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Determining the Appropriate Thresholds for P2P Content File Sharing in Disconnected MANETs

M.Suresh[1], D.Venkatesh[2], J.Raghunath[3]

[1] M.Tech Student, Dept of CSE, GATES Institute of Technology, Andhra Pradesh,India,
meenege.suresh@gmail.com

[2]Associate Professor in CSE, GATES Institute of Technology, Andhra Pradesh,India,
deancseit@gmail.com

[3]Assistant Professor in CSE, GATES Institute of Technology, India.

Abstract: *Peer 2 Peer over MANETs is the largely popular used pattern of file sharing within MANETs. P2P system is started in the middle of 1990s. P2P system is deployed on the Internet which is formed by creating an overlay network. P2P overlay consists of upper-layer connections among nodes, or peers, which are self-determining of the underlay or substrate network, abstract peer's view of the connections that make up the network. The communication among peers usually appears at network and application level. In general, a P2P file sharing system mostly consists two parts: search algorithm and a file transfer protocol. File transfer protocol is dependable to downloading files by use of TCP connection. While search algorithm is dependable for transmitting query messages and searching results. In the existing system a P2P content file sharing in MANETs based on a social network is proposed. For capable file sharing the existing system considers both node interest and contact frequency. The existing system has four key components: interest extraction, community construction, node role assignment and interest oriented file searching scheme for capable file sharing. In the proposed system it will aim to find out appropriate thresholds in the P2P file sharing systems. It also improves the capability of the file sharing in the disconnected networks. Further, the proposed system will relate the SPOON algorithm to larger mobile ad hoc networks to monitor the content based file sharing efficiency.*

1. INTRODUCTION

In the past few years, personal mobile devices such as laptops, PDAs, and smart phones have been more and more popular. Indeed, the number of Smartphone users reached 1 billion by the third quarter of 2012 and is expected to increase to 2 billion by 2015 [2]. The incredibly rapid growth of mobile users is leading to a promising future, in which they can form a mobile opportunistic network (MON) [3], which is also known as pocket switched network (PSNs) [4], to freely share files or forward packets between each other without the support of cellular infrastructures. Such networks are often shown in the form of mobile ad hoc networks (MANETs) [5] or delay tolerant networks (DTNs) [6,7], in which mobile devices, carried by people, are interconnected by opportunistic encountering. Though communication infrastructures exist commonly nowadays, we focus on exploring the unused peer-to-peer (P2P) communication among digital devices (e.g., through Wi-Fi and Bluetooth) for pervasive communication and computing without the constraint of infrastructures.

In such a scenario, mobile devices establish connections for message exchange only when they are within the communication range of each other, i.e., encountering based communication. As a result, MONs often experience frequent network partitions, and no end-to-end contemporaneous path can be ensured in the network. These distinctive properties make traditional file sharing or packet routing algorithms in Internet or mobile networks challenging in MONs. As a result, file searching and packet routing usually are realized in a "store-carry-forward" manner in MONs [7]. Specifically, when a node receives a file request or a packet, it carries the request/packet while moving in the network until meeting the destination node or a node that is more suitable to carry the request/packet. Then, the request/packet is forwarded to the newly met node. Through such a hop-by-hop forwarding strategy, the request/packet finally reaches the file holder/destination node.

Figure 1. *Demonstration of request/packet forwarding process in MANETs*

Figure 1 demonstrates this process. In the figure, a file request/packet is generated by the "source node", which forwards it to its nearby "relay node". However, the "relay node" fails to find a node that is more suitable to carry the request/packet from nearby nodes. Then, it carries the request/packet while moving around until it meets a more suitable "relay node "or the file holder or the destination of the packet.

Then, the "relay node" forwards the request/packet to it. The file sharing or packet routing process actually utilizes the node mobility in MONs to make up the lack of end-to-end paths. Therefore, deciding which node is more suitable to carry the request/packet is the key for efficient file sharing or packet routing in MONs. Ideally, the request/packet should be carried by the node that is most likely to meet the file holder or the destination node. Generally, when two nodes meet, they first exchange certain information to determine which node is more suitable for carrying which request/packet and then forward requests or packets to the other node accordingly.

2. Existing Works on File Sharing

2.1 Leveraging Social Networks for Efficient File Sharing in MANETs:

This paper investigated the scenario in which nodes can actively forward file requests to reach the file holders. The requested file can also be forwarded among nodes to reach the requester. In this case, by leveraging nodes social network properties on interest and movement pattern, we propose a Social network based Peer-to-peer (P2P) content-based file sharing system in mobile Opportunistic Networks (SPOON) [1] depicted in figure 2. SPOON classifies common-interest and frequently encountered nodes into social communities.

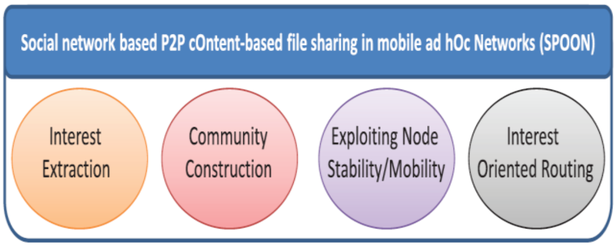

Figure 2. *Components in SPOON*

Then, SPOON considers the frequency at which a node meets different interests rather than different nodes in file searching. SPOON also chooses stable nodes in a community as coordinators and highly mobile nodes that travel frequently to foreign communities as ambassadors. Such a structure ensures that a request can be forwarded to the community of the requested file quickly. SPOON also incorporates additional strategies for file perfecting, querying-completion and loop-prevention, and node churn consideration to further enhance file searching efficiency.

2.2 Efficient Packet Routing among Nodes in MONs

The design of SMART is inspired by the social network property that the people a person frequently meets are usually stable. These people also play an important role in forwarding packets for the person [8]. For example, we often meet the same colleagues, friends, and family members daily, and we often rely on them to forward messages to others. Consequently, SMART mainly applies to scenarios in which node carriers belong to certain social structures. Specifically, in SMART, each node builds a social map to record its surrounding social network in MONs, which is constructed by learning each encountered node's most frequently met nodes (i.e., stable friends). Each link in the social map is associated with a weight based on the encountering frequency and social closeness of the two connected nodes. The weight is used to deduce the delivery abilities among nodes. Then, a node can decide whether to forward a packet to an encountered node by only checking its own social map, which can save the cost. Further, the social map is not limited to one or two hops and reacts possible long relay paths to provide better forwarder selection. As a result, packets can be routed to their destinations efficiently with a low cost.

2.3 Flooding-based File Sharing Methods

In flooding-based methods, 7DS [9] is one of the first approaches to port P2P technology to mobile environments. It exploits the mobility of nodes within a geographic area to disseminate web content among neighbours. Passive Distributed Indexing (PDI) [10] is a general-purpose distributed file searching algorithm. It uses local broadcasting for content searching and sets up content indexes on nodes along the reply path to guide subsequent searching. Klemm et al. [11] proposed a special purpose on-demand file searching and transferring algorithm based on an application layer overlay network. The algorithm transparently aggregates query results from other peers to eliminate redundant routing paths. Anna Hayes et al. [12] extended the Gnutella system to mobile environments and proposed the use of a set of keywords to represent user interests. However, these flooding-based methods produce high overhead due to broadcasting.

2.4 Advertisement-based File Sharing Methods

Tchakarov and Vaidya [13] proposed GCLP for efficient content discovery in location-aware ad hoc networks. It disseminates contents and requests in crossed directions to ensure their encountering. P2PSI [14] combines both advertisement (push) and discovery (pull) processes. It adopts the idea of swarm intelligence by regarding shared files as food sources and routing tables as pheromone.

Each file holder regularly broadcasts an advertisement message to inform surrounding nodes about its files. The discovery process locates the desired file and also leaves pheromone to help subsequent search requests. Repantis and Kalogeraki [15] proposed a file sharing mechanism in which nodes use the Bloom filter to build content synopses of their data and adaptively disseminate them to other nodes to guide queries. Though the advertisement-based methods reduce the overhead of flooding based methods, they still generate high overhead for advertising and cannot guarantee the success of files searching due to node mobility.

2.5 Social Network-based File Sharing Methods

Social networks have also been utilized in content publishing/dissemination algorithms [16, 19,17,18] in opportunistic networks. MOPS [17] provides content-based sub/pub service by utilizing the long-term neighbouring relationship between nodes. It groups nodes with frequent contacts and selects nodes that connect different groups as brokers, which are responsible for inter-community communication. Then contents and subscriptions are relayed through brokers to reach different communities. MOPS only consider node mobility while SPOON is more advantageous by considering both node interest and mobility as described previously. Moreover, unlike MOPS that only depends on the meeting of brokers for inter-community search, SPOON enhances the efficiency of inter-community search by (1) assigning one ambassador for each known foreign community, which helps to forward a query directly to the destination community, and (2) utilizing stable nodes (coordinator) to receive messages from ambassadors.

The work in [18] is a similar to MOPS. It selects centrality nodes as brokers and builds them into an overlay, in which brokers use unicast or direct protocols (e.g., Wi-Fi access points) for communication. Then node publications are first transferred to the broker node responsible for the node's community and then propagated to all brokers to find matched subscribers.SocialCast [19] calculates a node's utility value on an interest based on the node's mobility and co-location with the nodes subscribed to the interest. It publishes contents on an interest to subscribers by forwarding the contents to nodes with the highest utilities on the interest. Content Place [16] defines social relationship based communities and a set of content caching policies. Specifically, each node calculates a utility value of published data it has met based on the data's destination and its connected communities, and caches the data with the top highest utilities. The work in [20] considers social contact patterns and interests of mobile users to estimate users' potential interests in generated files and thereby realize efficient data dissemination.

3. PROPOSED MODEL

3.1 Interest Extraction:

We assume that node contents can be classified to different interest categories. It was found that users usually have a few file categories that they query for files frequently in a file sharing system. First we derive a node's interests from its files. The interest facilitates queries in content-based file sharing and other components of SPOON. Collective of nodes that share common interests and meet frequently is grouped as a community in which a node having high probability to find interested files in its community. The probability of similar interested nodes meeting together and sharing is high. If this fails the node can rely on nodes that frequently travel to other communities for file searching. We build the community for efficient file searching.

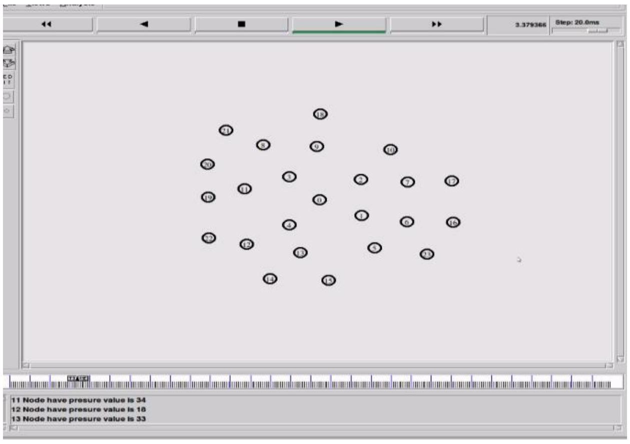

Figure 3. *Simulation Starting*

3.2 Community Construction:

Social network theory reveals that people with the same interest tend to meet frequently. By exploiting this property, SPOON classifies nodes with common interests and frequent contacts into a community to facilitate interest-based file searching. Nodes with multiple interests belong to multiple communities. The community construction can easily be conducted in a centralized manner by collecting node interests and contact frequencies from all nodes to central node. The figure 4 depicts the community construction.

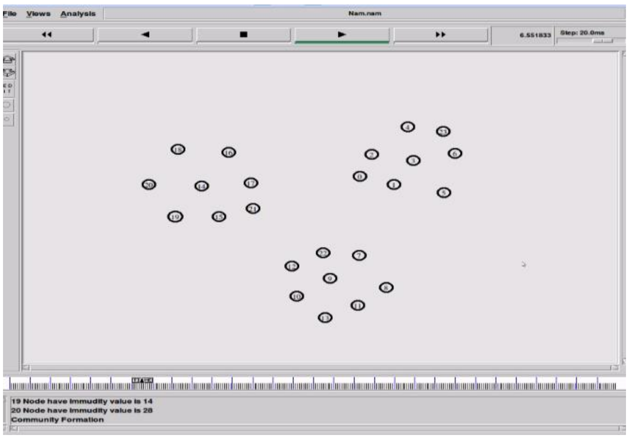

Figure 4. *Nodes after Community Construction*

3.3 Node Role Assignment:

From the past we came to know that in a social network consisting of several nodes. So we find the nodes based on some traits like node's mobility, strength and distance and based on this the nodes are assigned a responsibilities to query the data from the mobile node. We assign two roles namely(1) *Community Coordinator t*o maintain the index of similar interested files of mobile nodes.(2) *Community Ambassador* to query and retrieve the content from dissimilar community.

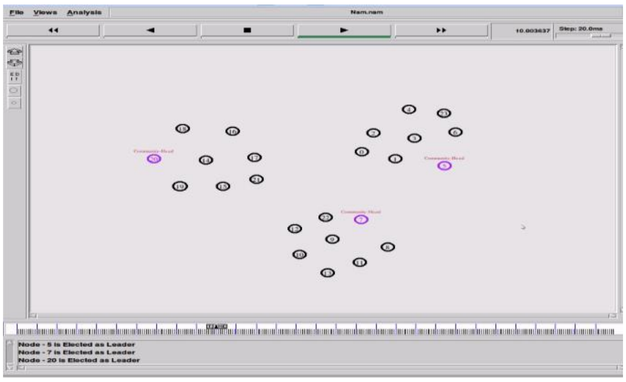

Figure 5. *Nodes after role assignment*

3.4 Community Coordinator:

We define a stable node that has tight contact frequency with other community members as the community coordinator. In network analysis, centrality is often used to determine the relative importance of a vertex within the network. We then adopt the improved degree centrality, which assigns weight to each link based on the contact frequency, for coordinator selection because it reflects the tightness of a node with other community members. In the initial phase of coordinator discovery, each node, say node Ni, in a community collects contact information from its neighbours in the same community and then calculates its degree centrality by

$$D(pi) = N/\Sigma wij \ J=1$$

Where wij is the link weight between Ni and Nj and N is the number of neighbours in the same community. To reflect the property that the coordinator has the most connections with all community members, wij equals 1 if the contact frequency between Ni and Nj is larger than a threshold and 0 otherwise. Though such a method cannot ensure its connection to every community member, it ensures that the coordinator has the tightest overall connection to all community members.

Each node periodically checks its degree centrality and broadcasts such information to all community members. If a node receives no larger centrality score than its own centrality for three consecutive periods, it claims itself as the potential coordinator. The potential coordinator would confirm its status as the coordinator when meets the previous one. If it is confirmed, it then requests the community information from the old coordinator. Also, when the new coordinator meets community members, they exchange information for group vector update and ambassador selection, as well as request routing.

3.5 Community Ambassador:

An ambassador is used to bridge the coordinator in its home community and a foreign community. We use the product of a node's contact frequency with its coordinator and that with the foreign community for ambassador selection. Each node i calculate its utility value for foreign community k by

$$Uik = F(Ni;Ck) * F(Ni;Nc), \quad (2)$$

Where Ck represents foreign community k, Nc is the coordinator in its home community and F (Ni:Nc) denotes the meeting frequency. Each node reports its utility values for foreign communities it has met to the coordinator in its home community. Then, the community coordinator chooses one ambassador for each known foreign community. Also, the node that has the highest overall contact frequency with all foreign communities is selected as the default ambassador. In case that a request fails to find a matched ambassador, the default ambassador can carry the request and seek for potential forwarders in foreign communities.

If an ambassador loses the connection with the coordinator for a certain period of time, a new ambassador that satisfies above requirements is selected. This arrangement facilitates interest-oriented file searching by enabling a coordinator to send file requests to matched foreign communities quickly. In above design, ambassadors are the key to connect different communities efficiently. Coordinators achieve balance between the centralized and distributed searching by checking whether a community can satisfy a query quickly, which is important in disconnected MANETs. The data transmission from community ambassador is depicted in figure 6.

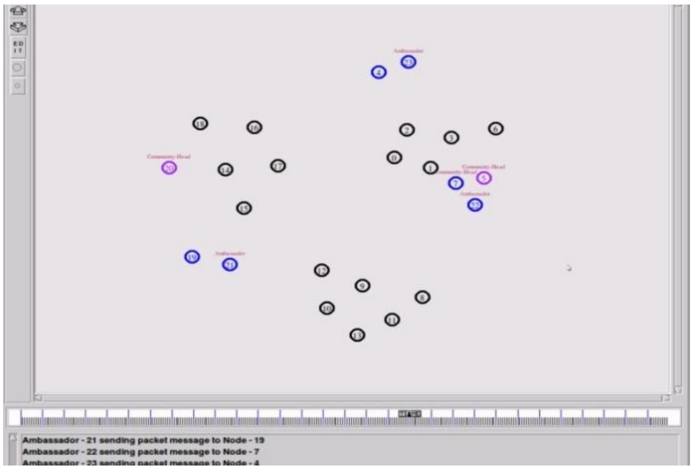

Figure 6. *Ambassador transmitting the data*

4. PERFORMANCE ANALYSIS

The system is completely implemented on basis of NS2.35 version and the system is tested for various metric analyses which include:

- Average Delay
- Delivery Ratio
- Hit Rate
- Maintenance Cost
- Packet Drops
- Throughput

For the analyses the proposed system is compared with the most widely used technique Mobile community-based Pub/Sub scheme (MOPS). In every aspect defined above the proposed system out performs the traditional MOPS.

The figure 7 depicts the comparison of average time delay between the MOPS and the proposed system note that in all the analysis section red line indicates the proposed system and the green line indicates the MOPS.

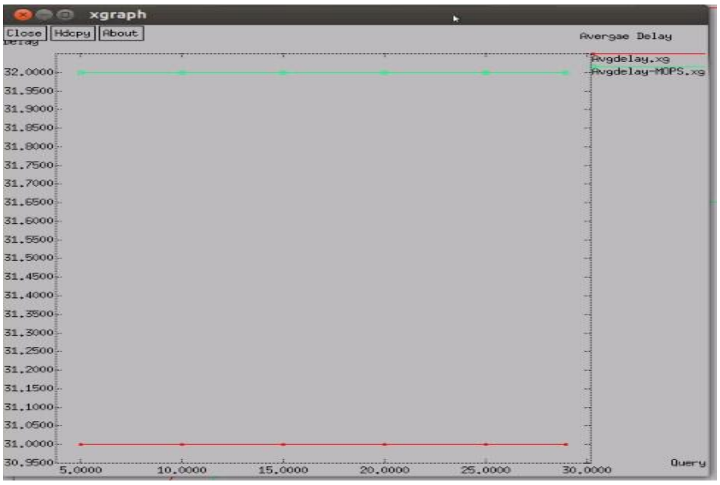

Figure 7. *Average Time Delay Comparison*

The next aspect is the Packet Delivery Ratio which has to be high the figure 8 depicts the comparison for packet delivery ration.

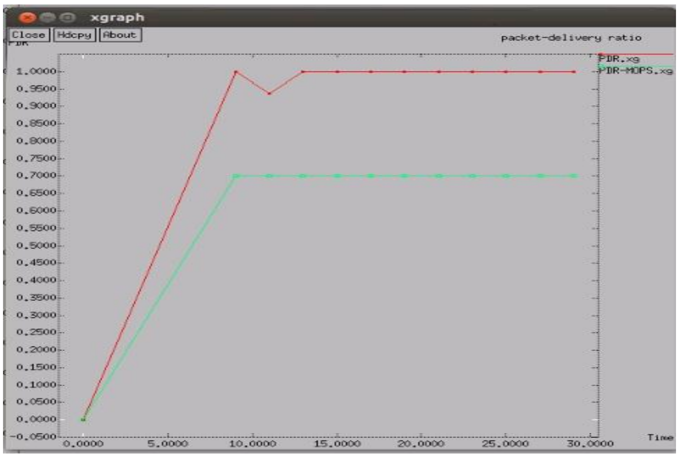

Figure 8. *Packet Delivery Ratio*

The another metric is the Hit Rate which indicates how often the nodes are active or how often the nodes are participated in the transmission figure 9 depicts the comparison of the hit rate.

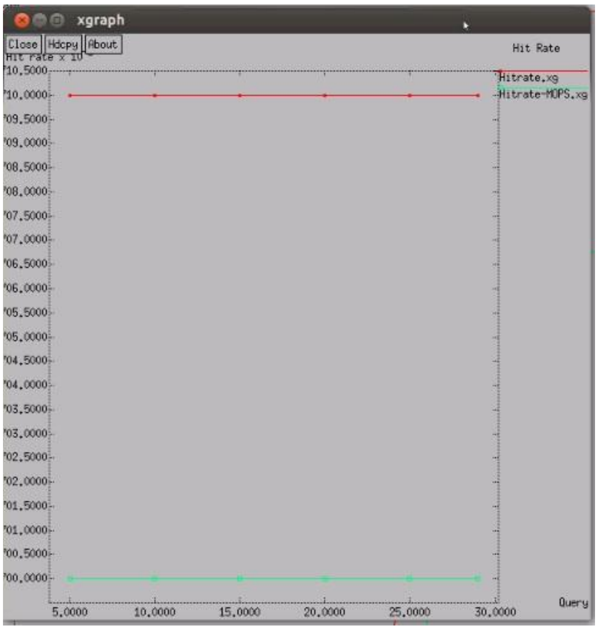

Figure 9. *Hit Rate Comparison*

The further metric is the maintenance cost comparison the cost factor is the most important metric of all the implementation analysis which is depicted below.

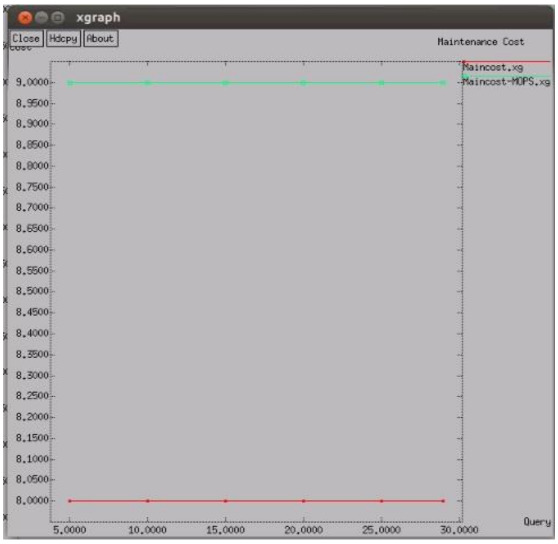

Figure 10. *Maintenance Cost*

Now the important metric for any MANETs is the packet drop calculation. A good system has to provide less packets drops and the proposed system clearly out performs the MOPS in this section. The results are depicted in the figure 11.

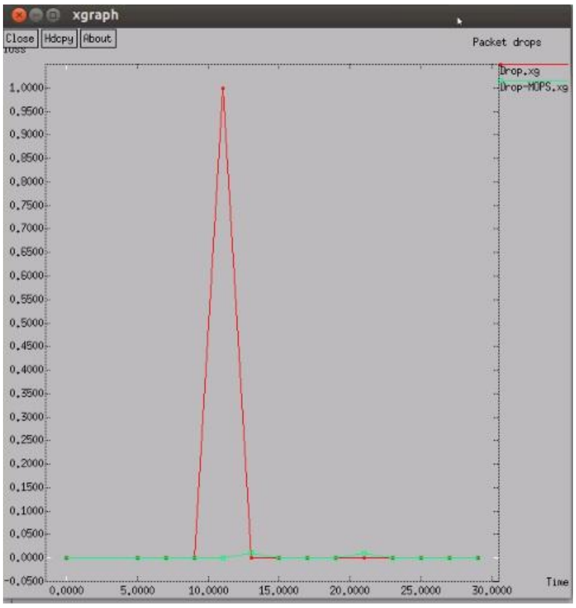

Figure 11. *Packet Drops Comparison*

The final and the important metric is the throughput of the network where all the other factors rely on this metric. The performance of any network is decide based on the throughput it provide. The proposed system provides better throughput compared to the MOPS and is showed in the figure 12.

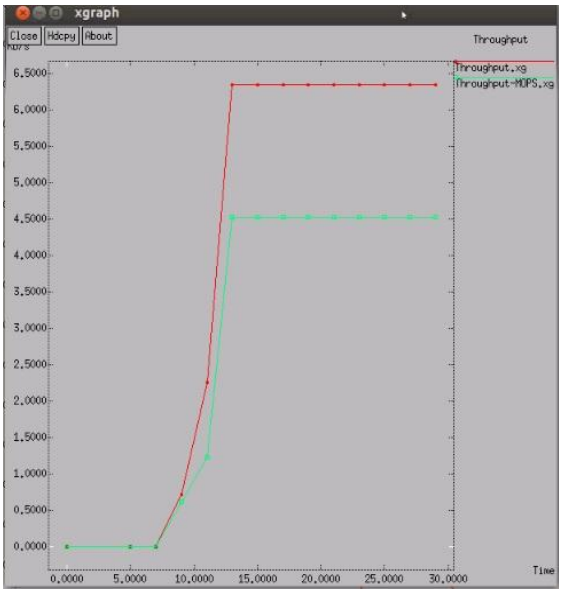

Figure 12. *Throughput Comparison*

5. Conclusion

Mobile Adhoc Networks (MANETs) have attracted significant attention recently due to the increasing popularity of mobile devices such as smart phones and mobile sensors. In such a network, mobile devices rely on the intermittent encountering for packet exchange without the support of infrastructures, i.e., peer-to-peer communication. Therefore, MANETs can exploit the otherwise wasted communication opportunities resulted from device mobility and bring about many beneficial services. For example, due to the distributed network structure, i.e., no central station is needed, it can enable certain communication services in areas without infrastructures, e.g., rural and mountain areas. Further, since nodes communicate with each other during the encountering, it can enable the encountering based social network services even in areas with communication infrastructures, e.g., campus.

However, due to the aforementioned properties of MANETs, file sharing and packet routing in MANETs, which are the key for many services built upon MANETs, are non-trivial. So, this paper extended the work of SPOON and increased the threshold value for every aspect and made extensive analysis to prove the proposed work outperforms the existing file sharing systems.

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AUTHORS' BIOGRAPHY

M. Suresh is pursuing his P.G. at GATES Institute of Technology Gooty.

Mr. D. Venkatesh is working as Associate Professor in GATES Institute of Technology, Gooty. He is having 15 Years of teaching experience and 3 Years of research experience. He obtained his M.Tech degree from JNTUH. Published 10 papers in various national and international journals. His areas of interest includes computer networks, MANET's, cloud computing etc.

Mr. J. Raghunath is working as Assistant Professor in CSE Department of GATES Institute of Technology, gooty. He is having 6 years of teaching experience. He obtained his Masters degree from JNTUACEA, Anantapur. Published 3 papers in various journals. His areas of interest includes ACN, IS and MANETs.