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# INVESTIGATION OF PACKET TRANSMISSION STRATEGIES OF MIMO EQUIPPED MOBILE ADHOC NETWORK USING SPACE-TIME CODING

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**Abstract:—**With the rapid growth of wireless communication infrastructure over the recent few years, new challenges has been posed on the system and analysis on wireless ad hoc networking. Implementation of MIMO communication in such type of network is enhancing the packet transmission capabilities. There are different techniques for cooperative transmission and broadcasting packet in MIMO equipped Mobile Adhoc Ntwork. Studying and investigating the different broadcasting algorithm, we propose a new scheduling algorithm which improves the packet transmission rate and energy performance of the network which is illustrated in this paper. The system model employed in the OPNET environment and simulated to show the packet transmission rate and some data are collected are shown in the tabular form. Also simulate the network for generating a comparative statement for each mobile node. And performance analysis is also done for the model network.

***Keywords:*** *Multi Input Multi Output (MIMO), Space-time coding, Ethernet Delay, ad hoc networks.*

## I. INTRODUCTION

The coding and signal processing are the major elements for successful implementation of MIMO communication system. The communication channel over which the MIMO system operates has an unprecedented complexity to exploit the channel space time resources to access the potential performance of practical multi antenna links between the transmitter and receiver. The signal transmission technique at the two sides of the MIMO communication links has a great potential to significantly improve the transmission efficiency of the wireless communication system without the need for extra operational frequency bandwidth [1,2,3]. The multi input multi output (MIMO) is envisaged for the purpose of next generation communications because of the MIMO technique has a lot of benefits over the traditional single input single output (SISO) signal transmission with respect to the Capacity, Bit-Error-Rate (BER), and transmission efficiency. Formal wireless networks are usually formed by hexagonal cells each with a base station(BS) and many mobile stations (MS), where the mobile terminal communicate with the base station which organizes multiple access to the intended MS user [4,5].To implement MIMO system with standard mobile communication system wills MS-BS have to be equipped with multiple antennas and their impact of antenna element properties – such as directivity , polarization, and mutual coupling-antenna array configuration and radio frequency (RF) architecture and communication behavior as well as suitable signal processing algorithms are to be considered judiciously at the mobile nodes. For the formal wireless network topology changes depends on distribution of BS-MS where in MANET technology, topology changes are distributed among the mobile nodes; No BS-MS concept is here. MIMO ad hoc network using different number of transmitting and receiving antennas combination shows that high channel capacity and high spectral efficiency compared to SISO network It has been observed that Spectral Efficiency has the limitation with the number of antenna [6]. And further studied are carried out with multi carrier modulation techniques-OFDM on MIMO combination of ad hoc network , OFDM technique reduces the equalization complexity by applying IFFT at the transmitter and FFT in the receiver to obtain the wideband signal [7]. The implementation of IFFT and FFT enhances the processing speed and reduces the processing complexity of large multiplication and addition for long data processing before transmission and reception through multiple numbers of antennas in MIMO system. Fading severity of the MIMO channel channels are measured by means the co-efficient variation (CV) of the amplitude and phase of the transmitted signal[7]. The Rayleigh and the Rician fading along with the Doppler Shift are considered to measure the AFD and LCR of the MIMO channel [8]. A new scheduling algorithm is discussed which is related with the firing of the network nodes. These changes the energy of the network i.e. transmission efficiency of the network by discussing Energy-Performance Metric (EPM).

## II. SYSTEM MODEL

Here we proposed an integrated scheduling scheme that take advantage of the random topology of MIMO based ad hoc networks to exploit the multiuser diversity and traffic demand for channel condition. A group of nodes in a mesh network take advantage of cooperative transmission; the sender node can transmit multiple data to downstream nodes, while a receiver can receive packets from upstream node.

The data scheduling schemes used here operates in cross layers and with the consideration of physical channel condition and service requirement of the user traffic.

MIMO Diversity Gain and Space-time coding are the two important parameter for designing a MIMO adhoc network.

Using Diversity Gain a node with multiple antennas transmits symbols on each antenna element with equal power. If the fading characteristics of the parallel channels formed among each pair of transmit and receive antennas are sufficiently different, the channels are "independent".

Using Space Time Block Code the modulated symbols are mapped onto a space-time code matrix, which generates the code symbols by exploiting both temporal and spatial diversity [10,11]. With STBC, a number of code symbols equal to the number of transmit antennas are transmitted simultaneously, on the different antenna elements. These symbols are combined at the receiver; the symbol combinations reduces the variations in the receive SNR. STBC thus improves robustness to channel impairments.

We consider here an adhoc network equipped with multiple antennas and space-time encoder as shown in Fig 1.

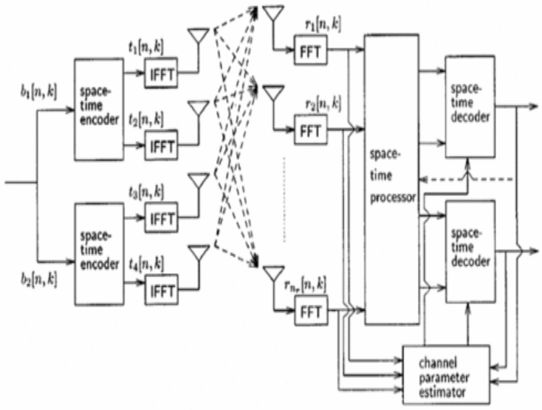


*Fig1: system model with space-time encoder*

To simulate an adhoc network with 40 number of nodes randomly deployed in the area of 10,000 (100*100) sqft in the OPNET environment. The model is devised to operate the nodes in AODV protocol based on IEEE 802.11b distribution coordination function (DCF) [17]. The deployed network is shown in Fig 2.

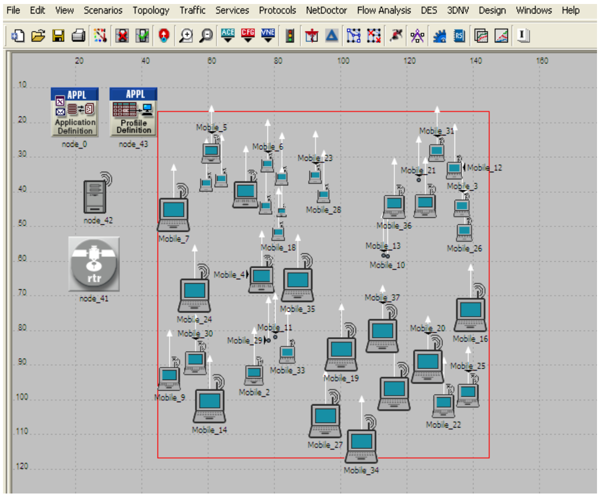

*Fig2: Randomly distributed MANET with 40 nodes*

The specifications for the above model network are given in table 1.

Table1:

| | |
|---|---|
| Node Transmission Power | .005Watt |
| Operational Mode | 802.11b standard |
| Data rate | 11 Mbps |
| Adhoc routing protocol | AODV |
| Technology | WLAN (adhoc) |

As the power consumption is a major factor of the adhoc network that the operating power of this network is set to 5 mWatt. Internal model for each node is shown in Fig3.

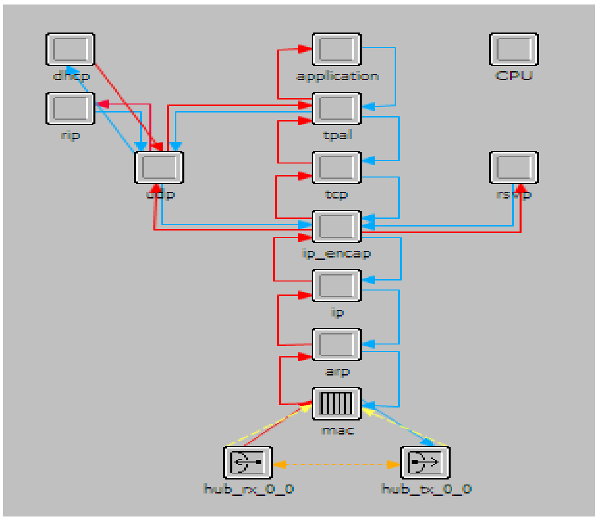


*Fig3: Internal model for each node*

In our proposed algorithm the scheduling time depends on the requests of the application, which ranges from processing node, data to network bandwidth, signal filters, etc., where requests are defined as jobs, which consists of information about the requirement on the resource that are necessary to execute a particular job firing for the node in the network environment. The system architecture of scheduling request can be categorized as centralized scheduling, hierarchical scheduling and decentralized scheduling. In centralized scheduling, central scheduler collects the information of network resources. In Hierarchical a scheduling different policy are used for local and global scheduling, and not depends on the single scheduler. In decentralized scheduling the distributed schedulers interact with each other and schedule jobs at remote nodes for execution. Local schedulers can submit jobs to/from each other through direct communication or a central job pool. Mobile ad hoc scheduling algorithms is responsible for firing of the network node as well as the job scheduling process. The congestion control decides which packets to be injected into the flows in each time. The next packet to be transmitted is determined by the job-scheduling algorithm. Scheduling request with firing node can be controlled by Network Utility Maximization (NUM) which is defined as

$$Max \sum U_f \left( X_f \right)$$

subject to

$$\sum \left( X_f \right) \le C_e \quad \text{where} \quad f \in S_e$$

where $C_e$ be the capacity of the server, $S_e$ be the set of flows passing through the server and $X_f$ be the current injection rate into flow $f$.$Uf(.)$ is defined as the utility function that represents the “benefit to the system” achieved by the given packet transmission rate.[16]. Joint energy-performance metric (EPM) for mobile ad hoc networks that allows routing protocols are evaluated for both performance and energy consumption. A good metric will capture the average behavior of a system, as common-case events determine the total utilization of a network. A family of energy-performance metrics is defined in our proposed scheduling method using the following equations:

$EPM(\alpha) = (Averageenergy)(Averageerformance)^{\cdot\alpha}$ where α is a parameter that determines the weighting between energy and performance [19]. Lower EPM values correspond to higher energy-efficiency and better joint energy-performance. First it needs to define how we measure energy and performance in such networks. The average energy of a network is simply the total network energy over the number of nodes. Measuring average network performance of an ad hoc network is more difficult. We choose to measure the average performance of a network based on its ability to successfully deliver packets, and we call this the transmission efficiency which is defined as the ratio of Network packet received to Network packet transmitted. Now substituting these definitions into our prior definition of EPM (α).

$$EPM(\alpha) = \text{(Network energy per node) (Transmission efficiency)}^{-\alpha}$$

$$EPM(\alpha) = \text{(Network energy/ node) (Network packet transmitted/network packet received)}^{-\alpha}$$

The choice of $\alpha$ is more important and difficult to get suitable EPM metric (the unit of energy). As for example at $EPM(0)$, the metric reduces to a pure energy metric and for $EPM(\infty)$, the metric is a pure performance metric. The main goal is to use a metric with an value somewhere in between these extremes. Finding a meaningful value of α is nontrivial and we will initially assume an α value of one and show empirically that this is a reasonable metric parameter for ad hoc network routing protocols.

## III. PERFORMANCE ANALYSIS

As discussed earlier we deployed the network, as shown in Fig1 simulated to find out the packet transmission rate. The simulation for packet transmission (50%, 75% and 100%) is shown in fig4, fig5 and fig6. Time taken for 50% transmission is 45sec, for 75% transmission is 66 sec and for 100% transmission in 92sec. The performance of different node in terms of their packet created, copied and destroyed. The active number of nodes with respect to time is also obtained are shown in Fig8. The packet lost for MANET Gateway in the network is very small or zero. During simulation the supporting devices like application config (node_0) and profile config (node_43) don't take direct role regarding packet transmission in the network.

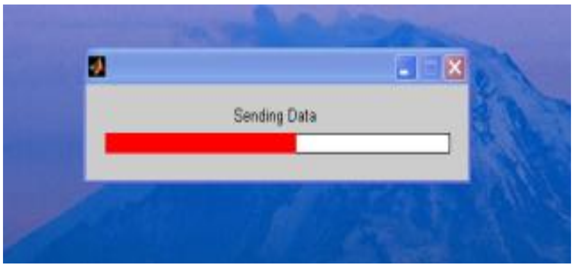


*Fig4: 50% Packet sent*

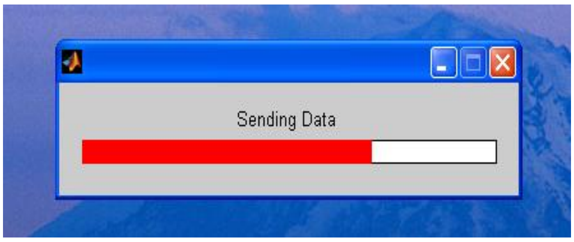


*Fig5: 75% Packet sent*

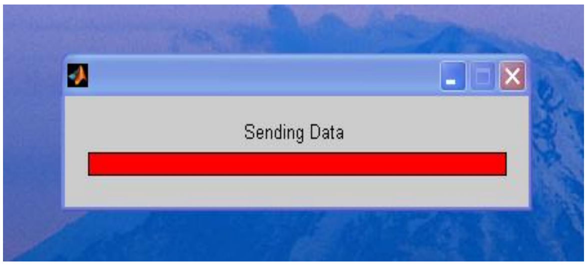


*Fig6: 100% Packet sent*

Packet transmission strategies for the model network are shown in Table2.

Table2:

| Node Name | Created | Copied | Destroyed |
|---|---|---|---|
| node_0 | 0 | 0 | 0 |
| node_1 | 26 | 8 | 24 |
| node_10 | 35 | 12 | 33 |
| node_11 | 17 | 4 | 15 |
| node_12 | 17 | 4 | 15 |
| node_13 | 17 | 4 | 15 |
| node_14 | 17 | 4 | 15 |
| node_15 | 17 | 4 | 15 |
| node_16 | 17 | 4 | 15 |
| node_17 | 14 | 4 | 15 |
| node_18 | 17 | 4 | 15 |
| node_19 | 26 | 8 | 24 |
| node_2 | 17 | 4 | 15 |
| node_20 | 17 | 4 | 15 |
| node_21 | 17 | 4 | 15 |
| node_22 | 17 | 4 | 15 |
| node_23 | 17 | 4 | 15 |
| node_24 | 17 | 4 | 15 |
| node_25 | 17 | 4 | 15 |
| node_26 | 17 | 4 | 15 |
| node_27 | 26 | 8 | 21 |
| node_28 | 17 | 4 | 15 |
| node_29 | 26 | 8 | 24 |
| node_3 | 17 | 4 | 15 |
| node_30 | 17 | 4 | 15 |
| node_31 | 17 | 4 | 15 |
| node_32 | 17 | 4 | 15 |
| node_33 | 17 | 4 | 15 |
| node_34 | 17 | 4 | 15 |
| node_35 | 26 | 8 | 24 |
| node_36 | 17 | 4 | 15 |
| node_37 | 26 | 8 | 24 |
| node_38 | 17 | 4 | 15 |
| node_39 | 17 | 4 | 15 |
| node_4 | 17 | 4 | 15 |
| node_40 | 17 | 4 | 15 |
| node_41 | 0 | 117 | 82 |
| node_42 | 813 | 240 | 360 |
| node_43 | 0 | 0 | 0 |
| node_5 | 17 | 4 | 15 |
| node_6 | 17 | 4 | 15 |
| node_7 | 17 | 4 | 15 |
| node_8 | 17 | 4 | 15 |
| node_9 | 17 | 4 | 15 |
| [Total] | 1562 | 549 | 1111 |

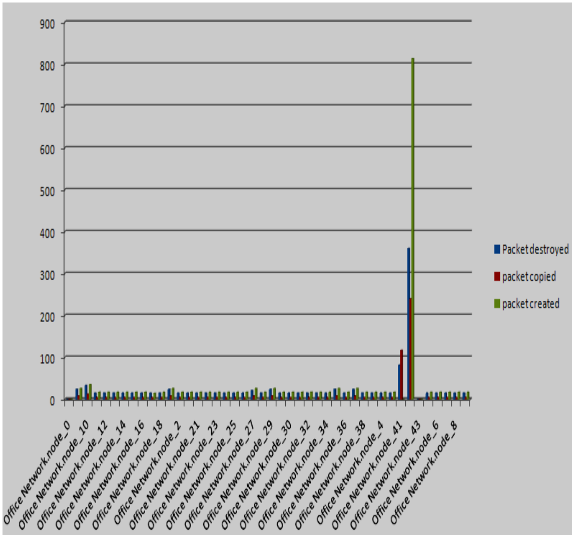


*Fig 7: Comparative study of packet transmission strategies*

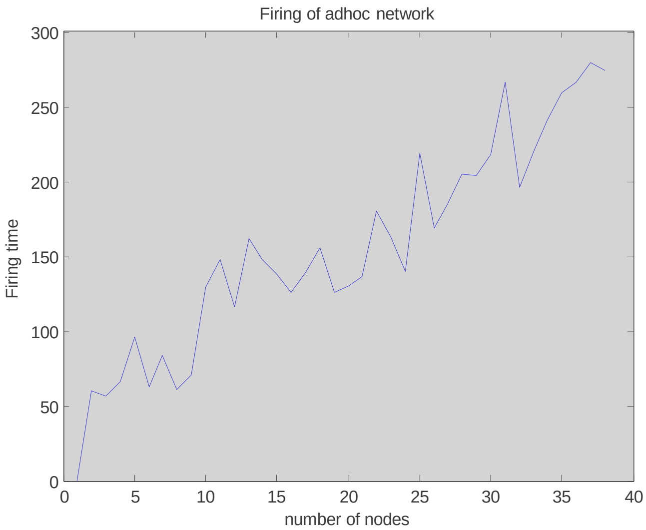


*Fig 8: Firing of adhoc node*

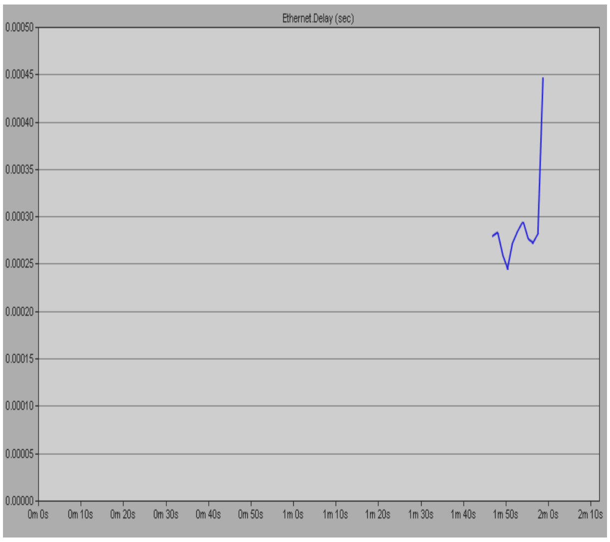


*Fig9: Ethernet Delay for each node in the model Network*

## IV. CONCLUSION

We have simulated a network with different number of nodes. The analysis result for a particular network is depicted here. Further studies are required for future analysis of the network studies.

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