CO-OPERATIVE P2P INFORMATION EXCHANGE (CPIE) USING CLUSTERING APPROACH IN WIRELESS NETWORK

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ABSTRACT

Wireless P2P networks such as ad hoc network, mesh networks, and sensor networks, have become a popular technology due to their potential to support huge volume of data with reliability and fault tolerance. Cooperative Peer to Peer Information Exchange (cPIE) is an innovative technique to improve the data availability using data present within the peers in the network. But the performance degrades gradually with increase in the number of peers in the network. Clustering approach is proved to be more efficient for solving the scalability problem in wireless networks. In this paper, we propose a cooperative PIE technique for large wireless P2P networks using clustering approach. Simulation result shows that the proposed technique improves the performance than the existing PIE techniques in network with large number of peers.

KEYWORDS: *P2P; cooperative; information exchange; wireless networks; cluster.*

I. INTRODUCTION

Regarding the perception of communication, there subsist a huge number of networks which we rely on such as internet, mobile networks, peer-to-peer (P2P) networks, wireless networks, etc. Efficient research has been concentrated on the operation and management of communication networks with the essential intention of information transfer in terms of high reliability, security, robustness, and throughput. Wireless P2P networks are more comfortable for many applications since it offers a higher level of self independence and also managing the services what they exploit. Normally in P2P networks the clients won't be cooperative. It highly depends on the way system is built, if it is not proper it leads to dreadful conditions of the service and also the entire system will be collapsed. Thus, making the wireless P2P network nodes work cooperatively improves the overall efficiency of the application and the network. On the other hand, distinct sending sequences or scheduling strategies will have a straight impact on the overall network due to the shared wireless channel and the de facto half-duplex transmission quality. In some cases, the gap between the optimal and the worst is vast. Therefore, the information exchange among a group of peers still faces one more scheduling problem, which is unlike from the block scheduling problem. In this paper, we recognize such a problem of determining peer sending sequences as the peer scheduling problem. In other words, the peer scheduling problem is how to determine the scheduling policy among a group of potential senders to achieve the maximal utilization of limited wireless resources.

A peer scheduling problem means between the groups of capability senders how to resolve the scheduling procedure to accomplish the maximal deployment of restricted wireless resources. We illustrate the peer scheduling problem using the following simple situation, consider in a wireless network which holds seven peers, nodes 1, 2, 3,4,5,6 and 7. And these peers communicate each other through a shared wireless channel. The main aim of this exchange is that each peer should have all the seven blocks and we are guessing to achieve this aim with lowest number of transmissions through arranging the sending sequence. These peers plan to exchange with each other a part of information which is consisting of seven blocks.

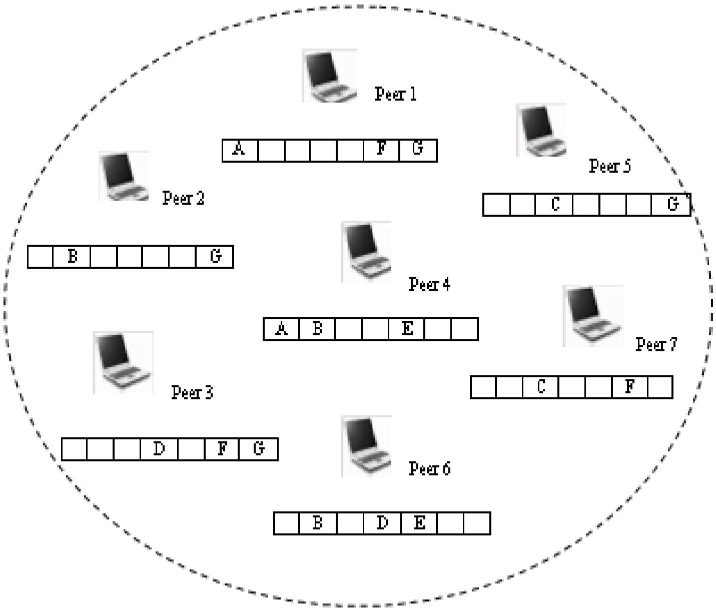


Fig 1. Cooperative Peer-to-Peer Information Exchange in Wireless P2P networks

Table 1 Peer Sending Sequence

IN-EFFECIENT	EFFICIENT
I) 1 < A, F, G > II) 2 < B, G > III) 3 < D, F,G> IV) 4 <A, B, E> V) 5 < C, G>	I) 1 <A, F,G> II) 6 <B ,D,E> III) 5 <C>

Presently, peer *1* owns block A, F and G; peer *2* owns block B and G; peer *3* owns block D, F and G; peer *4* owns block A, B and E; peer *5* owns block C and G; peer *6* owns block B, D and E; peer *7* owns block C and F. In this example we can confirm through our reconsidered principles that peer sending sequence of <1, 6, 5> is a finest solution but <1, 2, 3, 4, 7 > is not finest solution. The solution is given in terms of transmission efficiency under the account of no packet loss and the peer should always send out packet with all the blocks it holds. Since each wireless nodes help mutually, we can consider this problem as Co-operative Peer-to-Peer Information Exchange (cPIE) approach.

When the number of nodes in the network increases, the network performance decreases. It is evident from the theoretical analysis that even under the optimal circumstances, the throughput of each host decreases towards zero rapidly. Despite of the various solutions available, cluster formation seems to be more efficient for solving the scalability problem in adhoc networks. Clustering is the concept of grouping the network hosts which are in physical proximity. Thus clustering will help us to get scalability and it increases the network performance. Clustering algorithms designed at producing the minimum number of clusters that maximize the network lifespan and fault tolerance and provide load balancing and data throughput. From the above trace, we can justify that the cooperative approach among the peers improves the performance of cPIE application in wireless environment. But the throughput of the performance of the network degrades with increase in the number of nodes in the network. Thus in this paper, we propose an efficient Co-operative Peer-to-peer Information Exchange (cPIE) technique with an effective algorithm using clustering approach.

The rest of the paper is organized as follows section 2 discusses about the existing work related to the proposed system. Section 3 presents the proposed methodology for cluster formation in wireless environment with critical concerns. In section 4, Cooperative PIE Mechanism has been proposed and in section 5, the performance of the proposed cPIE scheme has been evaluated in terms of time taken and message exchange through extensive simulation. Finally, section 6 concludes the paper and presents direction for future work.

II. RELATED WORK

Wireless P2P environment becomes very significant research area with vast approaches to tune its critical performance criteria to make the system to get intended throughput. Regarding these P2P approaches and algorithms, there is a huge improvement in enlarging theoretical understanding. For example [1-4] [6] developed varieties of model to understand about throughput capacity of P2P algorithms beneath different models hypothesis [5,7] and others build up stochastic system models to estimate the managing rules with dynamic peer populations. These studies afford an excellent theoretical basis and several insights to why the P2P systems range so well. In P2P overlay building and P2P scheduling; a review of the best ways has been made which was given in [8].

A detailed study of structured and unstructured P2P networks and protocols is given in [9]. Popularities specified in [10-12] [25], certain file shows clustering in mainly real-world circumstances, system performance can be developed by regulating the fundamental overlay topology to imitate the clustering (e.g. . having a search overlay topology corresponding the data-sharing graphs of [10]). Yanfei Fan et al proposed a [13] cooperative Peer-to-peer Information Exchange (PIE) scheme with an efficient and light-weight scheduling algorithm which is suitable for a wireless network with very less number of nodes and notable drawback of the work is that the complete broadcast nature of wireless channels has not been fully developed.

Clustering has ample benefits. It can simplify the range of the routing table saved at the unique node by restricting the route set up within the cluster [14] [21-23]. Network clustering groups collectively the hosts that are in physical propinquity. Each cluster is methodized of a Cluster-Leader (CL) and a number of cluster members. Cluster head is chargeable for organizing the fundamental operations of the cluster members such as channel access scheduling, power measurements, and coordination of intra and inter-cluster communications [15]. Clustering can also preserve the communication data transmission rate because it margin the scale of inter-cluster interactions to CLs and evade unnecessary exchanges of data's among the nodes [16]. By using clustering technique [17] [24] the energy efficiency will be significantly developed and the all over network traffic can be decreased. It's not efficient to recluster the entire network periodically as it is a heavy burden on use of network [18–20, 15]. Hence the proposed cluster formation algorithms can increase the network efficiency. Because of this algorithm can reorganize the cluster whenever and wherever it is required, rather than doing it periodically.

Observation from the Studied Related Works: To summarize, Clustering is the best approach to improve the performance criteria such as throughput, fault tolerance and load balancing of large P2P networks. Thus in this paper we are going to utilize the various advantageous factors of clustering approach in large wireless P2P environment. The proposed work consists of two folds, first cPIE which provide efficient outcome for the problem explained in the previous section. Second layer is clustering of large network which segregate the overall computation burden of the technique among different clusters which maximize the effectiveness of the cPIE by applying excellent way to schedule the peers to use the wireless medium to completely utilize broadcast nature of wireless channels.

III. PROPOSED SYSTEM

In the proposed system section, we present our analytic framework with two levels of techniques, which are modeling the wireless peer-to-peer networks into clusters and to effectively achieve cPIE in the corresponding wireless environment.

3.1. Network infrastructure

In this work, we consider a peer-to-peer network model comprised of several wireless nodes which are also called peers. These peers share a common wireless channel and can communicate with each other directly. Thus, all peers can only communicate in actually a half-duplex mode. In other words, if two peers are transmitting at the same time, their signals will interfere with each other and no peer can correctly receive the transmitted signal.

Consider a wireless peer-to-peer network model which consists of numerous wireless nodes and this can also be called as peers. These peers communicate explicitly with each other by sharing the common wireless channel. In fact all peers in this network model communicate in a half-duplex mode. Otherwise stated as, no peer can exactly obtain the broadcast signal if two peers are broadcasting at the equal time since their signals will impede with each other. However, alternately each peer can fetch the wireless channels due to the transmit character of their wireless channels and regain the frames perfectly when one and only one is broadcasting.

With reference to a realistic application, we highlight the subsequent framework as shown in Fig. 2. A remote Base Station (BS) transmits a pack of packets (blocks) to the nodes in the network. Owing to weakening and mobilization of wireless channels, each and every peer gets some (maybe all or none) of these blocks. In order to modulate the overflow of downlink channels from the base station to those nodes and liberate the chokepoint of the base station as a network gateway, the nodes can share their received blocks with each other through local wireless networks.

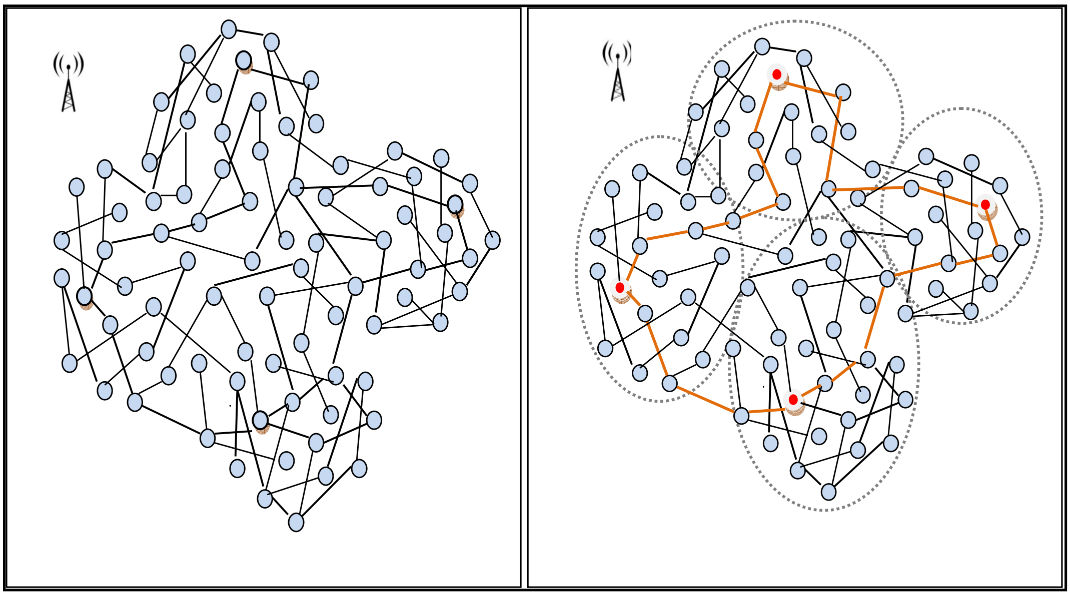


Fig.2 Wireless P2P Networks and Cluster formed Wireless P2P network

3.2. Cluster construction

It is presumed that nodes in the wireless networks are not uniformly distributed, and every node in cluster has a unique identity number which is called as node id. These nodes are limited by electric power, memory space, computation capacity, and communication range. A node can communicate directly with other nodes in the same cluster.

Table 2 Notations Used

NOTATION	DESCRIPTION
D_{ID}	Destination address field of message
S_{ID}	Source address field of the message
E_{node}	Energy Level of the current node
Data	Information field of the message
MyID	Address of current node
MyCL	Address of node's CL (initially null)
$ClusterMember_{Array}$	Array maintained by CL to hold its member addresses
***_msg	message to perform some operation
$$$(***_msg)	$$$ field value of ***_msg

The base station can be positioned at any place of the network, and it is not limited by electric power, memory space, or data-processing capacity. It has virtually unlimited computational and communication power, unlimited memory storage. The base station serves as the gateway for external communication.

The following description elaborate about the various operations performed in the wireless network such as Cluster Leader (CL) selection, Cluster formation for every CL and real-time node join/leave in the cluster.

3.2.1. Cluster leader selection

Stage – 1: Choosing cluster leader

Step 1: Action performed by participating nodes

S_{ID} = Current Node ID

Energy= E_{node}

D_{ID} = Address of Base Station

Create data_msg = (Energy + Source ID)

Send data_msg to D_{ID}

Step 2: Action by BS to select CL on receiving cluster data message (data_msg) from group of nodes

IF (Energy (data_msg) = High Level AND S_{ID} (data_msg) = Least ID)

Create ack_msg=”you are selected as CL”

D_{ID} = S_{ID} (data_msg)

Send ack_msg to S_{ID} (data_msg)

ELSE Discard data_msg

ENDIF

Pseudo Code for Cluster Leader Selection

Step 1: Action performed by participating nodes

For the effective transmission of data from the base station, a cluster leader should be selected. So this phase is for updating information of the entire nodes in the cluster. During this process of selecting cluster head, all the nodes of the cluster transmit a data message packet with message of their energy level which is denoted as E_{node} along with their source id (Energy + S_{ID}) to the destination id which is the base station. In order to reduce packet collisions, the nodes use random back-offs before sending the update packets. These nodes must exchange their data message only once, at the beginning of the network lifetime.

Step 2: Action by BS to select CL

During the selection phase of cluster head the nodes in the cluster send their energy data message to the base station. The base station can receive the energy data msg only for a finite duration of time which is called activation time. Beyond the activation time the base station cannot accept the energy data msg. Now the base station processes the data message and selects the cluster head that is having highest energy level. If a condition occurs where two nodes have same energy level, then the cluster head is selected on the basis of least ID. Least ID is the ID given to the node to provide user oriented priority such as node location, resource availability etc. After selecting the cluster head, an ack msg stating “You are selected as CL” is created in the base station. This ack msg is sent to the corresponding cluster head. If this process is not successful then the message is discarded.

3.2.2. Cluster formation

Stage – 1: Cluster Leader operation

Step 1: At the end of the cluster leader selection process, base station disseminates the ack_msg to the corresponding selected CL node. On the reception of ack msg the node checks if the field value D_{ID} in the message just received for match with its own id. If the message is intended to itself then, the node declares itself as the cluster head otherwise just discards the message. On success, CL creates an invitation message stating “I am CL, Join me” and this invite message is broadcasted by the cluster leader to all adjacent nodes.

Stage – 1: Cluster Leader operation
Step 1: On receiving acknowledge message (ack_msg) from BS
Check IF (D_{ID} (ack_msg) = MyID) THEN
Create invite_msg = "I am CL join me"
S_{ID}=D_{ID} (ack_msg)
Broadcast invite_msg
ENDIF

Stage – 2: Joining member nodes
Step 1: On receiving invite message (invite_msg) from any CL then
Check IF (MyCL = Null) THEN
Set MyCL= S_{ID}(invite_msg)
Create join_msg = "To join as Cluster Member"
D_{ID} =MyCL
Send join_msg to D_{ID}
ELSE
Discard invite_msg
ENDIF

Step 2: On receiving join message (join_msg) from any node
Add S_{ID}(join_msg) into $ClusterMember_{Array}$
Ack_msg = "Successfully added into Cluster"
D_{ID} =S_{ID}(join_msg)
Send Ack_msg to D_{ID}
ENDIF

Step 3: On receiving join acknowledge message (ack_msg) from its CL
Confirm MyCL and Discard ack_msg
ENDIF

Pseudo Code for cluster formation

Stage – 2: Joining member nodes operations

Step 1: The nodes receiving the invite message check whether its "MyCL" field is null which means that it is not under any CL. If yes, it set its "MyCL" field as S_{ID} field of received invite message and send join message to its CL otherwise discard the received invite message.

Step 2: On receiving the join message, the cluster leader processes the received information and adds the field S_{ID} of the join message to its cluster member array which holds all the member nodes of corresponding CL. To acknowledge CL creates an ack message mentioning "Successfully added into Cluster" to the newly added member node.

Step 3: After receiving the join acknowledge message from the CL, new member nodes confirms its MyCL and discards the ack message. At the end of this step, clusters are formed completely and the cluster formed Wireless P2P network has been shown in fig 2.

3.2.3. Intra Cluster Routing
Step 1: To send a data message to any node *(say 'x')* within its Cluster
Create data_msg="Some data"
S_{ID}= MyID
D_{ID} = Destination node address *(of node 'x')*
Send Data_msg to Destination ID

Step 2: On receiving data message (data_msg) from any node
If Receive Data message from Node (within its cluster) then
Check IF (S_{ID}(data_msg) = MyID) THEN

// "Some data received"
ELSE
WHILE ($E_{node} \neq 0$)
Send data_msg to D_{ID}(data_message)
END WHILE
ENDIF

Pseudo Code for Intra Cluster Routing

Step 1: Intra cluster routing is a form of communication by which exchange of information happens within the cluster. If a data message is to be sent to any node (say x) within the cluster, the source node (say node A) creates the data message. Since node A is the sender of the data, the source id S_{ID} is assigned as MyID which is the ID of node A. The destination id field of the message is assigned as the address of node x and forwarded.

Step 2: When a particular node in the cluster receives a data message from any other node, it checks if the destination id field of message, D_{ID} matches with its own id. If so, the message is intended to the current node otherwise, it forward the data message to the destination id given in the data message provided energy of the node is not zero.

3.2.4. Inter-Cluster Routing

Stage – 1: Operations on Home Cluster

Step 1: The inter cluster routing is a type of communication through which information is exchanged from one cluster to other cluster. A node (say y) in one cluster can communicate with another node (say x) in any other cluster using the following steps. The node y creates the data message with the S_{ID} as the address of the node y and the D_{ID} as the address of node x. The address of cluster leader of node y which is kept as MyCL is assigned to CLID field of the message and forwarded to MyCL.

Step 2: After receiving data message from any node of its own cluster the cluster leader checks if the CLID in the data message matches with its own id. If so, CL understood that the message is for a node in some other clusters thus it multicasts the data message to all other cluster in the network.

Stage – 1: Operations on Home Cluster

Step 1: To send a data message to any node *(say 'x')* outside its Cluster
Create data_msg="Some data"
Source ID= S_{ID}
D_{ID} = Destination node address *(of node 'x')*
CLID=MyCL
Send data_msg to MyCL

Step 2: Home CL operation on receiving data message from any node
If Receive data message (data_msg) from node (from its cluster) then
Check IF (CLID = MyID) THEN
Multicast data_msg to all other CLs in the network
ENDIF

Stage – 2: Operations on Destination Cluster

Step 1: Destination CL operation on receiving data message (data_msg) from any CL
Check IF ($ClusterMember_{Array}$ contains D_{ID}(data_msg)) THEN
Send data_msg to D_{ID}(data_msg)
ELSE
Discard data_msg
ENDIF

Step 2: On receiving data message (data_msg) from its CL
Check IF (D_{ID}(data_msg) = MyID) THEN
// "Some data received"

ELSE
WHILE ($E_{node} \neq 0$)
Send data_msg to D_{ID}(data_msg)
END WHILE
ENDIF

Pseudo Code for Inter-Cluster Routing

Stage – 2: Operations on Destination Cluster

Step 1: All the CLs in a network receive the data message which is multicasted by the source CL. Each cluster leader checks if the D_{ID} field of the message points to any node that comes under its cluster member. If the cluster member array contains the D_{ID} of the data message then its sends the data message to the destination id otherwise the message is discarded.

Step 2: When a particular node in the cluster receives a data message from any other node through its CL, it checks if the D_{ID} of the data message matches with its own id. If it matches, then the node gets to know that it has received some data. If the destination id of the data message does not match with its own id, it forwards the data message to the destination id given in the data message provided energy of the node is not zero.

3.2.4. New Node to Join:

When any node wants to leave from its existing cluster then it follow the following operations.

Step 1: When a new node wants to join a cluster, then it checks the cluster leader of its nearest node by creating a check message stating" inform me your CL". The S_{ID} field of the check message is set with the ID of new node and is broadcasted to all its adjacent nodes.

Step 2: In response to the check message, the nearest node creates an acknowledge message saying "I'm under given CL". The S_{ID}, D_{ID} and CLID fields of the acknowledge message are assigned with IDs of the node given response, the new node and the MyCL field of the response node respectively and forward to D_{ID}.

//When a new node wants to join into the cluster

Step 1: To check the CL of its nearest node
Create check_msg="Inform me your CL"
S_{ID}= MyID
Broadcast check_msg

Step 2: Any node receives Check message (check_msg)
Create ack_msg="I am under given CL"
S_{ID}= MyID
D_{ID} = S_{ID} (check_msg)
CLID=MyCL
Send ack_msg to D_{ID}

Step 3: when a node receive acknowledge message (ack_msg) for its check message
Check IF (D_{ID} (ack_msg) = MyID) THEN
Set MyCH= MyCLID (ack_msg)
Create join_msg = "To join as Cluster Member"
D_{ID} =MyCH
Send join_msg to D_{ID}
ENDIF

Pseudo Code for New Node Join

Step 3: Now the new node receives the acknowledge message for its check message from one of its nearest node. It checks if the D_{ID} of the ack message matches with its own id. If it matches, then it sets its MyCL field as the CLID field in the ack message and creates a join message saying ”to join as cluster member” and forwarded to its new CL.

3.2.5. Any Node to Leave:

When any node wants to leave from its existing cluster then it follow the following operations.

//When any node wants to leave from the cluster

Step 1: The node want to separate from cluster send the leave message to its CL
Create leave_msg=”To leave from your cluster”
S_{ID}= MyID
D_{ID} = MyCL
Send leave_msg to D_{ID}

Step 2: The CL receives Leave message (leave_msg) perform following operation
Check IF (S_{ID} (leave_msg) = MyID) THEN
Delete S_{ID} from $\text{ClusterMember}_{\text{Array}}$
ENDIF

Pseudo Code for Leave in lively manner

Step 1: The node which wants to get separate from its current cluster creates the leave message and forwards it to its CL.

Step 2: When the CL receives leave message from any node of its cluster. It just removes the ID of the requester node from its Cluster Member array.

IV. COOPERATIVE PIE MECHANISM

In the previous chapter, it is elaborated how the clusters are being formed and each cluster will be having exactly one Cluster Leader (CL) and more Cluster Members (CM). The Total number of peers in the network can be given as,

$$\textit{The total number of peers} = \sum_{i=0}^{n} (CM_i) + n$$

Where,

- ‘n’ is the number of clusters in the network
- ‘CM_i’ is the number of Cluster Members in the ‘i’th cluster

We have introduced a peer scheduling problem in the introduction part of the paper which deals about the concept of loss of packets which is broadcasted by the tower, at one time, to all the peers in the network. In this phenomenon, we can assume two facts, Fact 1: Each packet sent by the tower should be received by at least one peer. Fact 2: No peer shall receive all the packets that are sent by the tower. These facts imply that it is possible to find each packet sent by the tower within the network instead of requesting to broadcast all the packets again which will be tedious. To handle the problem effectively a technique introduced called Co-operative Peer to Peer technique (cPIE). By this technique, the peer can receive the packets directly from other peers which received it errorless rather than getting the missing packets from the tower. Here we elucidate the process to effectively achieve cPIE technique using the clusters which are already formed in the network in three stages.

Stage 1 – Sharing packets within single cluster

Stage 2 – Sharing packets among the CLs

Stage 3 – Sharing new packets within the cluster which are received from other CLs

Stage – 1:

Each node maintains a vector which is known as "*packet vector*" used to store the packets it received from the tower without any errors. After receiving each errorless packet from the tower, peers save it in the vector and till the completion of the broadcast process of the tower. Once the process gets finish, each CM sends its packet vector to its corresponding CL. Each CL waits until it receives packet vector from all of its *'k'* CMs, where k is the size of $ClusterMember_{Array}$ of that CL. When a CL receives the packet vectors from all of its CMs, it starts to form a packet matrix called *block matrix* which is comprises of the number of CMs and packets received errorless. The block matrix of CL of 'i'th cluster can be represented as BM_i [0….x, 0….y] where 'x' is the number CMs in the 'i'th cluster CL and 'y' is the total number of different errorless packets received by CMs in the network. It can be explained as, If BM [a,b] = *content of the packet*, then the peer 'a' received the packet 'b' without any error and if BM [a,b] = 0, then the peer 'a' received the packet 'b' with error. Based on the BM matrix values, each CL identifies which are the packets are not received correctly by each CM (i.e.) if BM [a,b] = 0. As a result, CL retrieves the packet from any peer which received it errorless and forwards it to all the peers which didn't receive or received with error.

Stage – 2:

After the completion of Stage 1, each CLs share the packets they have with each other. This is because some packets are received by CMs of any one cluster, to make it available to all other clusters stage 2 is performed. At the success of stage 2, each CL has all the packets, without any error, broadcasted by the tower.

Stage – 3:

At this stage each CLs share the new packets, which they received during stage 2, with their CMs. This makes sure that each CMs of each cluster has all the packets that are broadcasted by the tower without any error.

At the successful completion of all these three stages, each peer in the network holds equal and all the packets broadcasted by the tower without asking for re-broadcasting.

V. SIMULATION RESULTS AND ANALYSIS

In this section, we evaluate the performance of the proposed cPIE technique using clustering approach by conducting extensive simulation using OMNeT++ simulation tool. To justify the effectiveness and efficiency of the proposed technique, we assessed performance parameters such as size of the network, time taken to perform cPIE and the total number of message transfer between peers are compared against the PIE technique proposed in [13] (hereafter it will be mentioned as 'base PIE technique'). We have conducted evaluation in two stages, the change in the size of the network vs. time taken for completion of cPIE technique and change in the size of the network vs. the total number of message transfer between peers in the network.

Stage – I: Evaluation in terms of Change in the Size of the Network vs. Time Taken for Completion of cPIE Technique

In this phase, assessment has been carried out to justify that the proposed system is highly scalable. The time taken for performing cPIE operation increases optimally, whereas the same will increases tremendously with the increase in the size of the network in the base technique. From the simulation, the performance of the system with change in the size of the network vs. time taken for completion of cPIE technique has been assessed and tabulated in Table 3.

Table 3. Performance measures assessed during stage - 1 part of analysis

Sl. No	*Size of the network (peers)*	*Base PIE technique*				*cPIE technique*				*Efficiency improvement in terms of time taken (a/bx100)*
		Total packets broadcasted	*Number of peers involved*	*Packets exchanged*	*Time taken for complete in seconds(a)*	*Total packets broadcasted*	*Number of peers involved*	*Packets exchanged*	*Time taken for complete in ms (b)*	
1	*10*	*100*	*4*	*30*	*0.3*	*100*	*6*	*23*	*0.23*	*30.43%*
2	*100*	*500*	*39*	*152*	*1.52*	*500*	*59*	*63*	*0.63*	*41.26%*
3	*500*	*1000*	*68*	*289*	*2.89*	*1000*	*86*	*187*	*1.87*	*54.54%*
4	*1000*	*5000*	*121*	*1201*	*12*	*5000*	*137*	*625*	*6.25*	*92%*
5	*5000*	*5000*	*129*	*3204*	*32*	*5000*	*143*	*2120*	*21.2*	*50.94%*

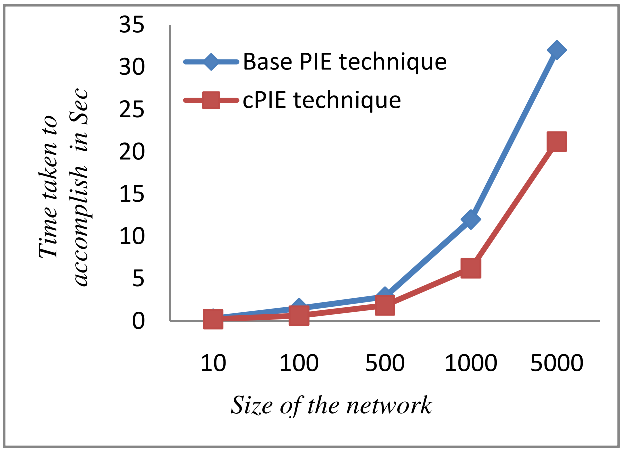
The tabulation is prepared as comparison between the base and the proposed cPIE techniques in terms of the total packets broadcasted from the source tower, the total number of peers involved in the information exchange, total number of packets exchanged and the time taken for completion of the technique in seconds. Fig.3 shows the comparison graph for which elucidates that the proposed technique out-performs the base technique at large number of peers in the network.

Stage II –Evaluation in terms of Change in the Size of the Network vs. The Total Number of Message Hops between Peers

In this phase, assessment has been performed to validate that the total number of message hops required for each message exchange required to cPIE is highly minimized using proposed system in network with large number of peers. Number of hops required for message exchange will be higher for network with sparsely distributed nodes. From the simulation results, the performance of the system with change in the size of the network vs. average message hops per message exchange has been assessed and tabulated in Table 4. The tabulation is prepared as comparison between the base and the proposed cPIE techniques in terms of the total packets broadcasted from the source tower, the total number of peers involved in the information exchange, total number of packets exchanged and the total number of message hops performed and the average message hops taken per message exchange. Fig.4 shows the comparison graph for which make clear that the proposed technique with clustering out-performs the base technique at large number of peers in the network.

Table 4. Performance measures assessed during stage - 2 part of analysis

Sl. No	*Size of the network (peers)*	*Base PIE technique*					*cPIE technique*					*Efficiency improvement in terms of hops (a/bx100)*
		Total packets broadcasted	*Number of peers involved*	*Packets exchanged*	*Total message hop performed*	*Average hops per message exchange (a)*	*Total packets broadcasted*	*Number of peers involved*	*Packets exchanged*	*Total message hop performed*	*Average hops per message exchange (b)*	
1	*10*	*100*	*4*	*30*	*62*	*2.07*	*100*	*6*	*23*	*43*	*1.87*	*10%*
2	*100*	*500*	*39*	*152*	*762*	*5.01*	*500*	*59*	*63*	*178*	*2.83*	*77.03%*
3	*500*	*1000*	*68*	*289*	*8247*	*28.54*	*1000*	*86*	*87*	*643*	*7.39*	*286.19%*
4	*1000*	*5000*	*121*	*1201*	*34536*	*28.76*	*5000*	*137*	*625*	*4563*	*7.30*	*293.97%*
5	*5000*	*5000*	*129*	*3204*	*134566*	*42.00*	*5000*	*143*	*2120*	*13255*	*6.25*	*572%*



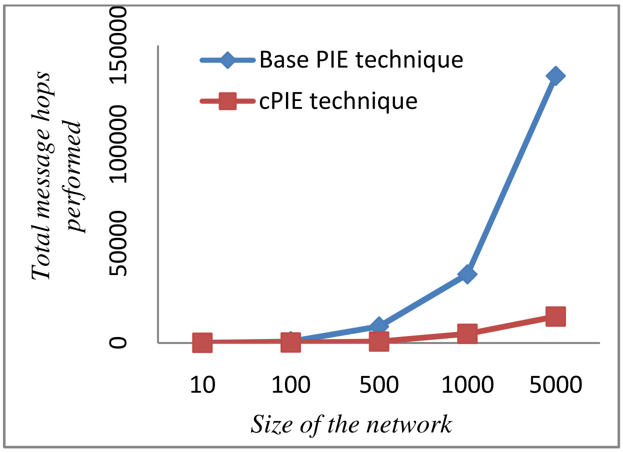


Fig 3. *Comparison of parameters assessed at stage - 1 of analysis* ***Fig 4****. Comparison of parameters assessed at stage - 2 of analysis*

VI. CONCLUSION

Cooperative Peer to Peer Information Exchange (cPIE) is a novel technique to improve the data availability using data present within the peers in the network. But the performance degrades gradually with increase in the number of peers in the network. In this paper, we proposed an effective Cooperative Peer to Peer Information Exchange technique using clustering approach for large wireless P2P networks. The proposed technique formulate the cPIE system perform efficiently even at large wireless networks by segregating it into number of clusters. We also elaborated about the various operations performed in the wireless network such as cluster leader selection and cluster formation. Our simulation results justify that the proposed technique is more efficient than the existing PIE techniques for the network which holds large number of peers. Our future works will focus on incorporating network coding technique to improve the efficiency of cPIE technique further and constraint based cluster leader selection.

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