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Comparative Analysis for EM-MAC, PW-MAC and EEC-MAC Protocols in WSN under Airborne Networks

Gagandeep Kaur[1], Jasvir Singh[2]

[1]Department of Computer Engineering, Master of Engineering, UCOE, Punjabi University Patiala, India

[2]Assistant Professor, Department of Computer Engineering, UCOE, Punjabi University Patiala, India

Abstract: ***The main focus of this paper is to do comparative analysis for MAC protocols with airborne applications. Efficient Multichannel MAC and predictive wakeup MAC protocols are most effective protocols at terrestrial level networks but it is very interesting to see the behaviour of MAC protocols on airborne applications where mobility is very high and very less time for communication setup. We have done comparison of these protocols with Energy Efficient Cooperative Duty Cycle MAC protocols which is very suitable in airborne applications by using OPNET simulator***.

Keywords: EM, PW, EEC, OPNET, MAC, WSN.

1. Introduction

In wireless communications and electronics have enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate unmetered in short distances. These tiny sensor nodes, which consist of sensing, data processing, and communicating components, control the idea of sensor networks. Sensor networks represent a significant improvement over traditional sensors. A sensor network is composed of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities [1].

Another unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are fitted with an onboard processor. Instead of sending the raw data to the nodes responsible for the fusion, they use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data. The above described features ensure a wide range of applications for sensor networks. Some of the application areas are health, military, and home. In military, for example, the rapid deployment, self-organization, and fault tolerance characteristics of sensor networks make them a very promising sensing technique for military command, control, communications, computing, intelligence, surveillance, reconnaissance, and targeting systems. In health, sensor nodes can also be deployed to monitor patients and assist disabled patients. Some other commercial applications include managing inventory, monitoring product quality, and monitoring disaster areas [1].

2. MAC Protocols in WSN

We have focussed in this paper on the following MAC protocols of wireless sensor network:

2.1 Efficient Multichannel MAC (EM)

EM-MAC is a *predictive*, asynchronous duty-cycling MAC protocol .It uses no *control channel* and enables a node to *dynamically* select the channels it switches among for receiving based on the wireless channel conditions it senses.[2]. EM-MAC achieves high energy efficiency by enabling senders to accurately predict the *wake-up channel* and *wake-up time* of a receiver. In particular, each time a node using EM-MAC wakes up, it independently selects its own wake-up time and channel according to a *pseudorandom function*, while avoiding undesirable channels on which it has detected high traffic loads or excessive wireless interference, including channels being actively jammed[2].

2.2 Predictive wakeup MAC (PW)

In PW-MAC, receivers wake up pseudo randomly and sender predicts receiver wakeup calls based on judged parameters. Prediction based retransmission is considered in this protocol standard and it is base for ON demand prediction-error correction. Measure prediction error and if error exceeds bounds then it request new prediction state[3]. **PW-MAC is a receiver** initiated protocol but introduces use of an independently generated pseudo-random sequence to control each node's wakeup times, allowing senders to accurately predict the time at which a receiver will wake up. Thus, whereas previous receiver-initiated protocols reduce the duty cycle only at receivers, PW-MAC reduces the duty cycle for receivers and for senders [3].

2.3 Energy Efficient Cooperative Duty cycle MAC (EEC)

The basic idea of EECDC-MAC is to schedule all nodes to wake up at the same time and network synchronization is implemented by sync messages in the first cycle in the network initialization phase inorder to establish rendezvous for data exchange among them. From the second cycle onwards, nodes follow the schedule provided by S to wake up at specific fixed time instants. In CDC-MAC, synchronization is done in the sync period prior to packet transmission in the data period, whereas in EECDCMAC it is a part of the data period and is done only in one cycle[4].

3. Simulation Tool

OPNET (Optimized Network Engineering Tool) Modeler 14.5 is used for the design and implementation of our thesis work.

3.1 OPNET

We have chosen OPNET simulator. In simulation the different types of scenarios are consider based upon mobile and fixed nodes on OPNET simulator. OPNET (Optimized Network Engineering Tool) Modeler 14.5 is used. OPNET is a network simulator that provides practical network communication environment. It is suitable for the research studies, network modeling and engineering, and performance analysis. OPNET Modular 14.5 is chosen because it is one of the leading environments for network modeling and simulation. It offers easy graphical interface, possibility to develop and run this simulation environment, validity of the simulation results. This tool is highly reliable, robust and efficient. It supports large number of fixed business standard network protocols, devices, and applications. Simulation with OPNET is generally divided into four parts, network model design, applying statistics, run simulation and then to view results and to analyze the results, if the results are not correct then it has to be re-modeled and then to apply new information.

4. Performance Evaluation Parameters

Table 1: Simulation Parameters

Parameters	*Values*
Network Size	1000x1000 meters
Type of Service	FTP
Number of Nodes	110
Routing Protocols	AODV, DSR, GRP
Node Model	WLAN_wkstn
Performance Parameters	Throughput, delay, network load
Simulation Time	3600 sec

5. Simulation Results

Performance comparison is evaluated based on the EM,PW AND EEC scenarios.

5.1 Delay

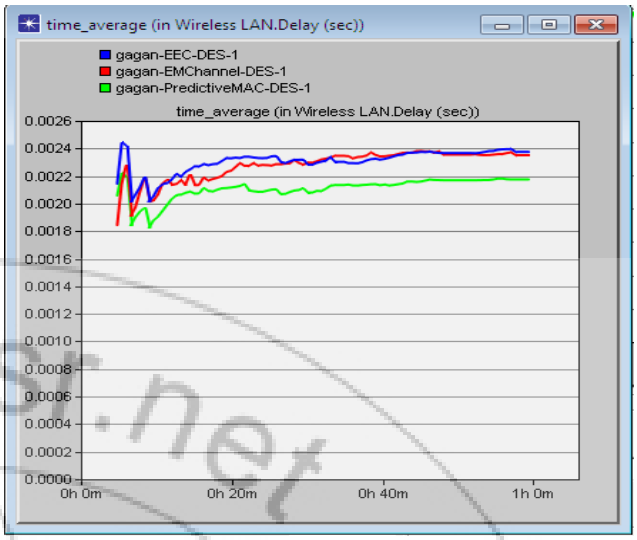

Figure 5.1: Delay (sec) comparison of all three scenarios

5.2 Throughput

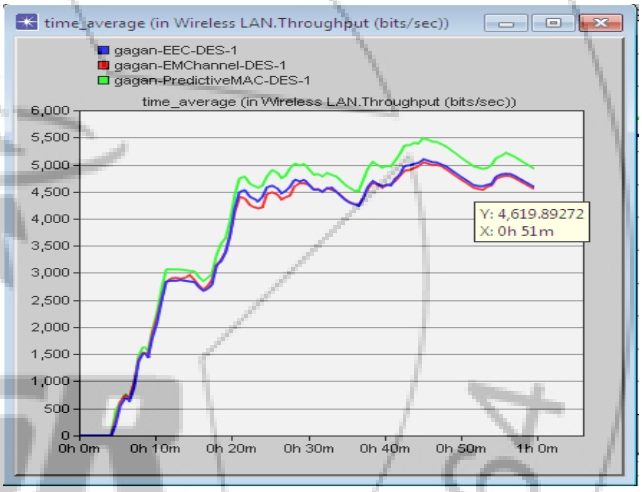

Figure 5.2: Throughput (bits/sec) comparison of all three scenarios

5.3 Network Load

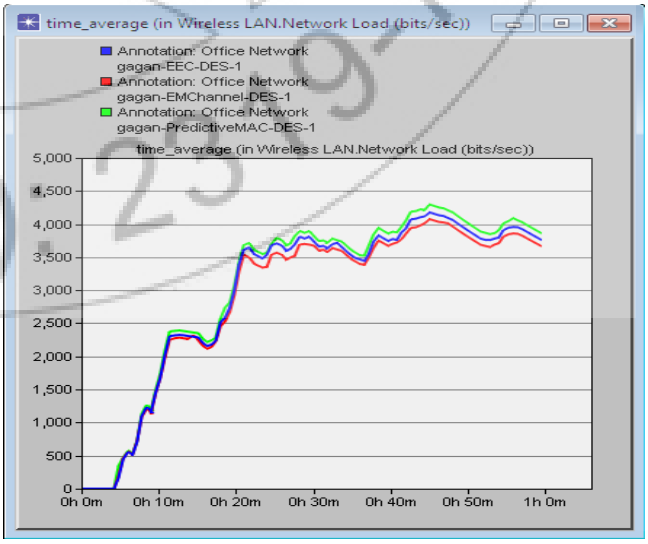

Figure 5.3: Network Load (bits/sec) comparison of all three scenarios

Table 2: Result Summary

Attributes	Simulation Time (sec)	EM mac	PW mac	EEC mac
Throughput (bits/sec)	3600	5000	5500	5000
Delay(sec)	3600	.0023	.0022	.0024
Network load(bits/sec)	3600	4100	4300	4200

6. Conclusion

MAC protocols are the best way to manage the power efficiency of the network performance. Various medium access control mechanisms have been applied by many authors or managing the uneven power utilization for wireless. In our proposed work, we have considered three medium access protocols for comparative study and found that predictive MAC protocol provide high throughput around 10% more than Efficient multichannel protocol and Energy efficient cooperative duty cycle mac protocol. In term of delay, predictive protocol is also providing low delay around 11 % less value than Efficient multichannel and Energy efficient cooperative duty cycle mac protocols. In term of network load also predictive MAC is better than other protocols. So overall predictive MAC provide good results than energy efficient cooperative duty cycle and efficient multichannel mac protocols in an airborne networks.

7. Future Scope

In this work, we have considered comparative analysis of the MAC layer based protocols which provided us the overview of the predictive nature of protocol, energy efficient view and efficient channel view. This study provides good idea of traffic flow and efficiency of the protocols. In future we can work on the reprogramming of medium access protocols to improve the efficiency in high mobility environment.

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