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Performance of MANET Using ALCC Algorithm & Energy Model

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Abstract: **The study of MANET remains attractive due to the eagerness to achieve better performance and scalability. MANETs are autonomous systems consisting of mobile nodes that are connected by wireless links. Such systems are self organized and allow communication in the network without any centralized body. Clustering has set as a necessary research field that increases system performance such as delay and throughput in MANETs in the presence of both mobility and a large number of mobile hosts. There are many protocols to improve throughput and reduce data query delay in MANETs. Few protocols have chosen the cooperative caching scheme, allowing multiple mobile nodes within a cluster to cache and share data in their local caches. Cross-layer design has not been fully utilized to improve the performance of cooperative caching. A cluster based cooperative caching scheme is used and a cross-layer design is used to further improve the overall performance of MANET. A basic energy model is proposed to minimize the energy consumption. The simulation results in the NS-2 simulation environment show clearly that the proposed system improves caching performance in terms of packet delivery ratio Consumed energy Throughput Normalized Routing load compared to the caching scheme without cooperative caching strategy.**

Keywords: **MANETs, Cluster, cooperative caching, Energy model, Packet delivery ratio, Consumed energy, Throughput, normalized routing load and delay.**

1. INTRODUCTION

Wireless technologies have become very popular as they exhibit some great features, fulfilling the demand of network communication world-wide. Since portable devices require fixed infrastructure such as access point, therefore they need an access to a fixed network to support their mobile device services. To supply a solution to this problem Mobile Ad hoc Networks (MANETs) have evolved. MANETs are autonomous systems consisting of mobile nodes that are inter-connected by multi-hop wireless links. MANETs are decentralized networks that will formed by self organization. MANETs are formed by the number of nodes that can transmit, receive and relay data among themselves. In MANET there is no fixed infrastructure therefore the mobile nodes communicate over multi-hop wireless links. These are often called as infrastructure-less network model because the mobile hosts in the network establish route between themselves.

Caching has been proved to be a very important method for improving the data recovery performance in mobile communication area. With caching, the data or information process delay is minimized since queries or requests are served from the local cache, thereby clearing the need for data transmission. Caching methods used in one hop mobile scenario may not be applicable to many hosts mobile scenario since the data or request may need to go through number of hops. As mobile clients in MANET may have identical tasks and common interest, cooperative caching can be used to reduce the bandwidth and power utilization.

2. SYSTEM MODEL

2.1. Brief about proposed Mechanism:

A Cluster Based Cooperative Approach (CBCA) is proposed [1]. First, the information search and cache admission control schemes are based on clustering architecture. Clustering is a special way to organize MANETs. Clustering reduces traffic overhead, flooding, and collisions in MANETs. It also makes the MANET more scalable. Second, cross-layer design scheme is adopted to enhance caching performance. A data structure called a stack profile is created, which is independent of the protocol stack and works as a data exchange buffer for different protocol layers. Stack profile fully supports cross-layer design scheme because all protocol layers can get cross-layer information through the stack profile. Finally, the prefetching technique is used to increase the cache hit ratio and decrease user-perceived data request response time.

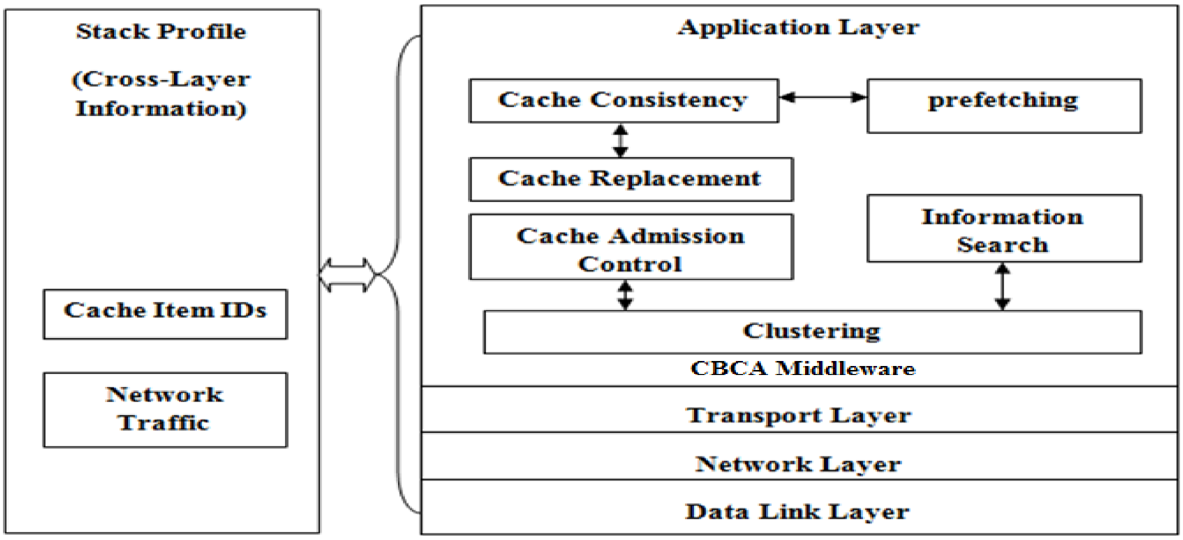

Fig.1 System architecture of CBCA

2.2. Cluster Based Cooperative Caching (CBCA):

The system architecture of Cluster Based Cooperative Approach (CBCA) is demonstrated in figure 1. CBCA is a cluster-based middleware which stays on top of the underlying network stack and provides caching and other data management services to the upper layer applications in MANET. CBCA includes prefetching modules, stack profile, information search, clustering, cache management, and. The stack profile module provides cross-layer information exchange. By the help of stack profile, cached item IDs which are in the middleware layer can be obtained by the network layer. The CBCA instances run in each mobile node. The network traffic information which is in the data link layer (DLL) can be obtained by the middleware layer for prefetching purposes.

2.3. Cross-Layer Information Exchange:

Implementations of the cross-layer design follows a principle demonstrated in [7] of vertical calibration across layers enabling shared data to be accessed to by the whole protocol stack. The module stack profile is independent of the protocol stack and provides a data exchange buffer for protocol layers in the protocol stack. In Cluster Based Cooperative Approach, two types of cross-layer information are implemented that are exchanged between different layers. The first information is Network Traffic Status, provided by the DLL. The middleware layer needs it for the prefetching operation. A mobile node starts the prefetching operation only when the network traffic is low, and the Data Center will not reply to the prefetching request if the network traffic is high. The second information is Cached Item IDs. It is provided by the CBCA middleware layer. The network layer needs the information. One of the steps in the information search operation is sending a request to the Data Center. When the request packet is passing along the route to the Data Center, it will be checked by forwarding nodes. If a forwarding node has the copy of the requested data item, it drops the request packet and sends the requested data item to the user. Because the above cross-layer information is exchanged only between two protocol layers.

2.4. Cluster Formation and Maintenance:

Clustering is used to partition a network into several virtual groups (known as clusters) based on certain predefined criteria. Figure 2 illustrate the clustering architecture. ALCC algorithm [1] undergoes the below steps.

1) Each node learns direct contact possibilities to other nodes.

2) A node decides to join or leave a cluster based on its contact possibilities to other members of that cluster. Cluster only if it's pair-wise contact possibilities to all existing members are greater than a threshold value. A node leaves the current cluster if its contact possibilities to some cluster members drop below threshold value.

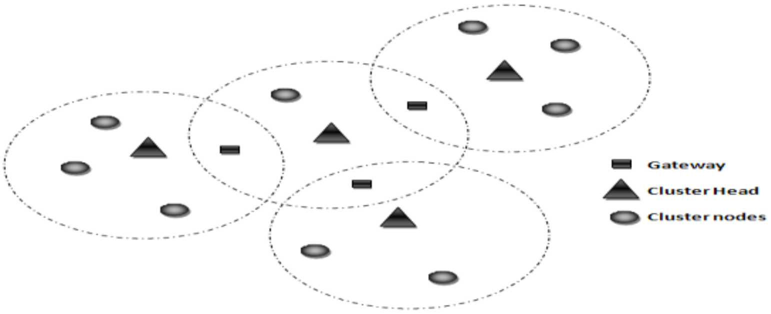

Fig.2 Illustration of clustering architecture

2.5. Local Cache and Neighbors:

The information search operation requests data items in the following order: local cache, neighbors, and eventually the Data Center as shown in Figure 3. The solid lines represent data item requests, and dashed lines represent data item replies. When a mobile host requests a data item, it first checks its own local cache. If the requested item is found in the local cache, the request succeeds, which has the least communication overhead and the least query latency. Otherwise, the search operation will continue to the next step: sending requests to neighbors. In this step, a mobile host searches the requested data item within the neighborhood. By exchanging hello messages, each mobile host has a record of all its neighbors. First, it checks whether the DC is its neighbor. If it is, the request is sent to the DC. If it is not, there are two situations, the mobile host is a cluster head and hence it checks its ID list or it is a cluster member and it sends the request packet to its cluster head. When a cluster head receives a request packet from its cluster member, it sends the requested item to the requester if it has already cached the requested item. If the cluster head does not cache the requested item, it forwards the request packet to the DC directly or via intermediate nodes.

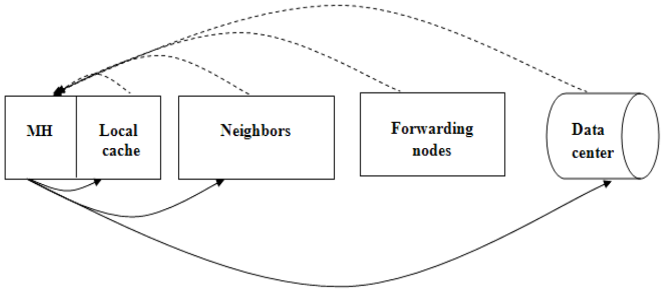

Fig.3 Information search operation

2.6. Information Searching at Neighbors:

Upon failing to get a reply from its neighbors, the mobile host initiates the request to the DC. When the request packet is passing along the route to the DC, it will be checked by each forwarding node. Because it is not a broadcast packet and the destination is not for the forwarding nodes, the checking process is executed in the network layer. Upon finding a passing-by request packet, the routing protocol queries the requested item ID to the middleware layer via the stack profile module. If the forwarding node owns the requested item, the routing protocol drops the request packet and replies with the requested data item to the requester. The request packet will not be further forwarded to the remote DC. This method is a typical example of using cross-layer design approach in a cooperative caching system to improve performance. If no forwarding node has cached the requested item, the request packet will eventually reach the DC. When the DC receives the request packet, it replies with the requested data item to the requester.

3. PREVIOUS WORK

Yin.L et.al [2] has analyzed Cooperative Caching in ad hoc networks focus on routing and not much work has been done on data access. Two schemes are used that is Cache Data, which caches the data, and Cache Path, which caches the data path. After analyzing the performance of those two schemes, this scheme propose a hybrid approach (Hybrid Cache), which can further improve the performance by taking advantage of Cache Data and Cache Path while avoiding their weaknesses.

Yang.N et.al [3] suggests Ad hoc network has emerged as an important trend of future wireless system that will provide ubiquitous wireless access. The performance optimization challenges of ad hoc network and cross-layer processing to improve its performance. Here cross layer processing was implemented between physical (PHY), Medium Access Control (MAC) and network (NET) layers.

Chand.N et.al [4] proposed Caching is one of the most attractive techniques that improve data retrieval performance in wireless mobile environment. With caching, the data access delay is reduced since data access requests can be served from the local cache.

Chiang.C.C et.al [5] has proposed a cluster head token infrastructure for multi-hop, mobile wireless networks has been designed. In this paper, a clustered multi-hop routing scheme implemented for mobile wireless networks.

4. PROPOSED METHODOLOGY

4.1. Simulation Model and Parameters:

We use NS2 to simulate our proposed algorithm. In our simulation, 15 mobile nodes move in a 1000m x 1000m square region for 50 100 150 200 seconds simulation time. We assume each node moves independently with the same average speed.

All nodes have the same transmission range of 100 meters. The simulated traffic is Constant Bit Rate (CBR).

Our simulation settings and parameters are summarized in table 1

Table.1 Simulation Settings & Parameters

No. Of Nodes	15
Area Size	1000 X 1000
MAC	802.11
Radio Range	100m
Traffic Source	CBR
Packet Size	1500
Mobility Model	Random Way point

4.2. Performance Metrics:

We evaluate mainly the performance according to the following metrics.

Throughput: The amount of data transferred from one node to another or processed in a specified amount of time. Data transfer rates for disk drives and networks are measured in terms of throughput. Typically, throughputs are measured in kbps, Mbps and Gbps.

Routing Overhead: In MANET nodes often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead.

Packet Delivery Ratio: The ratio of the number of successfully delivered data packets to the number of data packets sent by the sender to the destination.

Residual Energy: This metric indicates amount of energy remained in a node after transmission. Thus consumed energy can be calculated as the difference between initial energy of a node and residual energy. Here unit for energy is joules.

Delay: The amount time taken to send a bit of data from one node to another across the network. The delay indicates the transferring speed of the network. Network delay should be always less or null for better performance.

5. SIMULATION RESULTS

Figure 4 shows the packet delivery ratio as a function of Simulation time. The figure shows that proposed system always outperforms present system at all different simulation time. When simulation time is greater than 150 seconds the packet delivery ration is same whereas in present system it is slightly down.

Figure 5 shows the throughput as a function of simulation time. The figure shows that the throughput of proposed system is greater than present system at all simulation times. Thus ALCC algorithm gives good throughput.

Figure 6 show the normalized routing overhead as a function of simulation time. From the result we can see that the routing overhead of proposed system is much less than the present system

Figure 7 shows the residual energy as a function of simulation time. Here residual energy of proposed system is more than present system. Thus introducing an energy model in clustering saves much energy consumption.

Figure 8 shows the delay as a function of simulation time. Here delay of the proposed system is less than the present system.

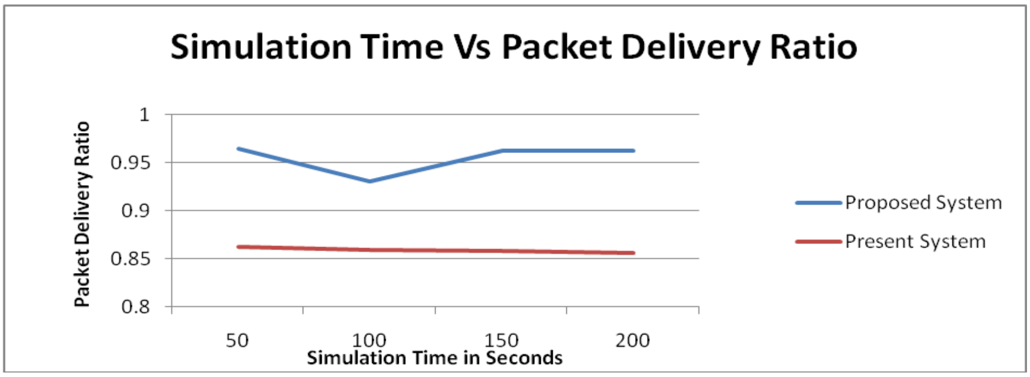

Fig.4 Simulation Time Vs Packet Delivery Ratio.

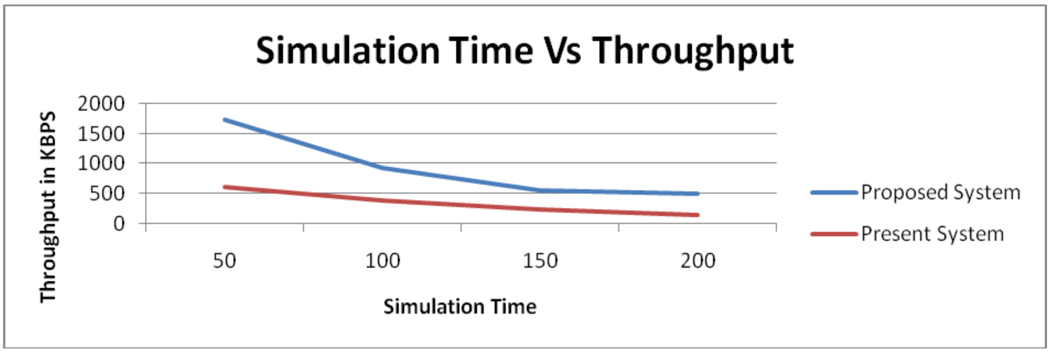

Fig.5 Simulation Time Vs Throughput

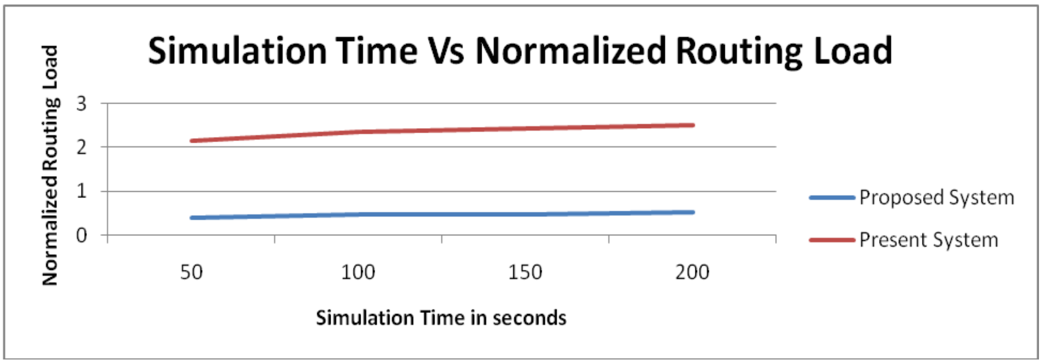

Fig.6 Simulation Time Vs Normalized Routing Load

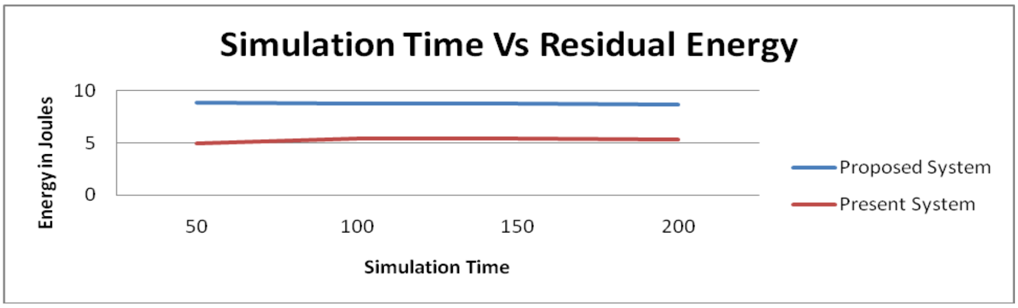

Fig.7 Simulation Time Vs Residual Energy

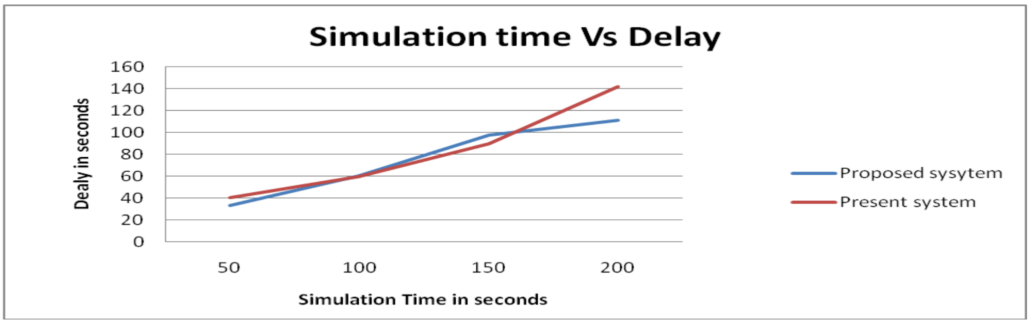

Fig. 8 Simulation time Vs Delay

6. CONCLUSION

In this paper, we provided with the fundamental concepts about clustering, including the definition of cluster and the necessity of clustering for a large dynamic MANET. Then we presented the related research work which has already been done in this domain. Then we presented an energy aware algorithm which is scalable and adaptable for various mobility conditions. The simulation results show that the performance of MANET in terms of throughput, packet delivery ratio, routing overhead and residual energy is improved when compared to without ALCC algorithm and energy model. The problem of cluster maintenance is not taken care by the proposed algorithm. Therefore an effective cluster maintenance scheme can be incorporated with the proposed clustering algorithm that can be taken up as the future work.

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