cases}$$

B.11 Performance analysis

Extensive simulation results of the proposed CSMA-MAC protocol along with ALOHA. In the simulations, the source nodes always have data packets to send and the following performance metrics are evaluated.

- Throughput
- Energy efficiency

Finally, CSMA-MAC can significantly improve the performance of throughput and energy efficiency compared to ALOHA.

C. Diagrams

C.1 Data Flow Diagram

The data flow diagram of the ad-hoc node model and the adaptive CSMA MAC module is given below.

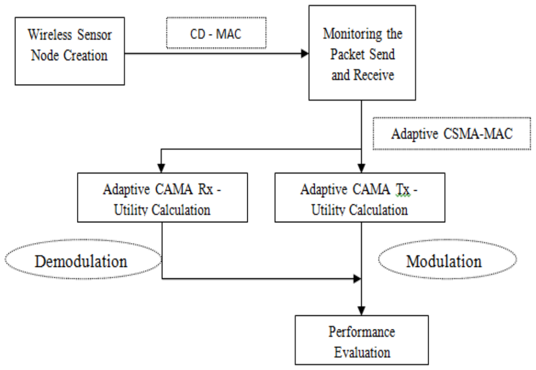

Figure 2. Data Flow diagram of the proposed system

VI. SYSTEM TESTING

The proposed implementation ``validated" in the root directory of the ns2 distribution and runs all the standard tests required to validate the protocols implementation in the most stable core of ns2. We ensure that validation passes on several different systems for each ns release, and run it over the daily snapshot.

The validation test encourages user to report problems with validated protocols on this implementation. This implementation resolves the problems rapidly as resources allow during the project implementation periods.

Even though ns2 supported protocols are ``validated", the test suite coverage is not complete. Users are advised to look at what aspects of the protocols are tested in the test suite before drawing research conclusions from these protocols.

Protocols and modules covered at least in part by validation include the following:

Application-level

- HTTP, web caching and invalidation, TcpApp
- telnet and ftp sources
- Constant-Bit-Rate (CBR) sources ,On/Off sources

Transport protocols (UDP, TCP, RTP, SRM)

- Basic TCP behaviour
- Tahoe, Reno, New-Reno, and SACK TCP under different losses
- FACK TCP
- TCP Vegas
- New-Reno TCP
- SACK TCP
- Full TCP partial validation only.
- TCP initial window behaviour
- rate-based pacing TCP
- RFC-2001 (Reno) TCP behaviour
- RTP
- SRM

Routing

- Algorithmic routing
- Hierarchical routing
- LAN routing and broadcast
- Manual routing
- Centralized multicast, DM multicast, not detailed DM, not multicast over Wireless LAN
- Routing dynamics
- Detailed simulation using virtual classifier
- Mixed-mode session-levels simulation
- Session-level simulation

Router Mechanisms (scheduling, queue management, admissions control, etc.)

- Several queue scheduling algorithms: FQ (Fair Queuing), SFQ (Stochastic Fair Queuing), DRR (Deficit Round Robin), FIFO (with drop-tail and RED queue management)
- CBQ (both in v1 and v2 mode)
- RED queue management
- ECN behaviour (and TCP interactions)
- admission control algorithms: MS, HB, ACTP, ACTO, parameter-based

Link-layer mechanisms

- Wireless LANs, with CSMA/CD MAC and ALOHA protocols

Other

- Error Modules

In addition there are a number of protocols in the standard ns distribution which are not covered by validation. Because they cannot be automatically tested, bit-rot sometimes breaks these protocols.

This implementation attempts to keep non-validated protocols working and welcome bug reports. Because of difficulties maintaining code that did not write and for which may not known the ``ground truth", and cannot promise that these protocols will remain working. This implementation strongly encourage people using these protocols in their research to examine their output carefully and implement test suites for them so that we can move them into the ``validated" categories.

Protocols and modules in the core but not validated include:

- Fack and Asym TCP
- RTCP
- RTP
- RLM (Receiver Layered Multicast)
- Token bucket filters
- Trace-generated sources

VII. RESULTS AND OBSERVATIONS

Screen Shots

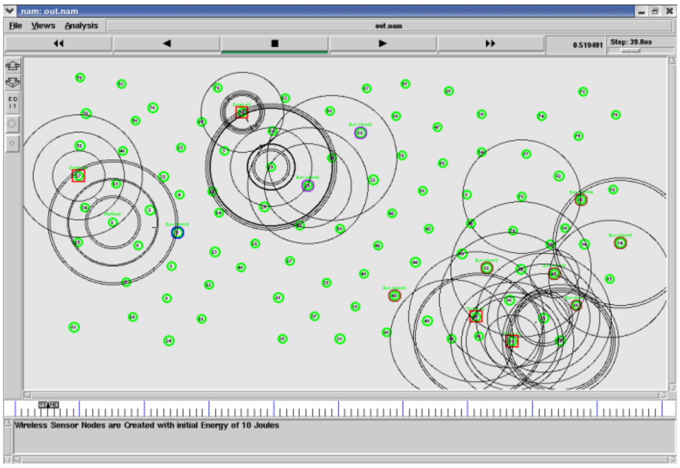

Figure 3. Wireless sensor nodes are created with initial energy of 10 Joules

In this figure,initially 100 nodes are created with 10 joules of equal energy for packet transmission.

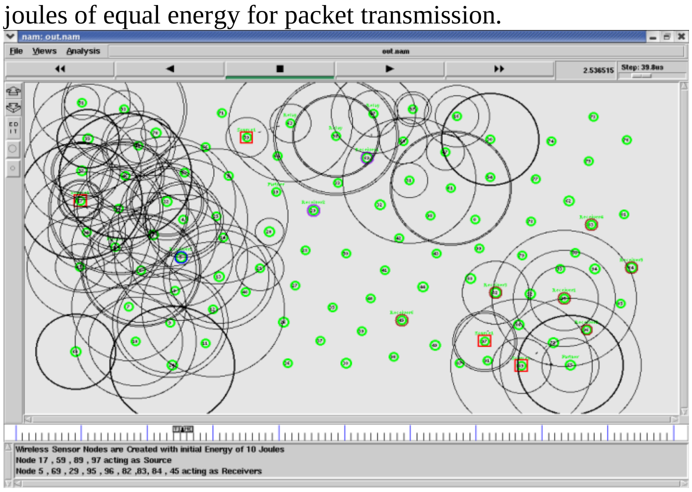

Figure 4. Nodes are acting as source and receivers

In this figure, wireless sensor nodes are acting as source and receivers

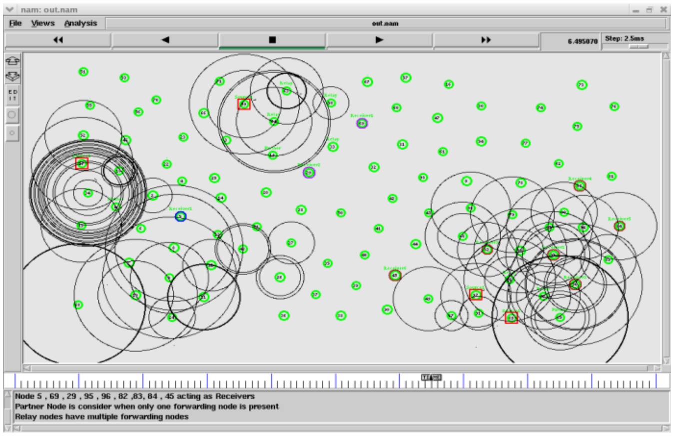

Figure 5. Partners and relay nodes are created for packets forwarding

In this figure,nodes are transmitting the packets through direct,partner and relay transmission types.

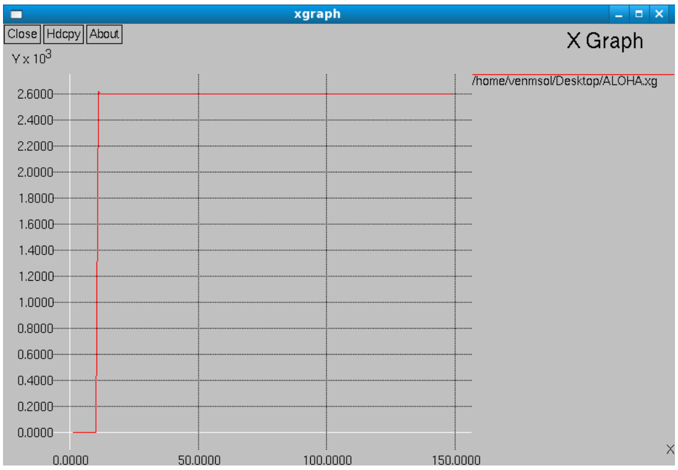

Figure 6 Aloha Throughput

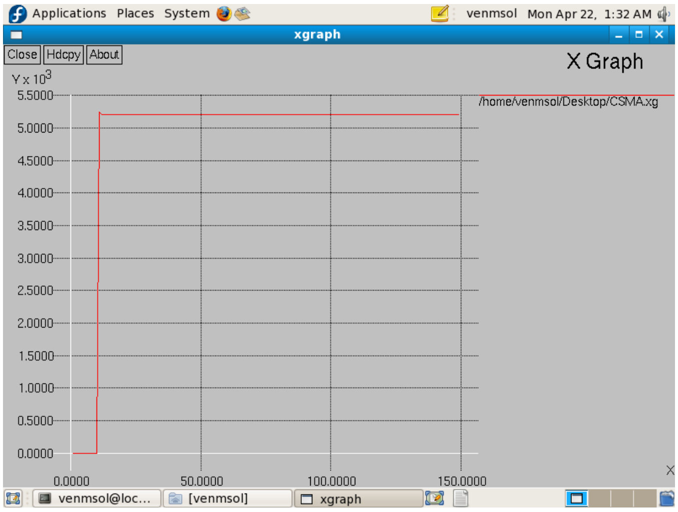

Figure 7 CSMA Throughput

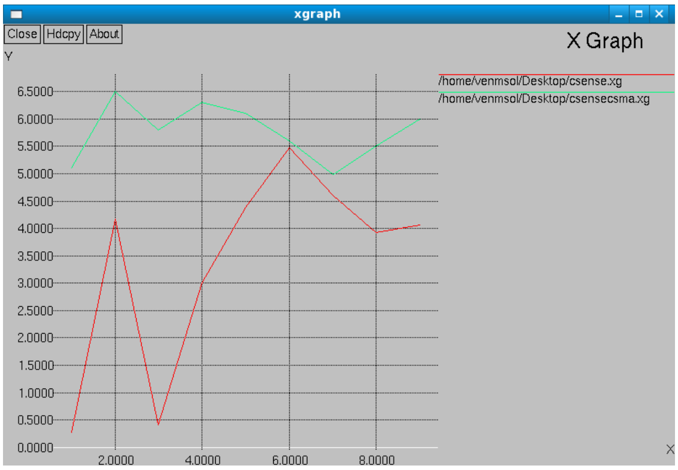

Figure 8 Power Conservation

VIII. CONCLUSION AND FUTURE WORK

In this proposed approach, a power control MAC protocol for Wireless Ad Hoc Networks was designed. This considered a network environment where every node participate in data transmission and applied a power control concept in that environment. The main goal of this work was to understand the different power conservation techniques in wireless Ad-Hoc Network and propose a protocol to achieve this goal.

Here the proposed a power control MAC protocol for mobile ad hoc net works which reduce the power consumption and increase the aggregate throughput. In this method, the 802.11 MAC protocol is modified to achieve our goal. For reduce the power consumption we have bused the transmission power control techniques. For improve the throughput, need to improve the spatial reuse of the network. Improvement in spatial reuse will make more simultaneous transmission possible and which will improve the throughput of the network. For this purpose, made some modifications in the virtual carrier sensing scheme of 802.11 MAC.

1.2 Future Enhancements

As wireless networks become more and more popular the increase of the users that demand high quality services by such networks is tremendous. But it faces some problems due to limited battery power of the mobile nodes. Since all mobile nodes are battery powered, need to use the power efficiently. In this proposed approach, consider a stable network environment for Wireless MAC design. Mobility of the nodes did not take into consideration. In future works can consider the mobility of the nodes to make it more suitable for mobile ad hoc networks.

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