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Elective Power-Cluster Method in Cooperative Wireless Communication for Effective Power Consumption and Data Reporting

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ABSTRACT: Communication between source and destination is improved using the relay node to enhance the signal for transmission in Cooperative communication. It improves the efficiency of data reporting and power consumption in wireless network by reducing the transmission power and interference. The relay channel uses three schemes such as decode-and-forward, compress-and-forward and amplify-and-forward which consumes power and resources from the relay nodes. Existing system targets over the enhancing efficiency over the single relay node, we proposed a new method to use the group of relay nodes as a single unit. Our proposed model termed as elective power-Cluster method enhanced the cooperative routing algorithm to improve data reporting and power consumption. Relay nodes are grouped into clusters and uses elective technique to distribute the power consumption over the clusters and Max-flow min-cut theorem is used to derive the channel capacity formula. The performance is increased by segmenting the routing area into clusters of nodes and routing through the effective power enhanced node in the clusters. Proposed model is simulated using ns2 and the results are favourable.

KEYWORDS: Cooperative communication; relay channel; power consumption; routing algorithm.

I.INTRODUCTION

Wireless communication plays a vital role in the network. Mobility and low maintenance cost are the major advantages over the wireless communication. The cooperative communication network is used to improve the network capacity in wireless network. It improves various key areas such as reducing the interference, improving the transmission power and effectively enhancing the transmission signal from source to destination nodes. When a signal is transmitted from source, the signal loses its strength with distance and it gets distorted to the destination.

Relay nodes [1] are used in between the source and destination to enhance the signal strength. Fig.1 shows the cooperative communication in which wireless nodes act as relay, which receives the signal, manipulate it and retransmit to the next node.

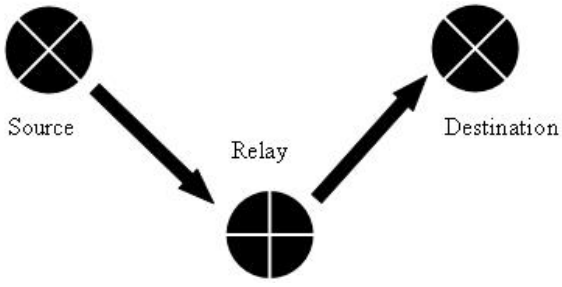

Fig. 1. Cooperative communication

$$y_{SourceRelay}=h_{SourceRelay(X)} + n_{sourceRelay} \quad (1)$$

$$y_{SourceDestination}=h_{SourceDestination(X)} + n_{sourceDestination} \quad (2)$$

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$$y_{RelayDestination}=h_{RelayDestination}f(y_{SourceRelay}) + n_{sourceDestination} \quad (3)$$

Decode-and-Forward:The source signal is decoded by the relay node and retransmitted to the next node. To decode the signal, the relay node should be a part of the sensitive node in the network and consumes more energy to decode and forward the signal.

Achievable rate =

$$\max_{p(x1,x2)} \min(I(x1;y1|x1),I(x1,x2; \quad (4)$$

Compress-and-Forward:The signal is received from the source and compressed before sending to the next node. Energy consumption is more since it encode the signal to compress it.

Achievable rate =

$$\max_{p(x1)p(\hat{y}1|y1)p(x2))} I(x1;\hat{y}1,y| \quad (5)$$

Amplify-and-Forward:It consumes less energy compared to the other schemes since the signal is not processed. Signal strength is enhanced and retransmitted to the next node.

II.POWER MANAGEMENT

Relay node consumes energy during retransmission of signal and data reporting. If a sender transmit large amount of signal to the destination, then the path of relay node to support will not vary if relay node reside in stable position. This uses the energy of the same relay nodes and it depletes the entire energy results in the dead state nodes. Then alternate relay nodes are used and this process is carried out which depletes power. Power management [2] in existing system should be enhanced to effectively segregating the usage of relay depending upon various network factors. We propose Elective Power-Cluster method which uses various network parameters to enhance the energy consumption in relay nodes and effectively improves uncertainties in signal propagation and data reporting.

Energy harvesting is a technique to gather energy resource using sustainable solutions such as solar power to provide power source to the relay nodes. Several power allocation methods are developed that allows wireless networks to process signals and power simultaneously using external power source. This energy uses multiple source-destination pairs that communicate each other via an energy harvesting relay. Individual nodes in a network may be overloaded with processing tasks which depletes the energy and shutdown the node. A proper flow should be adopted to organize the power depleting tasks. We have modelled cluster of nodes to handle the signal processing to handle the task distributed among the nodes. Total energy of the cluster are used as the energy harvesting technique without use of any hardware resources.

Various routing protocols are used in wireless network which decides the transmission path and controls the navigation of signal from source to destination.

II.I. Ad hoc On-demand Distance Vector (ADOV)

AODV is an on-demand routing protocol used widely in wireless communication. It adapt low processing, less memory overhead and has following characteristics.

- Reactive or on demand
- Uses bi-directional links
- Route the discovery cycle used for route finding

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- Sequence of numbers is used for loop to prevent looping and as route freshness criteria
- Provides unicast and multicast communication.
- Dynamic link generation

We have compared the power consumed using ADOV with the proposed model used in AODV to ensure the efficiency of the proposed model.

III.POWER CLUSTER

Collection of wireless devices are connected with each other as a cluster in wireless network. Wireless devices may perform relay behaviour at any time when there is a necessity for relay in the cooperative wireless network [3]. A cluster of wireless nodes which are capable of processing the signal and retransmitting to the next node are known as Power-Cluster. Power source of the nodes are considered as a vital key parameter to identify the cluster identities. A cluster consist of devices with various power capacity and are capable of exposing the relay behaviour as a unit. Depending upon the power capacity, the relay nodes are exposed as four types.

Top Processing Relay Node (TPRN) – relay nodes which has above 80% of power capacity.

Average Processing Relay Node (APRN) – relay nodes which has power capacity between 60% and 80%.

Medium Processing Relay Node (MPRN)– relay nodes which has power capacity between 40% and 60%.

Low Processing Relay Node (LPRN) – – relay nodes which has power capacity between 40% and 20%.

Cluster power base (ψ) is the percentage of power stable of cluster. It act as energy harvesting [4] relay scheme for other nodes in the cluster. Cluster power base is the key phenomenon that holds the efficiency of the cluster to manipulate the signal.

IV.ELECTIVE PROBABILITY OF RELAY NODE

Amplify-and-Forward consumes less amount of energy and Compress-and-Forward consumes more energy compared to other mode of relaying schemes [5]. MPRN are used to handle the AF schemes, APRN handles DF schemes and TPRN handle CF scheme.

Fig. 2 shows the cluster formation in the cooperative communication network. Fig. 3 shows the strength of cluster that can handle relay schemes. It depends on the percentage of processing nodes in the clusters

V.COOPERATIVE SCHEME

Cooperative scheme combines two signals received from source and relay nodes. The signals may be received from many relays. Without use of cluster formation as proposed, the nodes involved in transmission is not controlled. The signal propagation allows many nodes to react for signal transmission and drains the power of nodes. Channel capacity of the cooperative network can be derived from as

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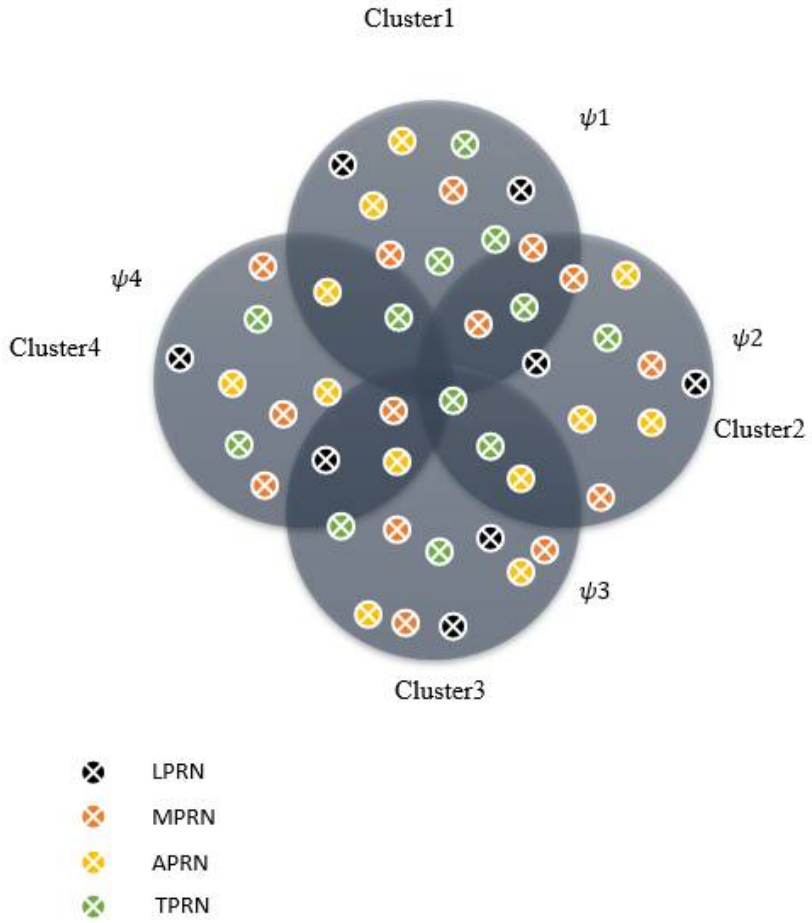

Fig. 2. Power-Cluster formation

$$\text{Capacity. } C = \max_{0 \le \rho \le 1} \min \begin{cases} \frac{1}{2}\log(1 + (1-\rho)(S_n + R_n)P_1 \\ \frac{1}{2}\log(1 + R_n P1 + D_n P2 + \\ 2\sqrt{\rho R_n D_n P1 P2}) \end{cases} \quad (6)$$

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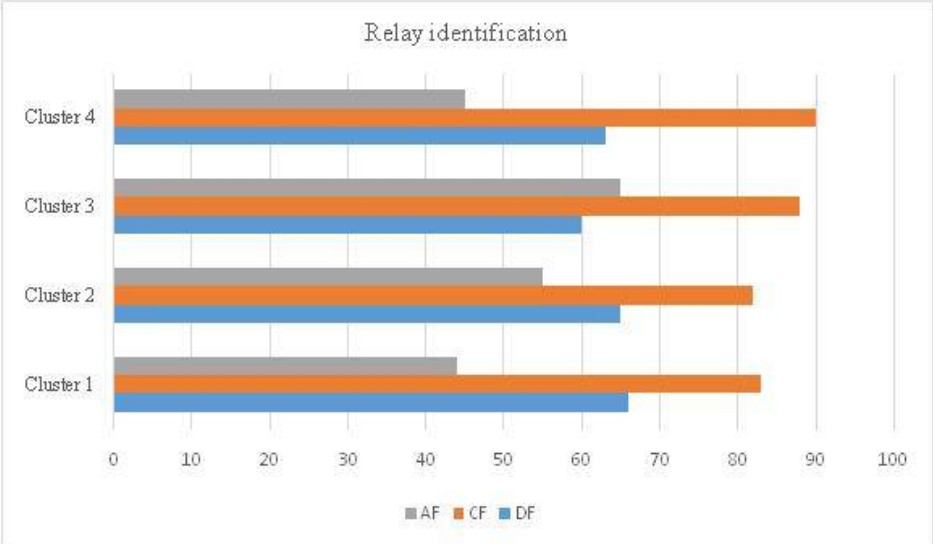

Fig.3. Relay identification

Equation (6) is derived by using Max-flow min-cut theorem which states that maximum flow passing from source to destination is equal to the capacity that caused the situation that no flow pass from source to destination. The linear program formulation of Max-flow min-cut theorem is used to derive channel capacity. The channel capacity should be increased with limited power consumption. When a signal is transmitted in wireless ad-hoc network, nodes relay act simultaneously results in the wastage of power. Proposed model limits the power consumption by using selective method of nodes to handle the transmission [6]. ADOV consumes various nodes to transmit the packet and consumes major part of the nodes in the network as relay nodes.

VI.ELECTIVE POWER – CLUSTER ALGORITHM

Cooperative scheme involves in sending signal from source to destination through relay networks. For references, multiple relay nodes transmit the signal from source to destination for signal referencing. Since it is not clearly structured in ADOV protocol, all nodes in the selected path may react to the signal propagation without any consideration over power energy. Continuous flow of energy in same path may deplete the full energy source and relay node moves to the dead state. An alternative route is determined and process takes place. Proposed model controls the propagation considering the power energy of the node. Since nodes in the group of clusters are tagged as LPRN, MPRN, APRN and TPRN, these nodes are used wisely depending upon the decode schemes. Cluster of node acts as an energy harvesting system in which node that involve in propagation may replace the other node due to the power energy depletion beyond threshold.

Cluster power base acts as the virtual limited energy harvesting technique for the nodes. The nodes that handle the transmission are changed periodically when the particular node power falls under different threshold as shown in Fig.4.

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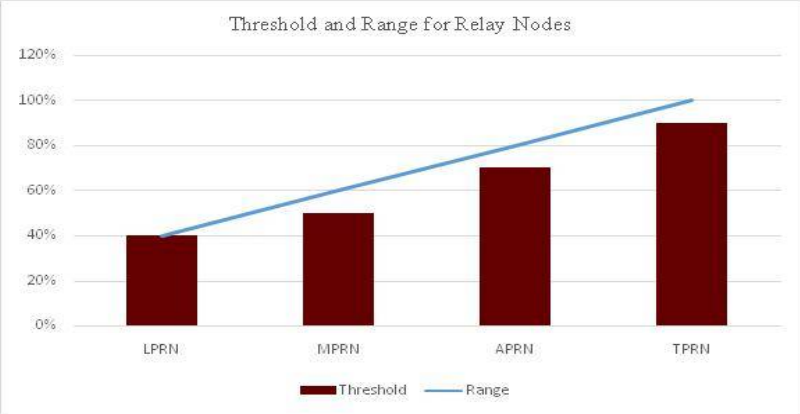

Fig.4. Threshold vs relay for relay nodes

Cluster power base

$$\psi = \sum_{n=1}^{N} P_n + C \qquad (7)$$

Where n represent node, Pn represent power in the node n and C represent any constant power consumption in the node. C is 0 when node is a dedicated relay node.

Fig.5 illustrates the cooperative network with relay nodes. AODV algorithm uses the all nodes as relay nodes to transmit the signal. Nodes are distributed among the network with varying power source. AODV randomly picks the shortest path node and transfer the signal to the destination. The power consumption lies on particular relay nodes which results in the shutdown of the nodes due to the persistent use of the nodes. Energy harvester act as an energy resource for the nodes and power up the nodes which results in the loss of power for particular node [7]. If the cluster has no energy harvesters, the concentrated power consumption over a node will remove the node from the network due to lack of power.

VII.FORMATION OF POWER – CLUSTERS

The nodes are arranged into power-clusters as described in section 2. Each nodes are grouped under various types of relay nodes. Channel capacity should be improved without consuming much power of the node [8]. Cluster power base is calculated using formula (2) which ensure the efficiency of the clusters.

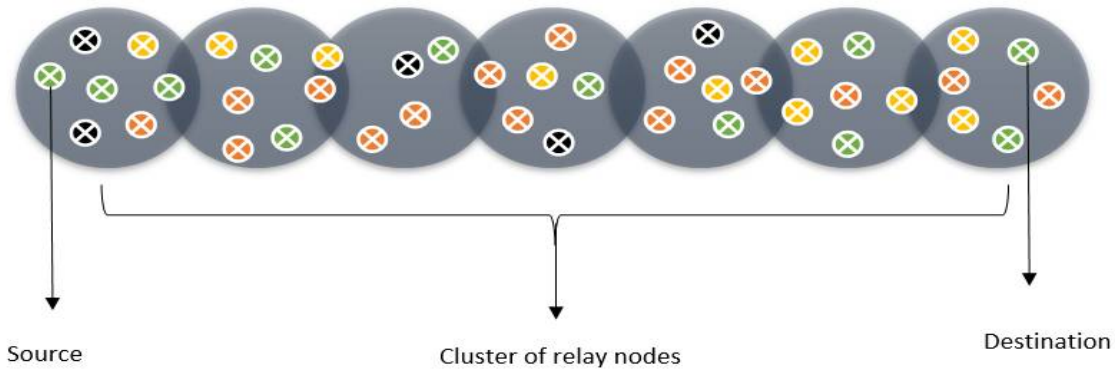

Fig.5. Cooperative network with relay nodes

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Energy harvester in the cooperative network are used when the Cluster power base falls under the threshold level. The threshold value is derived from the effective capacity channel and achievable rate of the cluster. When the capacity channel and achievable rate for cluster are not effective [9], the energy harvester are used to power-up the Low Processing Relay Nodes in the cluster. The power sources from the energy harvester are used only when the power is limited within the cluster whereas existing model power-up all nodes with low power [10]. This technique saves the power wastage over the nodes in the cooperative network while routing [11].

VIII. RESULT AND OUTPUT

In this section, the computer simulation will be carried out to demonstrate the performance of the Elective power-cluster model. Table.1 defines the configured settings for the ns2 simulation [12 - 15].

Table 1.Configuration setting in ns2 simulation

Simulator Time	141sec
Number of Nodes	1200nodes
Traffic Type	CBR
Energy Model	Energy Model
Minimum Initial Energy	2.23 joules
Antenna Type	Omni Antenna
Interface Queue Type	DropTail
Cookie Minimum Size	2Kb

Fig.6 and Fig.7 describes the comparison report of power consumption in AODV and effective power consumption method. AODV allows the energy harvester to reload the power in the nodes when power drains to shut down. Since certain nodes in the shortest path are used, persistent use of the node result in the loss of energy due to overheat and other parameters [16]. The nodes are compared as a cluster in existing AODV model for ease of comparison.

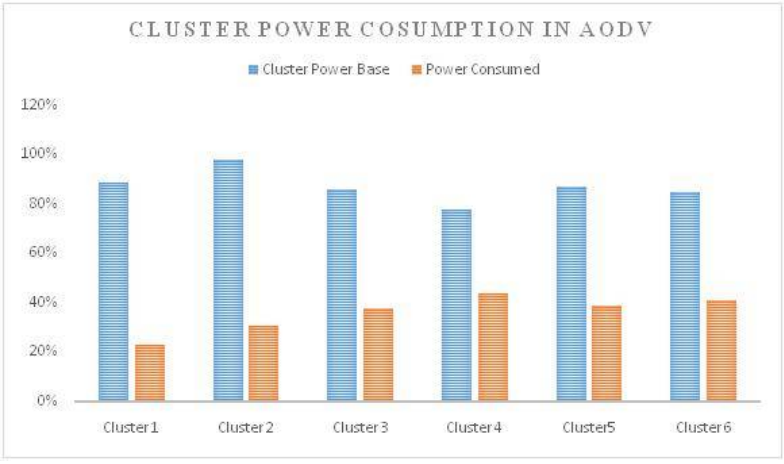

Fig.6. Cluster power consumption in AODV

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Elective power- cluster model reduces the use of same node for transmission of the signal. The use of node for various type of relay nodes are chosen electively as explained in section 2. When cluster drops power below effective achievable rate and capacity channel, energy harvester power-up the nodes and retain the efficiency.

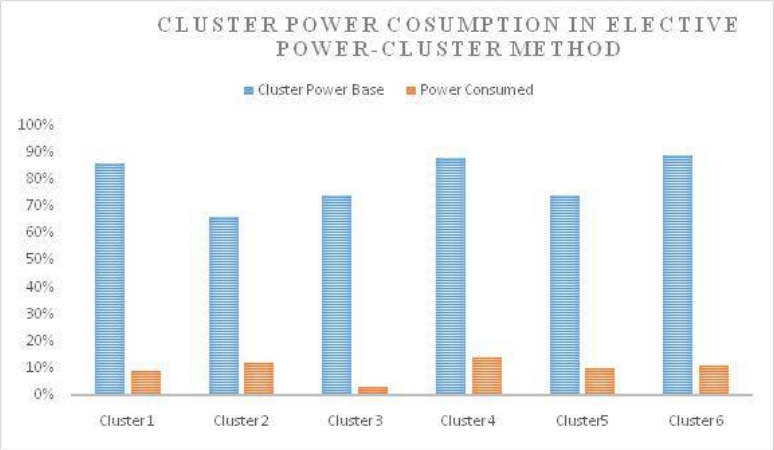

Fig.7. Cluster power consumption in Elective power-cluster method

Fig.8 shows the comparison graph of shut down nodes in the network without energy harvester. Due to the persistent use of the same relay node, power drops and leads to shut down. Proposed model will switch the use of node when it falls under the threshold value, which prevents the node from shut down.

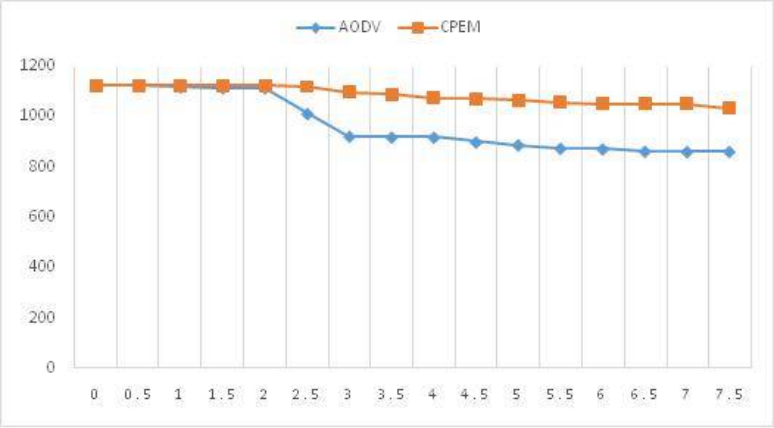

Fig.8. Shutdown nodes in the network

Data reporting acknowledge the sender for the successful delivery of the packets. Fig.9 shows the successful delivery of packet count for existing AODV model. The packets are dropped mainly due to the loss of relay nodes due to the shut-down. AODV changes path to transfer the packets when there is a loss of relay nodes and when these node mobile to out of range location.

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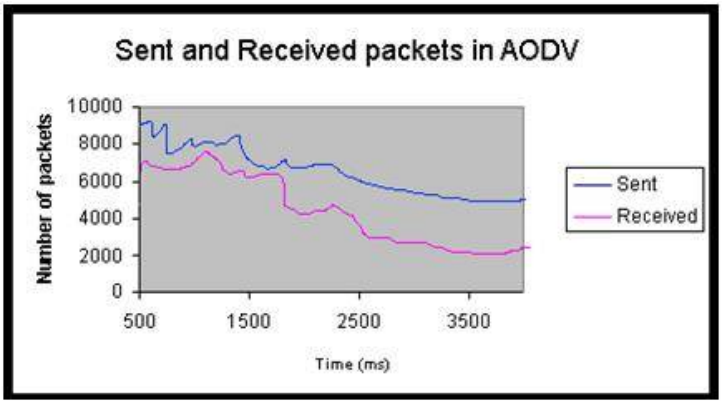

Fig.9. Send and received packets in AODV

Fig.10 shows the efficient packet transmission over the network since relay nodes are preserved during the transmission of the packets. When a node run out of power, proposed Elective power-cluster model calculates the cluster and select another relay node to transmit the data. Major packets are preserved and data reporting is carried out

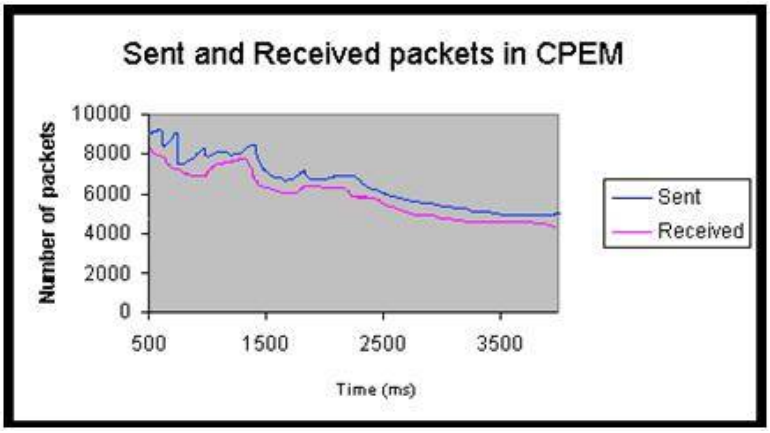

Fig.10. Send and received packets in CPEM

IX.CONCLUSION

We have proposed an effective way to handle the power utilization and data transmission of relay nodes in cooperative networks. Elective power-cluster method effectively manages the power consumption in the network by distributing the signal transmission load to various relay nodes. Clusters are formed depending upon the range of use. Larger cluster may result in performance degradation and signal transmission within the cluster is not advisable. Based on the threshold value, each cluster rearranges the nodes and transmitting relay nodes are changed frequently within the cluster. . The three schemes of relay channels such as decode-and-forward (DF), compress-and-forward (CF) and amplify-and-forward (AF) consumes energy differently. These schemes are handled separately and nodes in the energy cluster are used with different formation of node cluster. Thus individual node's energy is consumed based on the type of relay scheme and thus efficient power is consumed throughout the network. The simulation result shows that the proposed modal handles the transmission of packets [17] effectively to lower the power usage. Energy harvester that are used to power-up the nodes are discussed and proposed model handle it effectively to resume power backup only during the cluster threshold variation. In future work, the proposed modal can be improved to handle the dynamic shortest path identification during the loss of packets due to other network parameters.

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