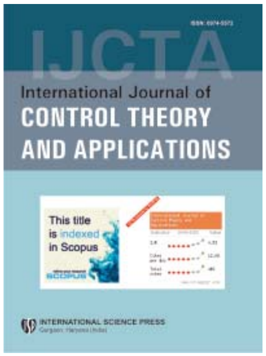

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Cluster Based TSS: An Efficient Rebroadcasting Algorithm for Wireless Adhoc Networks

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Abstract: Broadcast is a basic operation in network which allows the broadcast node to transmit a message to every nodes. All communications are carried out without wires in the perspective of wireless networks. Since network nodes are insufficient in energy, a proficient broadcast methodology is extremely necessary for improving the performance of the network. In this paper, a new broadcasting algorithm with dynamic topologies, Cluster based TSS (Time Sequence Scheme) is introduced for such network environments. The overall number of retransmission is reduced considerably by ranking and ordering timeslots of the broadcasting nodes with the help of CTSS algorithm. CTSS uses the direct neighbors information by that network reachability is attained with minimum broadcast delay. CTSS is implemented in both sparse and dense networks and the metrics considered to analyze the performance of this algorithm on both the networks are latency, hop count, reachability, delivery ratio and number of retransmissions.

Keywords: *Broadcast, Time Sequence Scheme, Sparse and Dense Network.*

1. INTRODUCTION

In Mobile Adhoc Networks, a source node that transmits message to every node is known as broadcast. The network nodes are inadequate in energy in their wireless medium and the efficiency of broadcast operation is determined by the number of rebroadcast and network reachability. For improving the performance of the network, a new approach to efficient broadcast in networks with dynamic topologies called Time Sequence Scheme (TSS) is introduced.

TSS ranks and orders the transmission of broadcasting nodes based on its time slots so that on the whole the number of re-broadcasts in the network is reduced. TSS uses the information about its direct neighbors by that network reachability is attained with minimum broadcast delay.

We have introduced the cluster based Time Sequence Scheme in dense network. The dense network is thus divided into different groups called as clusters. The clusters are formed by calculating the nearest neighbourhood information. The nearest neighbors are calculated using euclidean distance and based on that distance measure the clusters are formed. To broadcast the message to the nodes of each cluster, a cluster head is to be chosen among them. Hence Cluster head is selected by considering the middle node of each cluster. The broadcast node sends the message to cluster head and the head node passes the message to the neighbors of its clusters by applying Time sequence scheme on the network.

We have implemented and compared the Time Sequence Scheme in both Sparse and Dense networks which is clustered and is found to perform greatly in dense network even though the number of nodes is high. In sparse network the number of nodes considered is less comparing to dense network. The metrics considered to analyze the performance of this algorithm are Latency, HOP count, Reachability, Number of Retransmission and delivery ratio.

The objective of CTSS algorithm is to clearly make the most of the effectiveness of each broadcast. That is, each broadcast node i should reach as many as possible neighbouring nodes that have not received broadcast message. Also the number of rebroadcasts should be considerably reduced by that entire network is covered with minimum delay.

2. RELATED WORK

A number of existing studies in wireless networks focused on broadcasting information. In the literature review the disadvantages of broadcasting mechanism in MANET were discussed. Among the major limitations of pure flooding are the transmission complication and the broadcast storm problem [1].

Gossip-Based Ad Hoc Routing [3] describes where each node sends a message with some possibility, to reduce the overhead of the routing protocols. Gossiping exhibits dual mode behaviour in sufficiently large networks: in some executions, the gossip quickly dies and only just any node gets the message in the left over executions.

Broadcasting in Ad Hoc Networks Based on Self-Pruning [9] selects a small subset of hosts to form a forward node place to carry out a broadcast process. Each node on receiving a packet, determines whether to forward based on two-hop coverage conditions.

Another approach proposed by Donald J. Scott and Alec Yasinsac [5] describes the local topography of a network adjusts itself dynamically to provide efficient interaction between nodes in an ad hoc network.

3. PROPOSED WORK

The network model is designed with number of equal-sized nodes with unique identifiers, distributed randomly. Two nodes are said to be direct neighbors and can communicate openly if the euclidean distance measured between those nodes less than its range limit. The nodes are assigned with time slots such that no two nodes broadcast the messages during same timeslot. A node is covered if that node has been already retrieved the broadcast message. The start node of a broadcast session is always covered. The uncovered node is a node which has not yet retrieved the broadcast message.

The broadcasting node covers the maximum uncovered nodes on each transmission. Thus, each transmission deletes the maximum number of covered nodes with minimum transmission by that network reachability is attained.

An efficient broadcast algorithm should possess the features like Nodes Reachability, number of rebroadcasts, Latency and neighbourhood knowledge. The existing approaches discussed in related work do not satisfy all the above features. The message should be transmitted only once so that the number of rebroadcasts is reduced considerably with low latency which was not achievable using broadcast storm problem. The gossiping approach do not satisfy the important criteria *i.e.*, node reachability.

The features for an efficient broadcasting mechanism are satisfied by CTSS algorithm. CTSS's methodology prevents algorithmic limitations that affects broadcast scheme.

4. SYSTEM MODEL

In the context of network, a sparse network is a network with less number of links than the maximum possible number of links within the same network. The sparse nodes are deployed randomly in the network topology and also it provides the unique ID to the deployed nodes. The time slot is assigned to each node with the help of vector set construction algorithm.

Initially the broadcast node ranks and orders the transmission priority among its neighbors according to its time slot assigned.

The neighbour nodes are selected depending on the coverage area of the node. The distance measure used for the neighbour creation is Euclidean distance measure as mentioned in (1).

$$\text{dist}([x, y], [a, b]) = \sqrt{(x-a)^2 + (y-b)^2} \qquad (1)$$

Next the broadcast node transmits the broadcast message to its neighbors and marks them as covered. The neighbors that are not yet received the message are said to be uncovered. Those nodes schedule themselves again and reassign its time slot. The same process is followed until all nodes are covered. The system model is described in fig 1. In Time sequence broadcasting scheme, first step is the construction of the vector set which is done by every node during the broadcast session.

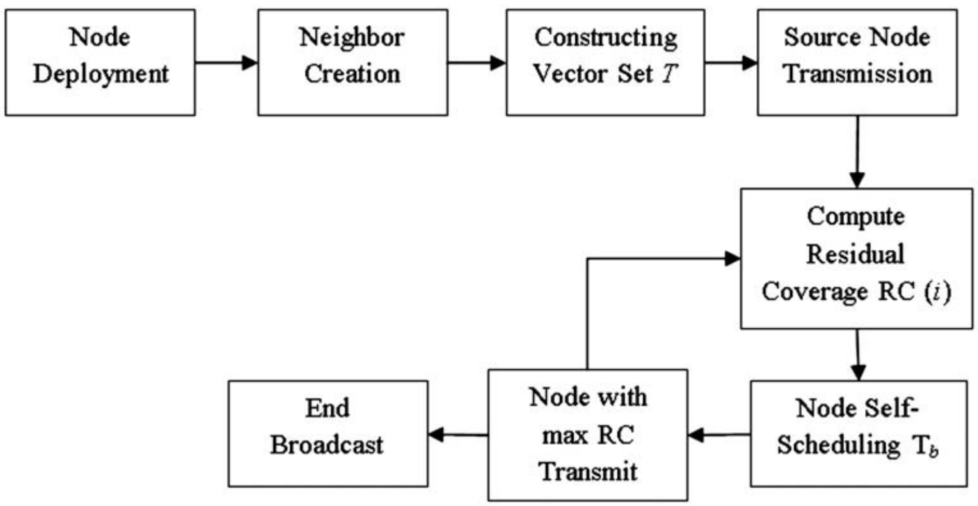

Figure 1: Architecture of TSS

The vector set construction algorithm is given below:

1. Initialize the Time slot with upper,lower and middle values.
2. Under the condition middle value greater than 1, Compare the middle value with lower value.
3. If both are equal, decrement lower value by 1. Otherwise decrement middle value by 1.
4. Determine next time slot values depending upon the previous values.

This algorithm generates some series of time slot at which the broadcasting of any particular node should take place. The time-slot is defined to have repeated timeslot units reordered for each epochs or levels. Then each node calculates the residual coverage for that node.

The residual coverage is the uncovered node in the neighbour. The residual coverage of the node is the uncovered neighbour of that node and this can be determined by two messages RQc and RPc. The residual coverage of a node is calculated from the number of its direct neighbors uncovered at time *t*. The coverage of network is calculated as mentioned in (2).

$$nc = RQc - RPc \quad (2)$$

where *nc* is the network coverage, RP*c* and RQ*c* are the reply on coverage and request for coverage on the network respectively.

The entire node then runs the Self-Scheduling algorithm to determine the time of transmission of that particular node.After the transmission of any node in the time-slot every other node should calculate the residual coverage again and then run the Self-Scheduling algorithm to determine their transmitting time-slot. The node Self scheduling algorithm is given below:

1. Associate the vectors constructed from algorithm1 to form current time slot.
2. If residual coverage of a node is greater than the current middle value, the node will transmit the message in the next allotted time slot.
3. Otherwise if the residual coverage is greater than lower, then the particular node will hold the current value.
4. If the residual coverage is even less than lower, then the particular node will hold the later level depending on its value.

The above modules are implemented in both sparse and dense network. A comparison is made between those networks to evaluate the performance. The sparse network is deployed and broadcast process is done as shown in figure 2 below.

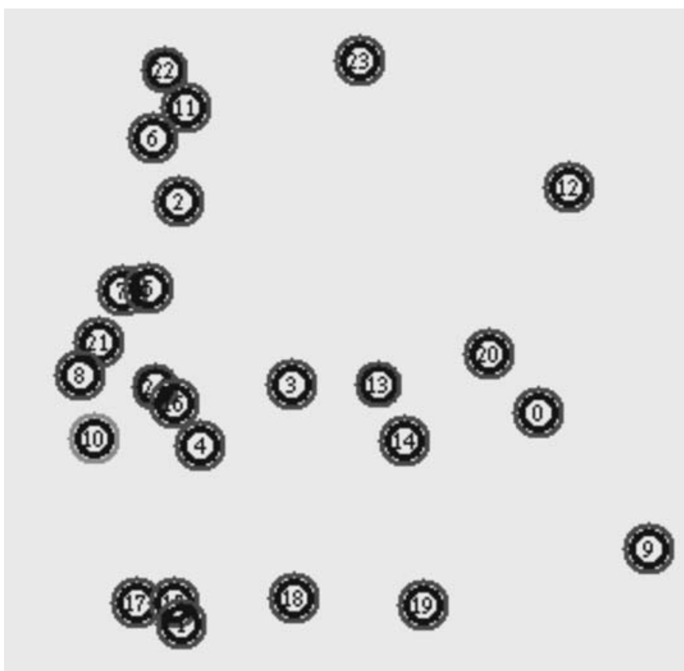

Figure 2: Sparse Network

5. CTSS IN DENSE NETWORK

A dense network is a network that has maximum number of nodes within its range of transmission. Each node is connected to almost all nodes. When CTSS is implemented in dense network since the number of nodes is seems to be maximum, the transmission time taken to cover all the nodes will be higher. In order to avoid this delay, clustering concept could be applied over dense network.

Deploy the dense network such that the number of nodes is close to maximal number of nodes. Partition the entire network region into four segments leads into intra clusters. A centric node is selected as cluster head among each intra clusters for transmitting message. Source node selected to transmit the message broadcasts to cluster head of all intra clusters.

CTSS is implemented in intra clusters by finding its neighbors. The neighbors are found out by ranking ordering their priority based on its assigned timeslot. Cluster head node covers its neighbors thus marking them as covered. The uncovered neighbors reassign its time slots in their next epochs and waits for the broadcast message. Each of the nodes that are covered then sends the message to uncovered neighbors by ranking them. The process is repeated until its region is covered.

The dense network is deployed with 4 clusters and broadcast process is done with the help of cluster head as shown in figure 3 below.

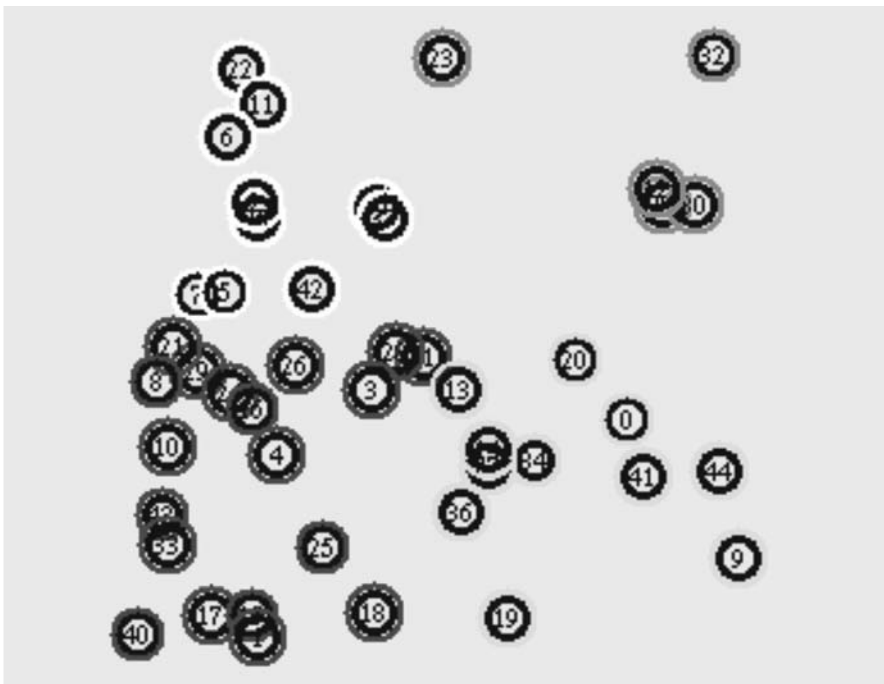

Figure 3: Dense Network

In sparse network the number of retransmission can be considerably reduced even though latency is little high when compared to dense network. But the entire network would be covered without any loss of information. Cluster based Time Sequence Scheme (CTSS) broadcasting nodes ranks in a distributed way by priority basis, so that on the whole the number of re-broadcasts in the network is reduced in dense networks.

6. PERFORMANCE EVALUATION

The performance evaluation is done between sparse and dense network based on the metrics such as number of retransmission, reachability, latency, and hop count and delivery ratio.

In this simulation Ad – hoc On – demand Distance Vector (AODV) routing protocol is used and the simulation studies are carried out based on the parameters described in the Table 1 below.

Table 1
Simulation Parameters

Simulator	*NS2*
MAC Layer	IEEE 802.11b
Packet Size	64–1000 bytes
Number of nodes	[100-1000]
Time-slot duration TSS/NTSS:	50[ms]
Network size	1000m x 1000m
Velocity of Nodes	0-10 m/sec
Node distribution	Uniform/clustered
Transmission range	300m

The network range is defined to be 100 to 1000 and number of nodes chosen as 25 to form a network. The coverage area is defined as 250 and node 10 is chosen as broadcast node.

The calculation of Packet Delivery Ratio (PDR) is based on the received and generated packets as recorded in the trace file.

In general, PDR is defined as the ratio between the received packets by the destination and the generated packets by the source and is illustrated in the figure 4.

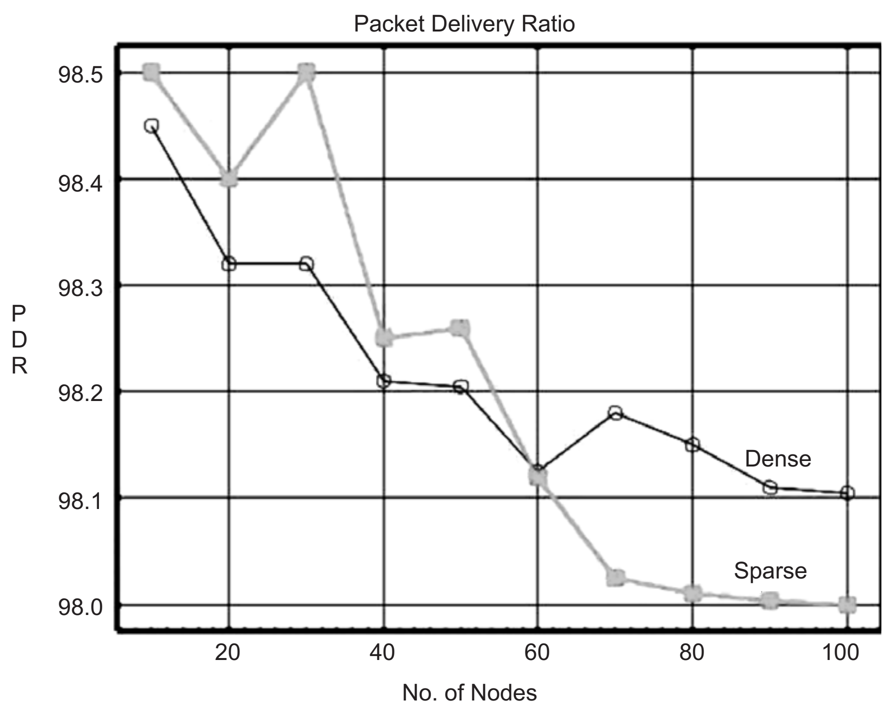

Figure 4: PDR

The analysis of node retransmission is made for sparse and dense networks is shown in fig 5. The number of retransmission is considerably reduced in dense network even the number of nodes is higher compared to sparse network.

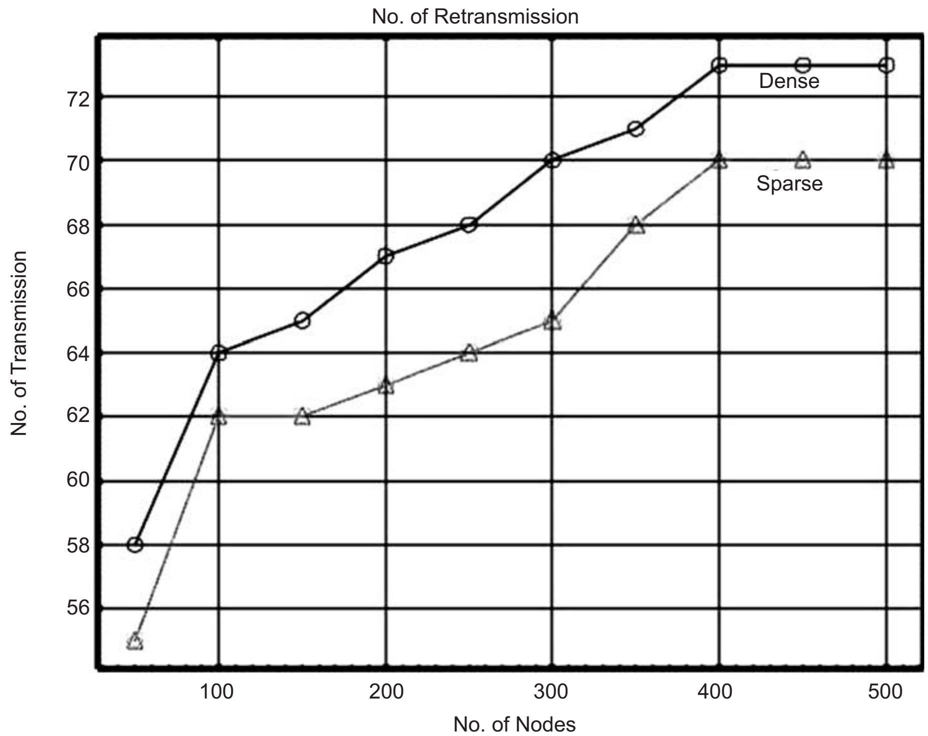

Figure 5: Number of Retransmission

The analysis of sparse and dense network for reachability is shown in figure 6. Reachability can be calculated as the number of nodes covered in every iteration.

In sparse network the fraction of nodes covered takes the probability approximately 1.0 to reach the network. The number of nodes considered for broadcast is between 100 and 500. *s*.

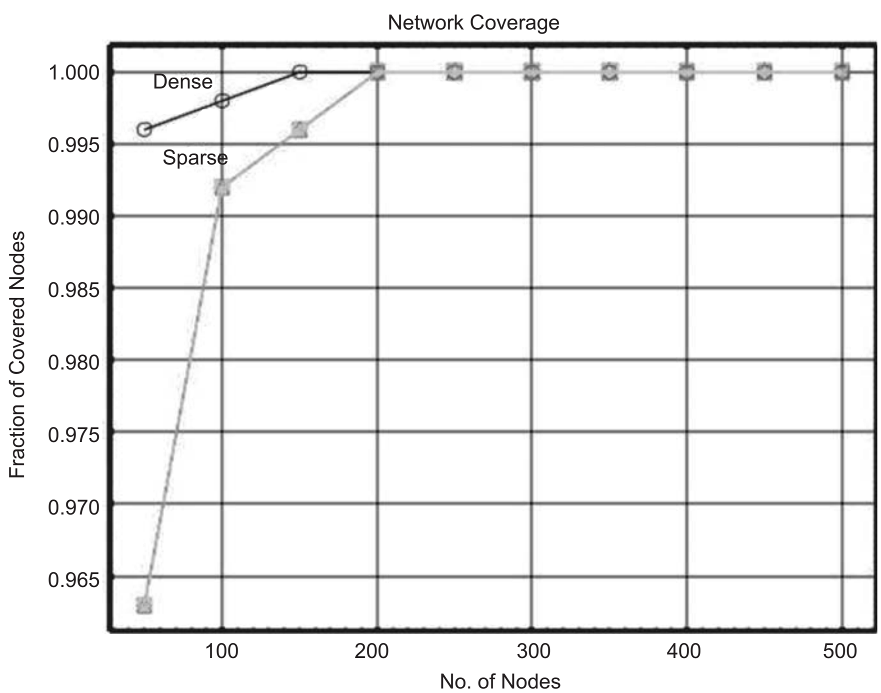

Figure 6: Reachability

The analysis of sparse and dense network for delay calculation is shown in fig.7. The delay factor is high in sparse network of about 7ms even though the number of nodes is less when compared with dense network.

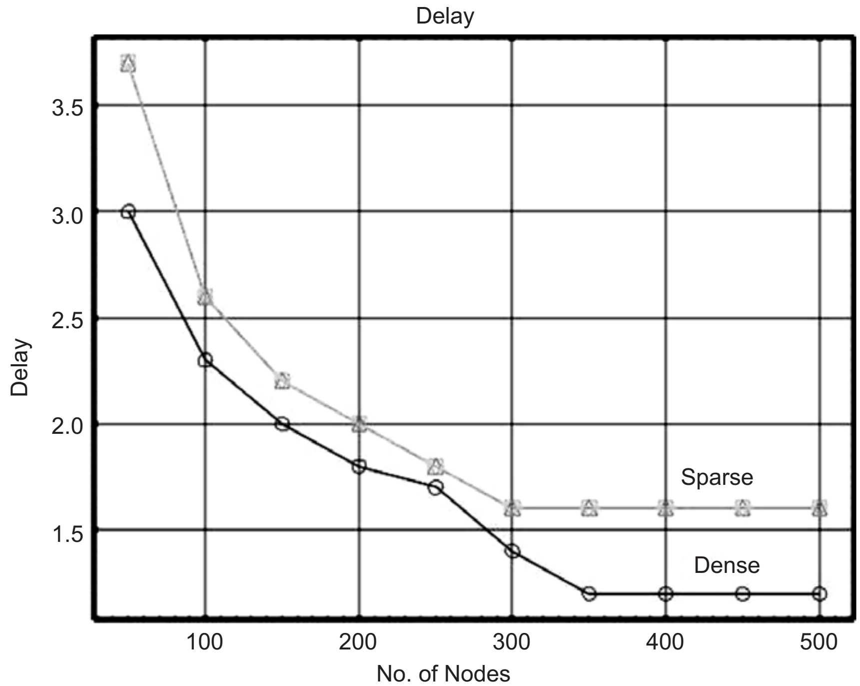

Figure 7: Delay

The CTSS based broadcasting algorithm is compared with the probabilistic based approach called as gossip based ad hoc routing. During analysis it is found that the Packet delivery is high with CTSS based approach than Gossip based approach. The figure 8 shows the compared results of both approaches for packet delivery ratio.

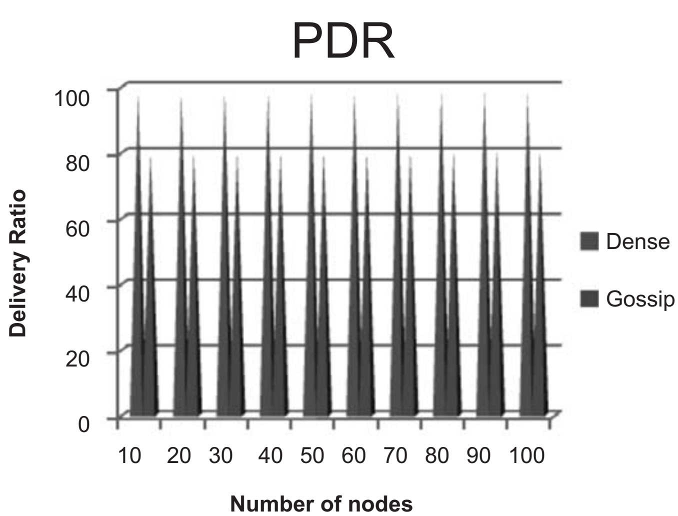

Figure 8: PDR for gossip and CTSS in Dense Network

While comparing the delay factor with gossip based approach and CTSS approach, the time taken to broadcast is high for gossip based approach to reach the entire network and is shown in fig 9 below.

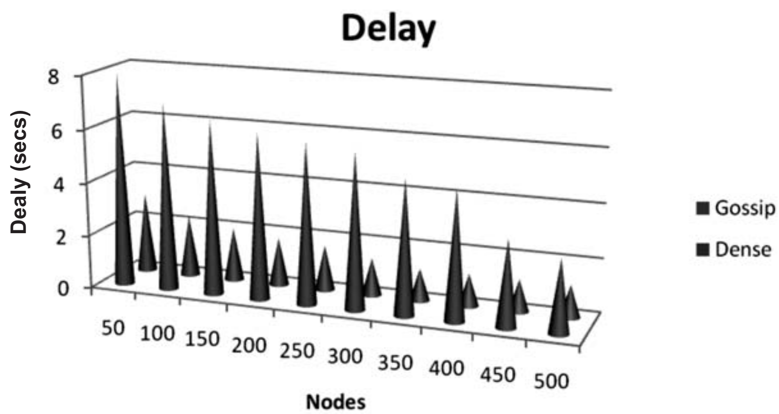

Figure 9: Delay for Gossip and CTSS in Dense Network

The comparison is made on both sparse and dense network is described in the Table 2 below. The number of nodes considered ranges from 50 to 350 is shown in the table. It is observed that the metrics like delay and number of rebroadcasts are reduced considerably with dense network.

The node reachability in dense network is attained higher than sparse network since the nodes are grouped into different clusters. Packet delivery ratio in dense network is also high compared to sparse network.

Table 2
Metrics Comparison

	Sparse Network				*Dense Network*			
No. of Nodes	*PDR*	*No. of Re-txn*	*Delay (ms)*	*Reachability*	*PDR*	*No. of Re-txn*	*Delay (ms)*	*Reachability*
50	98.5	55	3.7	0.96	98.45	58	3	0.996
100	98.4	62	2.6	0.99	98.32	64	2.3	0.998
150	98.5	62	2.2	0.99	98.32	65	2	1
200	98.25	63	2	1	98.21	67	1.8	1
250	98.26	64	1.8	1	98.205	68	1.7	1
300	98.12	65	1.6	1	98.125	70	1.4	1
350	98.02	68	1.6	1	98.18	71	1.2	1

CTSS based approach has number of advantages over other approaches referred in the literature. First, number of retransmissions is reduced considerably by covering entire nodes since the network is divided into zones and grouped as clusters. Second, Broadcast message is transmitted with low latency and network reachability is high.

7. CONCLUSION

In this paper, a new scheme is introduced called CTSS, for broadcasting in sparse and dense networks based on ranking and arranging the time slots fixed for the nodes in a network. The performance of broadcasting schemes on sparse and dense network is compared by analyzing the metrics like transmission complexity, delivery ratio and the delay. While comparing with other broadcasting schemes the performance is achieved with low delay and minimum number of retransmissions for the CTSS algorithm. Further, one among the soft computing techniques called Genetic algorithm could be applied on selecting cluster head in dense network that may broadcast messages to the entire network.

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