International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue 6, ISSN (Online): 2249–071X, ISSN (Print): 2278–4209

Improvement of Power Efficiency using Smart Antenna System in MANETs

Abhishek Kumar
GRD-IMT, Dehradun
Email: abk.engg13@gmail.com

Sumit Joshi
Assistance Professor, GRD-IMT, Dehradun
Email: joshigauta@gmail.com

***Abstract* – Performance of ad-hoc networks is low under omnidirectional antenna systems compared to smart antenna system. Directional antennas cover large area & save some amount of transmitted power because it focuses in desired direction accordance with mobility of nodes while Omni-directional antennas cover small area & needs large transmitted power as compared to Smart Antenna System (SAS). In this paper, we will overcome the problem of unnecessary transmitted power wastage with omnidirectional antenna system in ad-hoc wireless networks by using Smart Antenna Systems (SAS). We will calculate & analyze transmitted power variations with different number of mobile nodes in mobile ad-hoc networks [MANETs] with smart antenna system (SAS) & Omni-directional antenna system in different conditions. Firstly, we will calculate & analyze transmitted power during flooding of packets means in case of route creation, and secondly, when communication will established between transmitter & receiver.**

***Keywords* — Energy Management, IEEE 802.11 Standards, MAC, Omni-directional Antenna Systems, Smart Antenna System (SAS).**

I. Introduction

Energy consumption control in wireless ad-hoc networks is a more difficult problem due to non availability of access point in network. A node can be both a data source and a router that for other nodes. There is no centralized entity such as an access point to control and maintain the power control mode of each node in the network. There are number of challenges offered by mobile ad-hoc network environment like power, route failure, synchronization, security etc. Nodes in the mobile ad-hoc network environment have limited battery power. Energy consumption control is serious problem in MANETs [1].

Energy Saving By Route Discovery

It is observed from literature survey that ad-hoc network arbitrarily motion of nodes results in unpredictable and frequent topology changes. Additionally, since nodes in a mobile ad hoc network normally have limited transmission ranges, nodes cannot communicate directly with each other. Hence, routing paths in mobile ad-hoc networks contain multiple hops, and each node in mobile ad-hoc networks has the responsibility to act as a router. Because of importance of routing protocols in dynamic multi-hop networks, a lot of mobile ad hoc network routing protocols have been proposed in the last few years such as- DSDV, OLSR, TBRPF, DSR, AODV, TORA, ABR, SSR etc [2][3].

Energy Saving By Transmission Power

We know that high transmission power on a link may improve the quality, throughput on that link and increase the levels of interference on the other links [4]. Practically from experimental data, indentify three interference scenarios:

Overlapping Case: In this case, power control does not increase the maximum achievable throughput.

Hidden Terminal Case: Power control improves the throughput.

Potentially Disjoint Case: Proper power control can enable simultaneous transmissions and thus improve throughput.

Energy Saving By Transmission Range

It is observed from survey that radio transmission range as a system parameter affects the energy consumption economy of wireless ad-hoc networks. On the one hand, a large transmission range increases the expected progress of a data packet toward its final destination at the expanse of higher energy consumption per transmission. On the other hand, a short transmission range consumes less per transmission energy, but requires a larger number of hops for a data packet to reach its destination [5].

Energy Saving By Energy Management Model

It is observed from literature review that On-demand power management frame work is not effective for larger size network due to dynamic configuration of network. Power saving algorithms is not effective in case of high speed dynamic network. Ad-hoc medium access layer cannot maintain quality of service with low transmission power.

Therefore, Energy saving at routing protocols level is much easier as compared to energy saving at mobile nodes. Each of these techniques saves some energy of mobile device and if we use these different techniques in a combined in a manner it saves lot of energy and increase the lifetime of network [6].

II. Related Works

There are different ways to make an energy efficient mobile ad-hoc network [MANETs] described in above section. We will make an energy efficient mobile ad-hoc network [MANETs] using energy saving by transmission power concept. In this we will analyze the performance of antenna technology according to power consumption concept while we will assume that MAC protocol uses best Hand-Shake mechanism. To overcome the problem of unnecessary transmitted power wastage with omnidirectional antenna system in ad-hoc wireless networks, I will do analysis of mobile ad-hoc network with smart antenna system according to the transmitted power in different conditions.

III. IEEE 802.11 Standard

Currently, two main standards are emerging for ad hoc wireless networks: the IEEE 802.11 standard for WLANs, and the Bluetooth specifications for short-range wireless communications. Due to its extreme simplicity, the IEEE 802.11 standard is a good platform to implement a single-hop WLAN ad hoc network. Furthermore, multi-hop networks covering areas of several square kilometers can potentially be built by exploiting the IEEE 802.11 technology. IEEE 802.11 standard represents both medium access control (MAC) layer & Physical layer of the Open System Interconnection (OSI) model and it is suited for defining an Ethernet like- communication channel using wireless, such networks are known as WLANs (wireless local area networks). In IEEE 802.11standard, MAC layer & three different technologies have been specified like- DSSS (direct sequence spread spectrum), FHSS (frequency hopping spread spectrum) and infrared.

EEE 802.11 standard supports higher data rates; for example- DSSS uses IEEE 802.11b standard which operated at 2.4 GHz frequency with 11Mbps data rate whereas FHSS uses IEEE 802.11a standard which operated at 5.2 GHz frequency with 52 Mbps data rate. CSMA/CA (carrier sense multiple access with collision avoidance) is the basic access scheme of IEEE 802.11. This scheme is used to specify the status of the communication channel that means channel is free or not before transmitting a frame. If medium is free & remains free for a specific time interval, then station sends its frame to destination otherwise, the MAC selects a back-off value randomly from a contention window. If a collision happens, the contention window is set to twice its size and a back-off value is chosen from the new interval [6].

Hidden Terminal Problem (HTP)

When neighbors of receiver may not sense a transmission from the transmitter and if any of these stations transmits, there will be collision between packets at the receiver.

MAC Protocols

Authors have been proposed MAC (Medium Access Control) Protocols to providing best way for communication between transmitter & receiver. To overcomes Hidden Terminal problem & allows more rapidly collision detection, the MAC specifies a former hand-shake. In hand-shake mechanism a station has data to send, it first sends a RTS (Request to Send) frame & receiver replies with a CTS (Clear to Send) frame. RTS & CTS frame control information about the interval of the next data frames. All fellow stations hearing these frames set a variable called Network Allocation Vector (NAV) to keep track of the availability of the medium. Inspection the NAV before a transmission is known as Vector Carrier Sense mechanism [7].

Authors have been proposed many MAC protocols to overcome Hidden Terminal Problem. According to [8] authors proposed Omni RTS and directional CTS mechanism which will help us to reduce the unnecessary transmission power wastage.

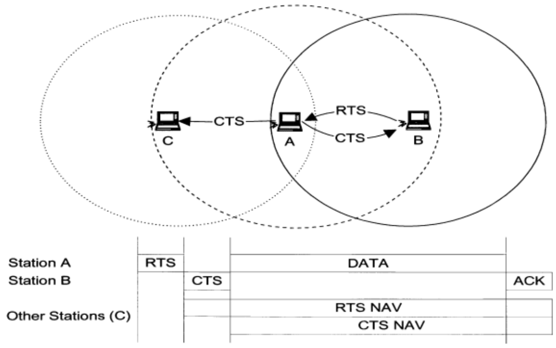

Fig.1. Collision avoidance algorithm in IEEE802.11.

IV. Omni-directional Antenna System (OAS)

The omnidirectional antenna [9] radiates or receives equally well in all directions. It is also called the "non-directional" antenna because it does not favor any particular direction. Figure 2 shows the pattern for an omnidirectional antenna with the four cardinal signals. This type of pattern is commonly associated with verticals, ground planes and other antenna types in which the radiator element is vertical with respect to the Earth's surface.

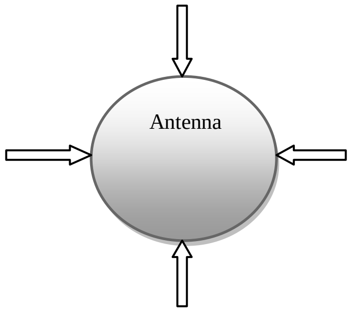

Fig.2. Basic concept of Omni-directional antenna

We will judge, the performance of such an antenna system in mobile ad-hoc network [MANETs] by the quality of transmission, coverage areas, power consumptions & throughput etc. Omni-directional antennas covers equally well in all direction, but in ad-hoc wireless networks it is not sufficient because mobiles are random in nature & freely to move anywhere.

V. Smart Antenna Systems (SAS)

Transmission power will be reduce by using antenna technology means if directional antenna used then ad-hoc wireless networks will be energy efficient and it will cover large area as compared to omnidirectional antenna system. A smart antenna system [10] combines an antenna array with a digital signal-processing capability to transmit and receive in an adaptive, spatially sensitive manner. The term “smart antenna” normally refers to any antenna array, concluded in a sophisticated signal processor, which can adjust or adapt its own beam pattern in order to emphasize signals of interest and to minimize interfering signals. Smart antennas generally encompass both switched beam

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and beam formed adaptive systems.

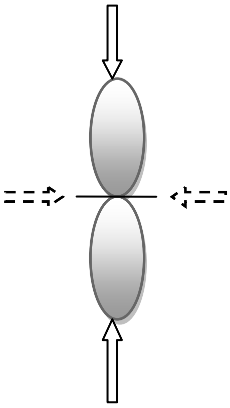

Fig.3. Radiation patterns of directional antenna systems

VI. Methodology

The work will be implemented using MATLAB. Performance of mobile ad-hoc networks can be evaluated based on the various information obtained from the trace files after simulation. The information can be increment or decrement of the number of nodes, transmitted power consumption, flooding power consumption etc. Following are the performance criteria that I shall examined during my simulation study are such as Power Consumptions during connection establishment and power consumption during flooding of packets in the networks while number of mobile nodes can be increased or decreased will be discussed from the simulation environment.

VII. Simulation and Results

Firstly, we will compare in the case of flooding of packets it is generally occurs in the case of route creation, and secondly we will compare in the case when communication is established between transmitter and receiver. Therefore, in this work we will create MANET which based on different number of nodes and according to that do analysis of energy efficiency or we can say total transmitted power and calculate the transmitted power by using Omni directional antenna and antenna array system, and compare both in different conditions.

During communication establishment, Transmission power will be calculate by using-

$$Pt = \frac{AG * \text{no.of hops}}{4\pi R^2} \quad (1)$$

Where A is the effective aperture of the antenna, G is antenna gain & no. of hops means active nodes.

During flooding in the networks, transmission power will be calculated by using-

$$Pt = \frac{AG * \text{no.of nodes}}{4\pi R^2} \quad (2)$$

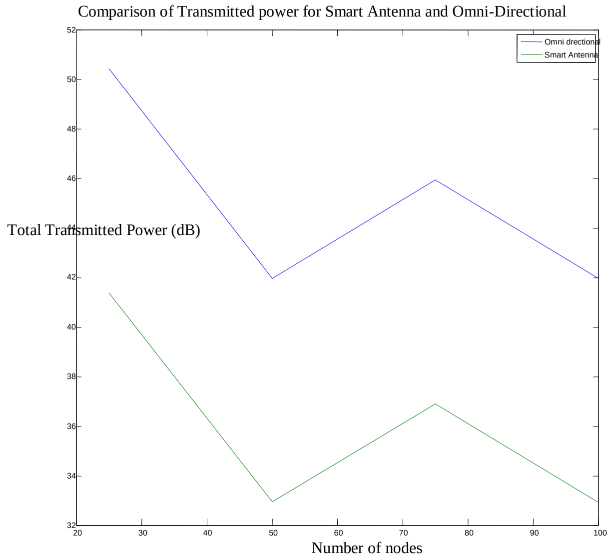

Fig.4. Comparison of Transmitted power for Smart Antenna and Omni-Directional

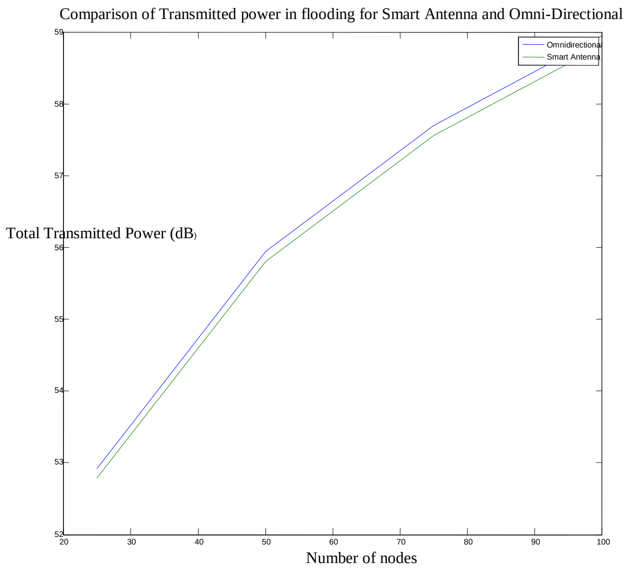

Fig.5. Comparison of Transmitted power in flooding for Smart Antenna and Omni-Directional

VIII. Conclusion and Future Scope

Firstly, we have compared transmitted power of Omni directional antenna with transmitted power of smart antenna under the flooding case & secondly, compared within communication establishment. By comparing our work with related all work we have improve power efficiency by fraction of 3-5 unit.

Here in this work we have done analysis of network according to the transmitted power, in future by using signal processing units and equipments one can cancel the signal to interference noise ratio (SINR), by doing this more energy efficiency can be achieved for this need to do analysis in the overlapping region neighboring of antenna radiation patterns.

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AUTHOR'S PROFILE

Abhishek Kumar

presently lives in Dehradun and completed his Graduation as a B.Tech. Graduate in the field of Electronics and Communication from Gautam Budh Technical University, Lucknow, UP, India in 2011. He is post-graduate scholar in the field of Wireless & Mobile Communication from Guru Ram Das Institute of Management & technology, Dehradun, Uttarakhand, India in 2014. Presently he is working on "Smart Antenna based energy efficient ad-hoc wireless networks".