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Performance Analysis of LANMAR Routing Protocol in SANET and MANET

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Abstract— An ad hoc network is a network that is independent of pre-established infrastructure and has the capability of handling any damage or changes in the topology. Ad hoc networks can be either static ad hoc network (SANET) or mobile ad hoc network (MANET). In SANET, the nodes have no moving property and they are fixed at one place within the network whereas MANET is a group of wireless nodes that can move and self-organize themselves to form a network for a temporary purpose. Nodes in the MANET have the liberty to join/leave the network due to their mobility property. This paper makes strive to explore the impact of LANMAR routing protocol in SANET and MANET environments.

Keywords— Ad hoc Network, MANET, SANET, LANMAR, Fisheye, EXata

I. INTRODUCTION

Network is well-defined as a set of nodes where the communication is possible. A network can be either wired network or wireless network. Wireless network can be an infrastructured network or infrastructure-less network [1]. Infrastructure-less network can be also called as ad hoc networks. The ad hoc networks can be either Static Ad hoc NETwork (SANET) or Mobile Ad hoc NETwork (MANET) as shown in Figure 1. In SANET, the nodes have no moving property and they are fixed at one place whereas in MANET nodes have the property of moving. It is referred to as the multi-hop network, since it takes the assistance of neighbor nodes to forward the packet from source to destination because of its restrained transmission range. MANET has the properties of mobility [2], dynamic topology, energy constraints etc.

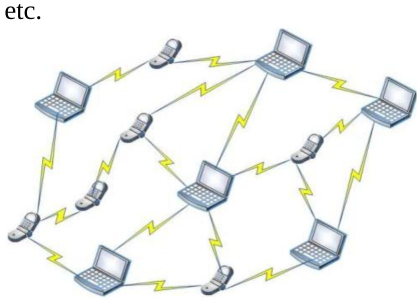

Figure. 1 Mobile Ad hoc Network

Providing QoS is a challenging issue in MANETs and is given a high priority; due to many years of research efforts, huge numbers of various schemes had been proposed, however still there is no usually tolerable protocol improves QoS in MANETs. To provide QoS, the network is likely to guarantee a collection of qualitative and quantitative metrics like throughput, number of control packets, routing control overhead, etc.

Based on the network structure the routing protocols in MANETs are categorized into flat, hierarchical and geographical routing protocols [3]. In flat routing, all the nodes in the network work at the same level with same routing functionality. Flat routing is easy and green for small networks. If the network becomes huge, the extent of routing data will become huge and it will take a long term for routing data to arrive at far flung nodes. This makes flat routing not suitable for scalable routing.

Hierarchical routing Protocols are best suitable for efficient scalable routing in High mobile ad hoc networks. One of the examples of hierarchical routing protocols is LANMAR routing protocol [4].

Rest of the paper is organized as follows, Section I contains the introduction of MANETs, Section II contains the description of LANMAR routing protocol, Section III contains the Methodology and Simulation Environment, and Section IV contains the Results and Discussion, section V Conclusion and Future Scope.

II. LANMAR ROUTING PROTOCOL

LANMAR Protocol adopts the idea of logical subnetting in which the members move as a group [5] [6] [7] [8] [9] [10] [11] [12] in a coordinated fashion. Every logical subnet as shown in Figure 2 has a header node (LANDMARK header), which serves for that subnet. Such LANDMARK header maintains subnet data.

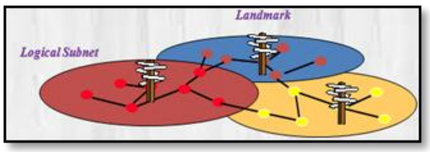

Figure. 2 LANMAR routing protocol

The LANMAR protocol uses Fisheye as the local scope routing protocol in which scope is measured in hop distance as shown in Figure 3. The scope or a range of covering most of the subnet members depends on location of Landmark header. If the form of a subnet is likely to be a round, all members of the subnet are covered by the scope of the centre node. By means of electing this primary node as landmark, requirement of the protocol is completely satisfied. The landmarks locations are distributed by a distance vector mechanism. All nodes maintain a distance vector for headers in all scope.

The no. of entries in distance vector table is identical to the number of logical subnets inside the network. If a landmark does not discovered at the centre of the scope, some nodes will drift off from its scope. The landmark will preserve a hint of the nodes in distance vector which drifters from the group.

Always there is an exchange of the distance vectors of landmark nodes and the drifters by a continuous periodical updates. The LANMAR is a proactive routing protocol that has the necessary routing data of the nodes inside the scope. For routing inside the scope, each node periodically interchanges the routing information to its one hop neighbours. In each update, the node includes all the routing table entries and sends to the nodes present in the scope.

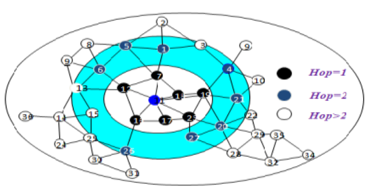

Figure. 3 Scope: measured in hop distance

When a node needs to transmit a packet and the destination is within its scope as indicated in the routing table, the packet will be forwarded directly by Fisheye State Routing (FSR) [13] [14] protocol. A landmark is dynamically elected in each group. Every node in fisheye scope uses FSR to route packets to the landmark header that directs the packets to the corresponding landmark of the destination node. The transmission between the landmark headers is done by Landmark routing protocol with respect to their scope ID.

The eye of a fish captures the pixels with high detail which are nearer to its focal point. As the distance from the focal point increases, the details of node decrease. In FSR, each node gradually reduces down the update rate for destination with growing hop distance. Consequently, entries related to nodes within a smaller scope are broadcasted to neighbor nodes with a greater rate. As an end result, a large portion of topology table entries (corresponding to far away destinations) are suppressed, hence reducing line overhead.

The various timing parameters used in LANMAR are shown in **Table 1**. LANMAR timing parameters values have worked well for high mobile large networks. The timing parameters should be configurable for different network sizes at different mobility speeds dynamically either experimentally determined values or dynamic adaptation.

Table 1. LANMAR Routing Protocol Timing Parameters

Timing Parameters	Default Value
MINIMUM_MEMBER_THRESHOLD	8
APHA	1.3
LANDMARK_UPDATE_INTERVAL	4s
NEIGHBOR_TIMEOUT_INTERVAL	6s
MAXIMUM_LANDMARK_ENTRY_AGE	12s
MAXIMUM_DRIFTER_ENTRY_AGE	12s
FISHEYE_SCOPE (HOPS)	2
FISHEYE_UPDATE_INTERVAL	2s
MAXIMUM_FISHEYE_ENTRY_AGE	6s

where minimum member threshold- States the least number of neighbours in order to be considered a landmark., alpha- Specifies the multiplication factor required to update the landmark., landmark update interval- Specifies the landmark update interval., neighbour timeout interval- Specifies the landmark neighbour timeout interval., maximum landmark entry age- Specifies the maximum age for landmark entries., maximum drifter entry age- Specifies the maximum age for drifter entries., fisheye scope- Specifies the Fisheye scope for local routing., fisheye update interval- Specifies the routing table update frequency within the Fisheye scope., maximum fisheye entry age- Specifies the maximum age for Fisheye entries.

III. METHODOLOGY

According to the IETF draft the static values are not suitable for dynamic environment i.e., MANET is very dynamic in nature, instead of using the fixed static configurable parametric values for all variety dynamic environments, if we tune the parametric values according to the dynamics of the network, it enhances the protocol performance.

The available methods for evaluating the performance of protocols are: mathematical, direct measurement and simulation. After keeping all the constraints into consideration, mathematical and computer simulation are appropriate for our research. There are numerous benefits of mathematical evaluation like cost, time and the potential of presenting fine predictive results. The direct measurement as a choice of technique will be high priced however an alternative to simulation. In direct measurement the evaluation is to be achieved on an operational network which could lead to disruptive condition and an operation network could be very costly in terms of configuration complexity. The benefit of direct measurement is accuracy in results.

A Simulation Environment

SCALABLE was founded in 1999 by Dr. Rajiv Bagrodia. Various versions: QualNet [15], EXATA (2008) EXATA/Cyber (2010). EXATA [12] is a widespread collection of tools for simulating and emulating different types of networks. It develops tests and evaluates, and train users on cyber war and network security technologies. It maps physical devices using EXATA. EXata simulator/emulator 5.41 is used to create a simulation environment. The simulation parameters are shown below (Table 2).

Table 2 Simulation Parameters

Simulation parameters	Values
Simulation Platform	Exata
Number Of Nodes	60
# Of Logical Groups	4
Simulation Area	1000 x 1000 Sq-Meters
Traffic Resources	Constant Bit Rate
Link	Wireless
Radio Range	150m
Item To Send	512 bytes
Start Time	1sec
End Time	0sec
MAC Layer	IEEE 802.11
Antenna Model	Omni Directional
Data Rate	2mbps
Energy Model	Generic
Pause Time	0 sec
Network Type	SANET, MANET
Transport Layer Protocol	UDP
Routing Protocol	LANMAR
Simulation Time	900 Sec
Mobility	Reference Point Group Mobility Model

In group mobility models the nodes are prearranged into 4 different groups (0-3groups) each group has equal no. of nodes with different mobility speeds.

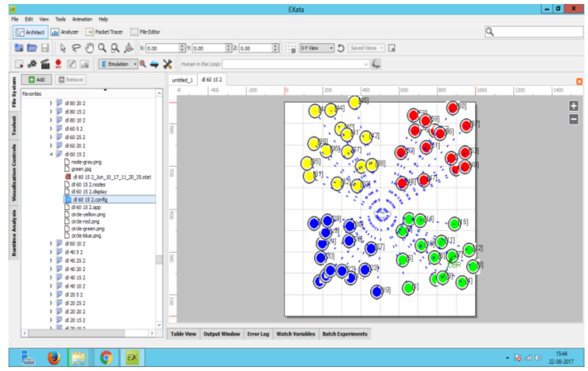

Figure. 4 Snapshot of Simulation environment of LANMAR protocol before simulation starts

The MANET scenario (Figure.4) is created with different network sizes (20, 40, 60, 80, and 100) by dividing the nodes into 4 groups (group 0, 1, 2 and 3). Each colour represents different group. Number of mobile nodes as created and they are connected through wireless links in 1000X1000 square meters terrain. All the nodes are set to move in 'reference point group mobility' fashion.

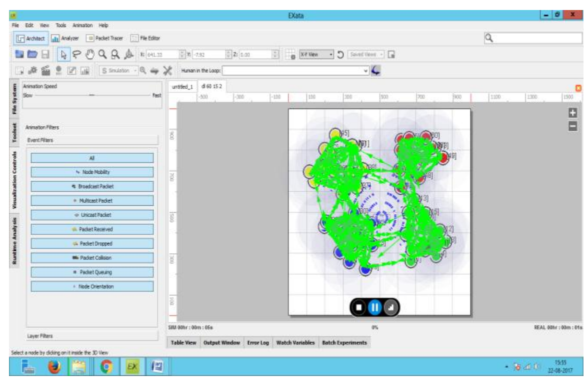

Figure. 5 Snap shot of MANET scenario of LANMAR routing protocol during simulation

The Figure.5 shown above is during simulating the created network scenario. During simulation, the mobile nodes of different groups in the terrain region start transmitting data by moving in a 'reference point group mobility' fashion with different mobility speeds.

IV. RESULTS AND DISCUSSION

To assess the routing protocols' performance, the following metrics are considered.

1. Throughput (bits/s): The number of bits sent in the network during the simulation.

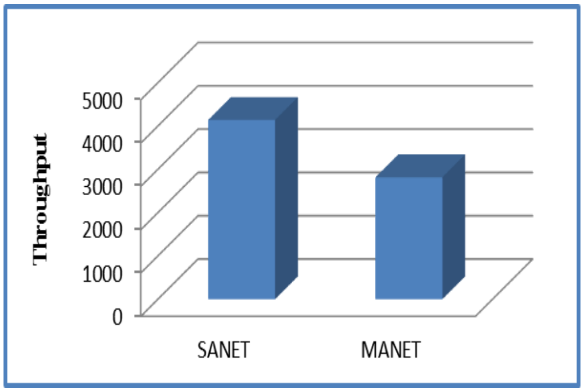

Figure. 6 Variation in throughput in SANET and MANET

In the above graph (Figure. 6), Throughput is high in the case of SANET when compared to MANET.

2. End-to-End Delay(s): The average time taken by a data packet to reach the destination.

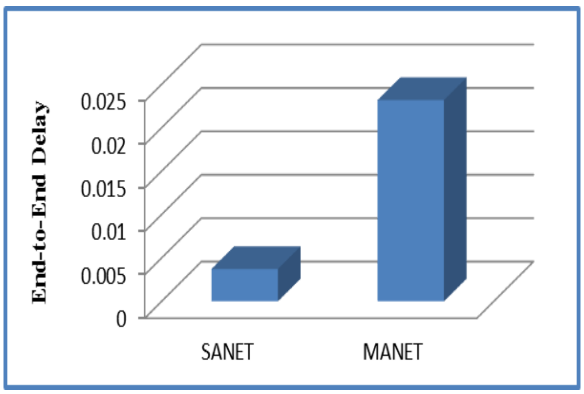

Figure. 7 Variation in End-to-End Delay in SANET and MANET.

In the above graph (Figure.7), End-to-End Delay is low in the case of SANET when compared to MANET.

3. Average jitter (s): The variance of minimum and maximum delay is jitter.

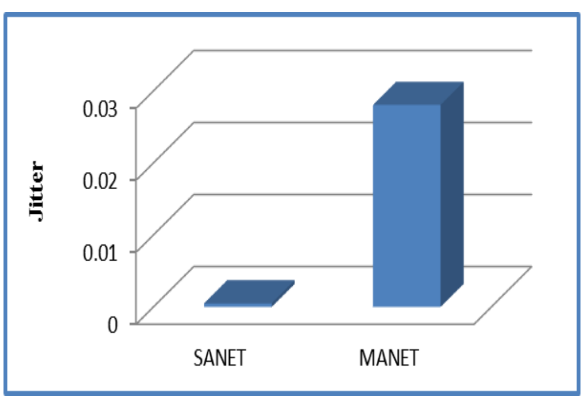

Figure. 8 Variation in Average jitter in SANET and MANET.

In the above graph (Figure. 8), Jitter is low in the case of SANET when compared to MANET.

4. Control Overhead (bytes): Total number of bytes sent as control packets.

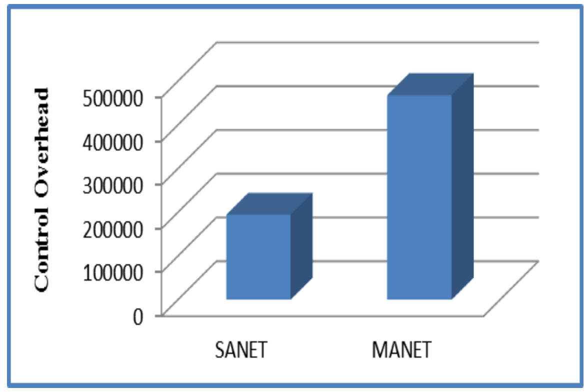

Figure. 9 Variation in control overhead in SANET and MANET

In the above graph (Figure. 9), Control Overhead is low in the case of SANET when compared to MANET.

5. Number of Control Packets: Total number of control packets sent.

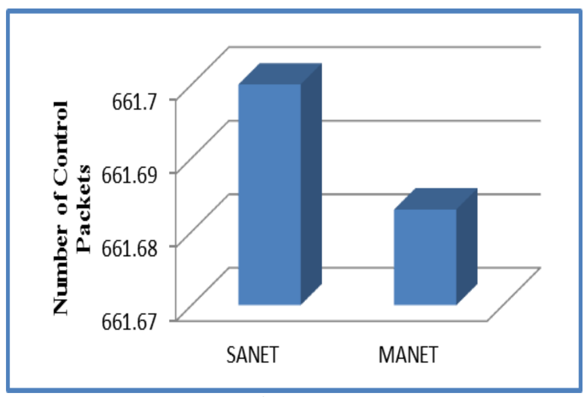

Figure. 10 Variation in number of control packets in SANET and MANET

In the above graph (Figure. 10), number of Control Packets is high in the case of SANET when compared to MANET.

Energy Efficient Routing Algorithms not only reduces the total energy consumption of a node but also rises the network lifetime. The main purpose of energy efficient algorithm is to make the network functioning last long. In MANETs, energy consumption takes place while transmitting, receiving and sleeping. Nodes consume more energy to transmit. Nodes are idle in sleep state, neither transmits nor do they receive any signals.

6. Energy consumption in transmit mode (mj): Energy consumed (Tx) by a node when it sends data packet to other nodes in network.

$$Tx = (330*Plength)/2*106$$

Where Plength: is length of data packet in Bits.

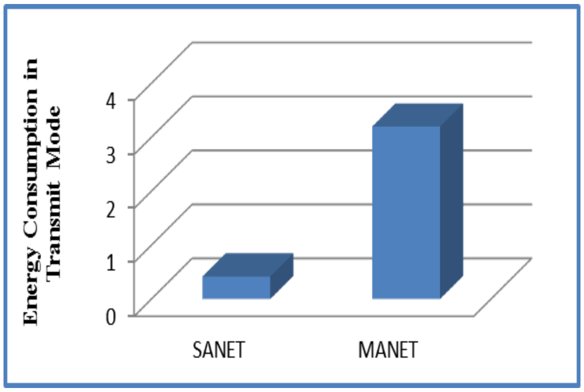

Figure. 11 Variation in energy consumption in transmit mode in SANET and MANET.

In the above graph (Figure.11), Energy consumed in Transmit mode is low in the case of SANET when compared to MANET.

7. Energy consumption in receive mode (mj): Energy consumed (Rx) by a node when it receives a data packet from other nodes in network.

$$Rx = (230* Plength)/2*106$$

Or

$$PR = R x / Tr$$

Where PR- Power consumed to receive packet, Rx- energy consumed to receive packet, Tr-time taken to receive data packet and Plength-length of data packet in Bits.

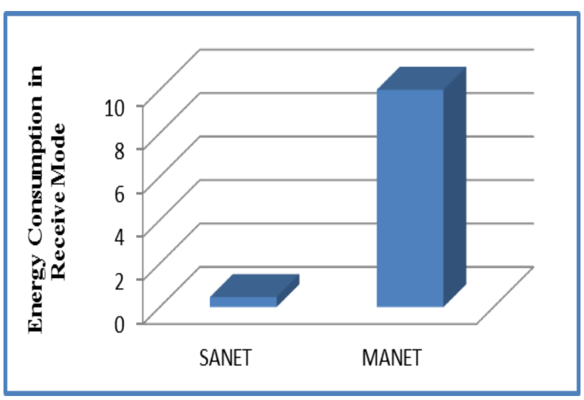

Figure. 12 Variation in energy consumption in receive mode in SANET and MANET.

In the above graph (Figure.12), Energy consumed in Receive mode is low in the case of SANET when compared to MANET.

8. Energy consumption in idle mode (mj): In this mode, the node is not transmitting or receiving any data packets. But because the nodes have to eavesdrop the wireless medium constantly to detect a packet that it should receive the energy is consumed.

$$PI= PR$$

Where PI is power consumed in Idle Mode and PR is power consumed in Reception Mode.

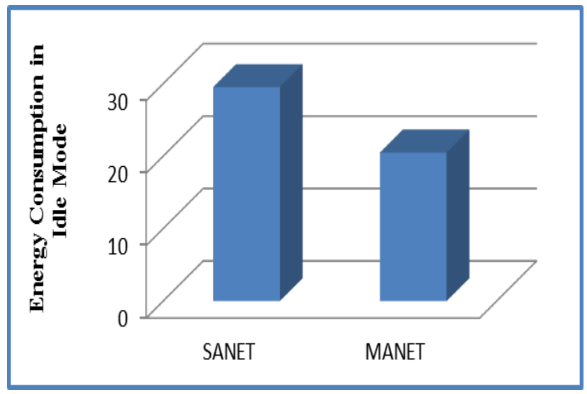

Figure. 13 Variation in energy consumption in idle mode for SANET and MANET.

In the above graph (Figure.13), Energy consumed in idle mode is high in the case of SANET when compared to MANET.

9. Total Energy consumption (mj): sum of all the energy consumptions in transmit, receive and idle modes.

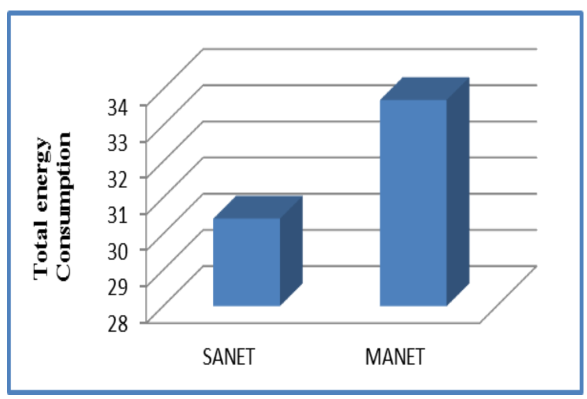

Figure. 14 Variation in total energy consumption in SANET and MANET

In the above graph (Figure. 14), Total Energy consumption is low in the case of SANET when compared to MANET.

V. Conclusion and Future Scope

This paper brings forth the basic difference between SANET and MANET using LANMAR routing protocol in terms of Average Throughput, Average Jitter, Average End-to-End Delay, Control Overhead, Number of Control Packets, Energy consumed in transmit mode, Energy consumed in receive mode, Energy consumed in idle mode and total energy consumption. In Mobile Ad hoc Network, nodes consume more energy as they move while in Static Ad hoc Network, nodes consume less energy as the nodes are static or have very less mobility .This work can be extended by incorporating the above techniques into the routing protocols of the wireless sensor networks for minimizing the energy consumption.

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