Survey of Customized Medium Access Control Protocol for Co-operative Wireless Network

1Poorvi Behre, 2Prof. Pankaj Sahu
1EC Department, Gyan Ganga Institute of Technology and Sciences, RGPV Bhopal
2Assistant Professor ,EC Department, Gyan Ganga Institute of Technology and Sciences, RGPV Bhopal
poorvi20behre@gmail.com
pankajsahu@ggits.org

Abstract: **Wireless signals have an inborn broadcast nature, which makes it possible for the adjacent stations to overhear the transmissions destined for a particular node. When these neighboring stations help the transmissions by choosing a high data rate path (among various paths) instead of the low data rate path, then such a scheme is called a co-operative transmission scheme. The co-operative scheme always promises a higher throughput and lower delay performances at the cost of overhead. Here, a medium access control scheme known as Customized-MAC is proposed, where the neighbor i.e. the relay node is selected not only on the basis of higher data rate and reliability which are conveyed through the relay frame broadcasted by all the relay nodes. So, a better decision may be taken when deciding whom to co-operate with. This will make the overall system reliable and also increase the lifetime of the network.**

Keywords: **MAC, Wireless Network, Simulation, Relay Node, Co-operation.**

1. INTRODUCTION

1.1 The performance of any network measures in terms of different performance indicaters i.e. throughput, delay and the number of collisions. Overall goal of any research has been done in order to enhance the throughput of the network. One approach is DMA (Different MAC Service Data Unit size (MSDU) Adaptation) [7], where smaller MSDU size data packets are given to those stations whose transmission rates are lower. And larger MSDU size packets are given to those stations whose transmission rates are higher. Another approach is Different Initial Contention Window size Adaptation (DICWA) [3]. Here higher data rate stations have smaller initial contention window sizes, so the back-off counter reduces to zero rapidly which implies better chance to access the channel rapidly in preference to those stations which have lower transmission rates. Another approach was to combine both the above mentioned techniques [3].

Our approach to increase the throughput is, through co-operation. In this strategy the mobile nodes assist one another in the transmission of the data packets. The source node after occupying the channel transmits the data and if the transmission fails the neighbor nodes which overhear the transmission, transmits the data to the destination. This approach greatly enhances the throughput [8] and reduces the delay. Many other co-operative strategies have already been developed, in the past, and we would discuss them in the later sections.

1.2 Mobile Ad-hoc Network

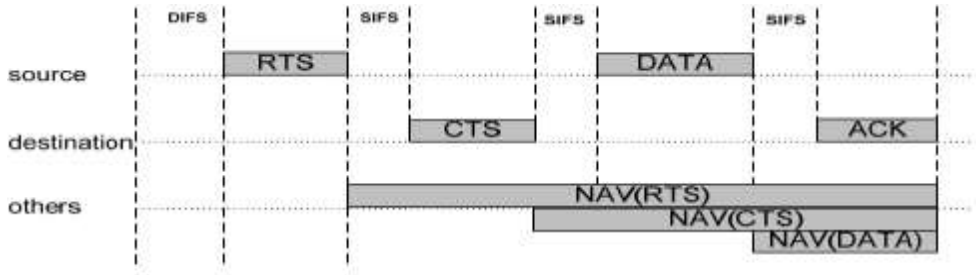
A Mobile Ad-hoc network [5] is distributed type of network and it does not rely on a pre-existing infrastructure, such as routers or access points. Here each node itself acts as a router to take its decision to route or relay the data packets.

1.3 Wireless Co-operative Network

In such type of network the neighboring nodes [10] located near the source and the destination help in the data transmission from the source to the destination .These neighboring nodes may be high data rate nodes and may improve the transmission by reducing the delay and improving the throughput.

1.4 Wireless Relay Node

A relay node is impotent concept, realize that [11] it is an intermediate node which is a neighbor or closer to both the source node and the destination node. The function of the relay node is to implement co-operation between the source and the destination to forward the data frame.



MAC Protocol CSMA/CA: Four Way Handshaking

1.5 MAC Protocols in Ad-hoc network:
In any wireless network [12], it is easy to know that ultimately a medium is shared among various users. So, a sensible decision is to be taken to efficiently utilize the scarce wireless medium so that delay is reduced and the throughput is enhanced. The accountability to take such a decision lies with the medium access control (MAC) layer which is a part of data link layer. Main reason of decrements in the performance of MAC protocols is hidden terminal problems, in which collisions may occur so MAC layer is responsible for keeping the collisions to its minimum.

In general MAC protocols are classified as Static and Dynamic protocols [6]. The examples of Static protocols are TDMA (Time Division Multiple Access), where a specific time slot is allocated to the users, FDMA (Frequency Division Multiple Access), where a specific frequency slot is allocated to the users and CDMA (Code Division Multiple Access), where the entire spectrum is utilized for transmission. In the literature There are two types of CSMA [4] protocols namely, CSMA/CD (Carrier Sense Multiple Access with collision detection) suitable for wired medium and CSMA/CA (Carrier Sense Multiple Access with collision Avoidance), suitable for wireless medium. The responsibility of MAC layer is reliable delivery of packets when the channel is noisy and unreliable. Two access mechanisms are used here. One is called PCF (Point Coordinated Function) and the other is called DCF (Distributed Coordinated Function). PCF uses a polling scheme and works on top of DCF. DCF is more widely used for the distributed network like an ad-hoc network.

1.6 MAC protocols with Relay Working on concept of relays started in 2003 with rPCF (Relay Point Co-ordinated Function) [1]. It has been decided that, If the direct link has a low data rate and there exists a relay node such that links from source to relay and relay to a destination provides better data rate , then transmission can proceed using the relay node. Further same concept has been applied in Distributed Co-ordination Function (DCF) by introducing rDCF (Relay Distributed Co-ordination.

2. LITERATURE SURVIEW

In [1] a modified medium access control protocol called CoopMAC have been presented, in which high data rate stations assist low data rate stations in their transmission by forwarding their traffic. In this protocol, each low data rate node maintains a table, called a CoopTable, of potential helper nodes that can assist in its transmissions. During transmission, each low data rate node selects either direct transmission or transmission through a helper node in order to minimize the total transmission time. In this work total network throughput increases with reduction in delay, if such cooperative transmissions are utilized.

In [2] multihop wireless networks (MWNs), the mobile nodes usually act as routers to relay other nodes packets to enable new applications and enhance network performance and deployment. In this work an incentive system is proposed to stimulate the nodes' cooperation in MWNs. A reactive receipt submission mechanism is proposed to reduce the number of submitted packet.

In [3] this paper, a new cooperative medium access control (MAC) protocol, which is termed the 2rcMAC protocol, is proposed for a small-sized network. The protocol makes use of two cooperating nodes to achieve superior throughput and delay performances, compared with the existing cooperative MAC protocols. The secondary relay path is invoked as a backup path. In this protocol two best relay(high data rate) have not chosen so it is

limited for small size n/w and throughput cannot be extended up to higher range.

In [4] as we know a wireless ad hoc network does not have an infrastructure so it needs the cooperation of nodes in forwarding other nodes' packets. In this a reputation system is used to give nodes incentives (credit value) to cooperate in packet forwarding which is an effective approach. In [5] a mathematical model has been proposed to describe the impact of the number of RSs (Relay Stations) on the channel capacity of two-hop relay n/w.

Impact of the number of RSs on the average link length between user and RSs have been analyzed.

Table 1 - Summary of literature survey

S.NO	Author	Journal Name	Scope	Research Finding
1	Murad Khalid, Yufeng Wang, In-ho Ra, and Ravi Sankar 2011	IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY [4]	This work can be used for small size network.	It is limited for small size n/w and throughput cannot be extended up to higher range.
2.	Mohamed Elsalih Mahmoud and Xuemin (Sherman) Shen 2010	IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY,VOL. 59,NO.8,OCTOBER2010 [6]	This protocol can be used where as routing overhead and congestion can be tolerated	Routing overhead increases due to increases in control packet which will also increases congestion in the n/w and also increasing possibility of the collision
3.	P.Liu, Z.Tao and S.Narayan 2007	International Journal of Selected Area in Communication [11]	Used in Ad-hoc Network, Vehicular Ad-hoc Network	Network throughput increases with reduction in delay
4.	Tingting Chen, Fan Wu, Sheng Zhong 2011	IEEE TRANSACTIONS ON COMPUTERS, [2]	Network in which nodes behavior is not predictable	After cooperation of nodes in forwarding other nodes' packets. nodes incentives (credit value) t of nodes increses which show the reliability of nodes and relay.
5	Zilong Jin, Weidong Su, Jinsung Cho Member, IEEE, and Een-Kee 2010	IEEE COMMUNICATIONS LETTERS [7]	Where we need precise value, we use this method	Impact of Relay Station have been analysed using mathematical model

3. PROPOSED SOFTWARE TOOL

3.1 Simulation: NS-2.34 shown [16] is widely used simulation tools for modeling ad-hoc networks. NS-2.34 has MAC implementations at user level in other words MAC is readily available to be used for any ad-hoc network scenario. If the proposed work is required to implement then the original implementation of MAC need to be modified. To modify the original implementation of these protocols, one has to comprehend the internal architecture of the simulation tool and the programming language used to implement the simulation tool. In order to use these simulation tools, more time is required to comprehend the internal architecture of the simulation tool before the implementation takes place.

In order to accurately depict the impact of various factors of routing protocol and its effect on the MAC protocol, it is necessary to simulate our work. We implemented our simulation in Network Simulator, Version 2 (NS-2.34), which is a discrete event simulator designed for networking research. The NS-2.34 simulator includes a simulation of both a physical layer (e.g., Wireless communication) and a median access layer (e.g., IEEE 802.11). NS-2.34 is supported by organizations such as DARPA, University of California, Berkeley, Xerox PARC, NSF and Sun Microsystems (NS2 homepage, 2000).

3.2 Standard Network Simulator (NS-2.34)

NS-2.34 [16] is the de facto standard for network simulation. Its behavior is highly trusted within the networking community. It is developed at ISI, California, and is supported by the DARPA and NSF. NS-2 is a discrete-event simulator organized according to the OSI model and primarily designed to simulate wired networks.

The support for wireless networking had been brought by several extensions. The Monarch CMU projects [Mon98] made available an implementation of the IEEE802.11 layers (Wi-Fi). N.S-2 provides a set a randomized mobility model, including random waypoint. These constitute a progress towards realistic simulation.

The core of NS-2 is a monolithic piece of C++ code. It is extendable by adding C++ modules. The configuration relies on OTCL (a dialect of TCL, developed by the MIT) scripts. NS-2 then appears to the user as an OTCL interpreter. More precisely, it reads scenarios files written in OTCL and produces a trace file in its own format. This trace needs to be processed by user scripts or converted and rendered using the NAM tool. We should be very thankful to its open source license and its popularity, new extensions are sporadically proposed. For example a physical model based on ray tracing and Markov chains. This extension, which can be very useful for Manet's simulation, makes the simulator to be about 100 times slower.

NS-2 is a sound solution for MANET simulation. Unfortunately it suffers from its lack of modularity as well as from its inherent complexity (NS-2 was a candidate to be the basis for the Quaint [6] simulator but got finally rejected). Indeed, adding components/protocols or modifying existing ones is not as straightforward as it should be. For a long time, NS-2 has been said to have few good documentation. The situation recently changed, as several users have put online their experience in the form of tutorials or example-driven documentations.
Another well-known weakness of NS-2 is its high consumption of computational resources. A harmful consequence is that NS-2 lacks scalability, which impedes the simulation of large networks (NS-2 is typically used for simulations consisting of no more than a few hundred nodes). Several projects have aimed at improving NS-2's runtime. For example, staged simulation [4] and parallelism has turned out to be efficient solutions used was NS-2 version 2.26 and reported their experience, as follows: the wireless ad-hoc version of NS-2 can handle a few hundred nodes, but the simulation time grows at least quadratic ally so more than just a few hundred is simply not feasible, in fact most current work is done simulating about 50 wireless nodes or less.

The Parallel/Distributed Networks Simulator, pdns, is developed at the Georgia Tech Institute, California. It aims at overcoming the limitation of NS-2 is regarding its scalability. Pdns boosts NS-2 processes by distributing the simulation over a network of closely coupled workstations (a common TCP/IP-based local area network is used).

More precisely, it achieves an efficient parallelization of the simulation process by making distinct instances of NS-2 simulating distinct sub-networks. Pdns is said to be able to simulate networks consisting of up to hundreds of thousands nodes.
Although its code (particularly its library of protocols) has not been validated entirely, it is a heavily trusted simulated among the community. The development of the next major revision of the NS-2 simulator has started in July 2006

5.3 Constraints of NS-2.34 Simulation Framework
The limitations of the NS.2 simulation framework are due to its inherent complexity, pre-processing load, scalability issues, large memory requirements, not being dynamic in nature and not distributed.

The NS2 simulation environment is complex. A substantial amount of time is required to understand the internal working and code-base before you can use it. Competency is required in the TCL / OTCL to start even the basic simulation. OTCL provides a simplified interface but increases the simulation turnaround time for large simulation initiatives. Use of C++ interface is the fastest way to build new features into NS2. The NS-2 MANET framework requires generation of mobility files whose size and generation time increases exponentially with an increase in the number of nodes. This also implies that the time needed to load the movement file into computer memory increases exponentially and so does the simulation completion time.

NS-2 is too slow with big scenarios. Experience with simulation time-around time both for this thesis and those experienced by others using NS2 are not satisfactory. NS-2 has too much runtime memory requirements and has very conservative output file size limitations. Once the NS2 simulation is loaded and simulation is in progress, there is no built-in method to dynamically configure it. There is no support for distributed simulation which reduces scalability of the NS2 simulation framework as the number of MANET node increases.

4. APPLICATION: Applications of MAC protocol used in various fields such as Wireless Sensor Network & Vehicular Ad-hoc Networks.

4.1 Application of MAC protocol in Wireless Sensor Networks: A typical sensor node consists of a wireless communication unit, a processing unit, a sensing unit, and a power supply unit. Their applications range from civilian to military. The energy source of a node is generally considered non-rechargeable. Thus, the most concern of the recent researches is placed in tradeoffs between energy conserving and performance. A wireless radio is the most energy consuming unit of a node. It can operate in three or four different states: transmit, receive, idle and sleep [14]. However, all the active states consume almost the same energy. This problem can be addressed at software level, e.g. the network stack. A MAC layer is the most suitable level to address the energy inefficiency. This layer is used to coordinate node access to the shared wireless medium. The MAC layer provides fine-grained control of the transceiver, and allows switching the wireless radio on and off. How frequent and when such switching have to be performed is the major goal of an energy saving mechanism of the MAC layer. It should maximize sleep period of the node, while preserving the highest throughput, the minimum latency, and the maximum energy conserving in a wireless sensor network.

4.2 Application of MAC protocol in Vehicular Ad-hoc Networks:
The communications of information among the vehicles to vehicles and vehicles to roadside provide a great opportunity for the development of new driver assistance systems. These systems will be able to disseminate and to gather real time information about other vehicles, road traffic with environmental conditions. Such data will be processed and analyzed to facilitate the driving by providing the user with useful information [15].
In VANETs the major problems which the MAC protocol has to resolve are:
i. Transmission collision
ii. Hidden terminal problem
iii. Exposed terminal problem

5. CONCLUSION

In the proposed protocol Customized-MAC, the physical layer **multirate capability** has been efficiently utilized, by the use of two Relay nodes, which transmit data at various rates.
The protocol proves to be **robust**, in case the direct transmission from source to destination fails.
Customized-MAC protocol makes the overall system **reliable** and also **increase the lifetime** of the network.

The algorithm is compared with the existing original 802.11 MAC protocol, CSMA/CA(Carrier Sense Multiple Access with Collision Avoidance). Simulation results show that Customized-MAC performs better than existing MAC in terms of Throughput, Packet Delivery Ratio (PDR) at the cost of Avg. End-to-End delay & Sometimes Routing Overhead at higher number of Nodes.

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