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### EFFICIENT ENERGY AWARE CLUSTER AND LOADBALANCING IN MOBILE ADHOC NETWORKS

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#### ABSTRACT

Routing is the process of selecting the best path in the network. Here it is focused on routing layer in order to increase the performance of the system. An Energy Aware Clustered algorithm based Routing is introduced which forms several clusters, finds energy aware node-disjoint multiple routes from a source to destination and increases the network life time by using optimal routes. Clustering is an important research area in mobile networks because it improves the performance of flexibility and scalability when network size is huge with high mobility. All mobile nodes operate on battery power hence the power consumption becomes an important issue in Mobile Network. Through the simulation with an enhanced version of NS-2 simulator Energy Aware Clustered algorithm shows the improvement in throughput, Energy Consumption and delay when compared to other algorithms.

**Keywords**— Mobile adhoc networks, load balancing, cluster,nodes, Energy.

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#### INTRODUCTION

Mobile networks (MANETs) is a self configuring mobile devices with no infrastructure. Each node in a MANET act as a router and has capability to deploy anytime and anywhere. The application of mobile network are military ,disaster management, industry and many more. Some characteristics of mobile networks are dynamic topology, distributed operation multi hop routing. Mobile nodes in the network moves and changes its topology frequently.

MANET are becoming increasingly common, and typical network loads considered for MANETs are increasing as applications evolve. One of the fundamental issues in a mobile ad hoc network is the load balancing problem. Load balancing is a method for distributing workloads across computing resources. Load balancing is to provide a single Internet service from multiple servers is the commonly used application. Load balancing is transfer load balancing is the main field in mobile ad hoc networks.

The protocols that are designed and developed for mobile networks can be classified into three major divisions such as proactive or table-driven, reactive or on-demand and hybrid. In proactive routing protocols the routes to all the destination nodes are determined at the start up, and maintained by using a periodic route update process. The proactive routing protocols are DSDV, WRP, GSR, FSR, STAR DREAM, MMWN, CGSR, HSR, OLSR, TBRPF. In reactive protocols, routes are determined when they are required by the source using a route discovery process. The reactive routing protocols are AODV, DSR, ROAM, LMR, TORA, ABR, SSA, LAR, RDMAR, ARA, FORP, CBRP. Hybrid routing protocols combines the properties of the first two classes of protocols into one. Hybrid routing protocols are ZRP, ZHLS, SLURP, DST, DDR. That is, they are both reactive and proactive in nature. Each group has a number of different.

To improve the energy efficiency under non uniform load distribution several protocols and mechanism are

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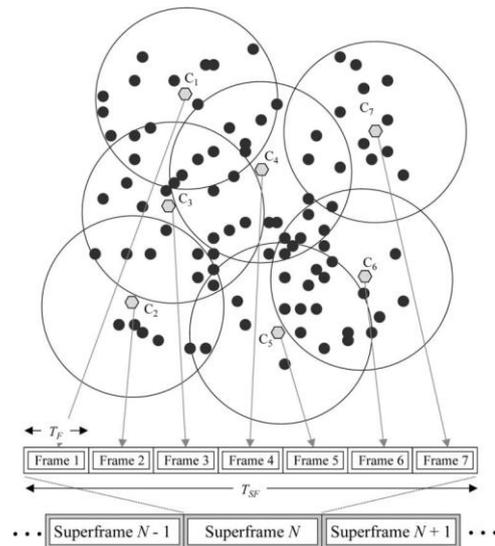
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used. Energy efficiency can be achieved by increasing the life time of mobile network. Even by minimizing the delay, jitter, and interference energy is made efficient. One of the key research areas in mobile networks. For reliable data Some mechanism has been used to improve the bandwidth under non-uniform load distribution. There are lot of approaches, mechanisms and protocols developed for energy efficiency in mobile ad hoc networks. In order to improve the energy efficiency in non uniform load distribution we had done a survey of literatures which deals with many approaches. In this research, energy efficiency can be improved under non uniform load distribution in mobile ad hoc network.

## RELATED WORK

Multi hop time reservation using adaptive control for energy efficiency (MH-TRACE)[1]. It is a medium access control (MAC) protocol which combines fully centralized and fully distributed networks for energy efficiency. MH-TRACE clusters are just for coordinating channels access and minimizing interference. Energy dissipation for receiving unwanted packets and collided data packets are avoided. By the use of transmission scheduling intra-cluster data collisions are completely eliminated and inter-cluster collisions are avoided. Two technique is used to save energy. First technique is used to reduce energy dissipation at MAC layer. Second technique is to reduce energy dissipation by avoiding packet receptions that will be avoided at higher layer. Whenever possible nodes should be in sleep mode to avoid 1) dissipating energy in the idle state; 2) Overhearing transmissions initiated from nodes that are further than the successful transmission range 3) receiving corrupted packets due to collisions. When compared to existing CSMA-type broadcast protocols like 802.11, MH-TRACE provides energy efficiency due to the use of Time Division Multiple Access (TDMA). This allow node to go for sleep mode often. It also provides higher throughput due to coordinated channel access. Fig 1 shows a MH-TRACE clustering and medium access for a portion of an actual distribution of mobile nodes. Nodes C1 through C7 are cluster head node



**Fig.1. MH-TRACE clustering and medium access for a portion of an actual distribution of mobile nodes. Nodes C through C are cluster head nodes.**

A novel cross-layer Distributed Energy-adaptive Location-based CMAC protocol (DEL-CMAC). DEL-CMAC is designed based on the IEEE 802.11 Distributed Coordination Function (DCF). DCF is a widely used standard protocol for most of wireless networks. DEL-CMAC is used to improve the performance of MANET in network lifetime and energy efficiency. To deal with the complicated medium access interactions an efficient Cooperative Medium Access Control (CMAC) protocol is needed. The existing CMAC protocol mainly focus on the throughput enhancement and not on energy efficiency. Effective relay selection strategy is introduced for best relay terminal and a cross layer optimal power allocation. Cooperative Communication (CC) is a technique for conserving the energy consumption in MANET. Spatial reuse is enhanced to minimize the interference among different connections by using novel NAV settings. When compared with IEEE 802.11 DCF and Coop MAC at relatively low throughput and delay degradation cost. cross-layer cooperative diversity-aware routing algorithm together with our DEL-CMAC is also used to conserve energy.

Device-Energy-Load Aware Relaying framework (DELAR) is used to achieve energy

conservation. Energy conservation is the fundamental issue in heterogeneous mobile ad hoc networks. It consist of powerful nodes (ie.P-nodes) and normal nodes (ie B-nodes). B-nodes are equipped with limited power sources like batteries. P-nodes have unlimited power supplies like solar cells. A hybrid transmission scheduling scheme, combining both the reservation-based and contention based medium access control schemes, to coordinate the transmissions among P-nodes and B-nodes. Mini-routing technique and the novel Asymmetric MAC (A-MAC) protocol is introduced enable the MAC layer acknowledgements over unidirectional links due to the use of asymmetric transmission power levels between P-nodes and B-nodes. A multi packet transmission technique to further improve the delay performance. Energy conservation techniques such as power saving modes, transmission power control and power aware routing can be integrated to jointly achieve better energy conservation. DELAR reduce energy conservation and increase the lifetime of the network.

A heuristic algorithm that balances the energy load among all the devices in the network. To consume energy and maximize network lifetime this algorithm is introduced. Energy-Aware Scheduling strategy that assigns computational task over a network. Scheduler is used to find the task allocation. When compared to time-based traditional schedulers the proposed scheduler enhance the performance of the system. Energy-Aware Scheduler 1) is effective in prolonging network lifetime by reducing the energy consumption 2) is able to complete a greater number of tasks in the same experimental settings 3) in all the experiments performed, is able to keep alive all the devices thanks to its energy load balancing scheme.

Efficient power aware routing (EPAR). To improve the communication energy efficiency at individual nodes power aware is a important challenge. EPAR is used to increases the lifetime of network in MANET. EPAR must be able to handle high mobility of the nodes that often causes changes in the network. EPAR protocol is compared with three other protocols 1) Proactive Energy-Aware Routing 2) Reactive Energy-Aware Routing 3) DSR protocol. In small size network the energy and throughput does not show any significant changes but in large networks DSR performance is inefficient. In medium and large networks EPAR and MTPR produced good result and

good throughput. EPAR identifies the capacity of the node not by its residual battery power but by expected energy spent when forwarding the data packets. EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. EPAR reduces for more than 20% total energy consumption and decrease the mean delay for high load networks. EPAR algorithm outperforms the original DSR algorithm by 65% A lightweight dynamic channel allocation mechanism and cooperative load balancing strategy. In Dynamic Channel Allocation (DCA) the channel controllers continuously monitor the power level in all the available channels in the network and assess the availability of the channels by comparing the measured power levels with a threshold. the channel coordinator starts using an additional Channel If the load on the channel controller increases beyond Capacity. Cooperative load balancing algorithm is that the active nodes can continuously monitor the load of the channel coordinators and switch from heavily loaded coordinators to the ones with available resources. Coordinated channel access protocols are well suited for uniform load distributions. This protocol is not suited for non-uniform load distribution as uncoordinated channel access. It is due to the Lack of on-demand dynamic channel allocation. In order to address this problem lightweight dynamic channel allocation mechanism and cooperative load balancing strategy are introduced in cluster based MANET. Here these two algorithms are implemented in coordinated MAC protocol named as MH-TRACE for managing non uniform load distribution and propose CDCA-TRACE Before proposing CDCA-TRACE these two algorithms are incorporated in TRACE framework leading to DCA-TRACE and CMH-TRACE. In wireless network MAC protocol is classified as uncoordinated MAC and coordinated MAC protocol. In uncoordinated protocols such as IEEE 802:11, nodes contend with each other to share the common channel. Coordinated MAC protocols the channel access is regulated. Fixed or dynamically chosen channel controllers determine how the channel is shared and accessed. MAC protocol providing support for non-uniform load distributions. Integrating spatial reuse into a MAC protocol drastically increases bandwidth efficiency. These protocol utilized to improves throughput, energy consumption and inter-packet delay variation (IPDV). DCA-TRACE includes two additional mechanisms on top of MH-TRACE: i) a

mechanism to keep track of the interference level from the other CHs in each frame; and ii) a mechanism to sense the interference level from the transmitting nodes in each data slot in each frame. In this paper bandwidth is improved by using those algorithms. Energy must be made efficient by any of the algorithms.

## SYSTEM MODULE

Various routing layer considerations of TRACE systems is addressed in previous work. Here the performance of the MAC layer is focused. Hence, simple network and transport layer protocols is utilized that provide local broadcasting. A connectionless transport layer model is assumed in which the transport layer directly connects the upper and lower layers. All data packets are assumed to be destined to the local neighborhood (i.e., local broadcasting). All received data packets are passed to the application layer and are not relayed further. Matching the network layer algorithm, link layer broadcasting is assumed. All the nodes in the vicinity of the transmitter receive the packet as long as the power levels permit successful decoding. DCF mode for link layer broadcasting traffic is used for IEEE 802.11. Note that in this mode, the RTS/CTS and ACK mechanisms are disabled. Similarly, no ACK mechanism is used in the TRACE protocols either, and there are no packet retransmissions. For IEEE 802.15.4, beacon enabled mode of operation is used with guaranteed time slot (GTS) mechanism. The ACK mechanism is disabled for the data packets but is active for the control messages.

The TRACE protocols require time synchronization at the MAC layer. In simulations, nodes are assumed to be perfectly synchronized. TRACE does not implement a node synchronization algorithm. In real life implementations, synchronization should be provided either using specialized systems such as GPS or external synchronization algorithms implemented alongside TRACE. It is possible to obtain high synchronization accuracy on the order of nanoseconds by using GPS systems. The synchronization algorithms that are based on packet exchanges are less accurate and introduce synchronization errors to the system, especially for larger networks. These synchronization errors may reduce the performance of implementations that use inaccurate synchronization algorithms.

The default propagation model (two-ray ground model) that is available in ns-2 is used. For all

simulations, a constant transmit power is used that results in a maximum receiving range of 250 m under zero interference. In the case of interference, all packets received during the interference period are dropped unless one of the packets captures the receiver with a power value at least 10 times larger than the power of any interfering packets. The source application generates real-time traffic in constant bit-rate (CBR) mode that generates packets every 25ms. Due to real-time communication constraints, packets become obsolete and are discarded at the source if they are not sent within 25 ms. The channel rate is set to 2 Mbps for TRACE and 802.11 while the default channel rate of 250 Kbps is used for 802.15.4 in order to ensure consistency with various internal timer values such as association timeouts and ACK timeouts. In order to account for the data rate difference, a source coding rate of 4 Kbps is used for 802.15.4 while 32 Kbps is used for the other protocols. Starting at  $t_s=2$  s (80th packet generation interval), every 5 packet generation interval one source node starts generating packets, thereby increasing the number of active sources and the load in the network.

For TRACE, the super frame duration is matched to the source packet generation interval of 25 ms. each super frame consists of 6 frames with 6 data slots each. For 802.15.4, super frame order SO is set to 1, leading to a super frame duration of 30.72 ms. For node mobility, the random way-point mobility model is used, where the node speeds are chosen from a uniform random distribution between 0.0 m/s and 5.0 m/s with zero pause time. The energy model discussed in is used. Multi-hop extensions of the IEEE 802.15.4 protocol use full functioning devices (FFDs) that transmit their own beacons and respond to association requests. However managing a large number of FFDS in an IEEE 802.15.4 network is problematic due to the overhead associated with the increased number of control messages. Initial simulations showed that under targeted node densities, overhead overwhelms the system resources, reducing the system performance severely. Efficient cluster tree creation and maintenance for multi-hop 802.15.4 networks is an open problem and is out of the scope of this paper. In order to isolate the problems, for the multi-hop scenarios 25 stationary coordinators is pre deployed in a uniform grid formation to cover the entire network. The dimensions in the grid are selected to have each coordinator separated by less than the communication radius from all the adjacent

coordinators. Here an initialization period is allowed for these nodes by turning them on 20 seconds before the other nodes.

### **MH-TRACE Protocol**

Certain nodes assume the roles of channel coordinators in MH-TRACE, here called cluster-heads (CHs). All CHs send out periodic Beacon packets to announce their presence to the nodes in their neighborhood. When a node does not receive a Beacon packet from any CH for a predefined amount of time, it assumes the role of a CH. This scheme ensures the existence of at least one CH around every node in the network. In MH-TRACE, time is divided into super frames of equal length, where the super frame is repeated in time and further divided into frames. Each cluster head (CH) operates using one of the frames in the super frame structure and provides channel access for the nodes in its communication range. Each frame in the super frame is further divided into sub-frames. The control sub-frame is used for signaling between nodes and the CH, and the data sub-frame is used to transmit the data payload. In the Beacon slot, CHs announce their existence and the number of available data slots in the current frame. The CA slot is used for interference estimation for CHs operating in the same frame (co-frame CHs). During the CA slot, CHs transmit a message with a given probability and listen to the medium to calculate interference caused by other CHs operating in the same frame. By monitoring the interference levels in the medium during the Beacon and CA slots of each frame, CHs switch to the least noisy frame from their perspective.

Contention slots are utilized by the nodes to send their channel access requests to the CH. A node that wants to access the channel randomly selects a contention slot and transmits a Contention message in that slot. After listening to the medium during the contention slots, the CH becomes aware of the nodes that have channel requests and forms the transmission schedule by assigning available data slots to the nodes. After that, the CH sends a Header message that includes the transmission schedule. There are an equal number of IS slots and data slots in the remainder of the frame. During the IS slots, nodes send short packets summarizing the information that they are going to be sending in the corresponding data slot. By listening to the relatively shorter IS a packet, receiver nodes

become aware of the data that are going to be sent and may choose to sleep during the corresponding data slots. These slots contribute to the energy savings mechanism by letting nodes sleep during the relatively longer data slots whose corresponding IS packets cannot be decoded. IS packets can also carry routing information. However, for the purposes of the work, the assumption made is that all the nodes that can successfully receive the IS packet listen to the corresponding data slot, since the performance of the MAC layer is only tested. Routing considerations addressed are out of the scope .

Another use for the IS packets is to notify the CH about the utilization of the slot by the assigned node. CHs automatically reserve a data slots for nodes that had a reservation in the previous super frame and actively used it. CHs drop the reservation in the case of either missing IS packets or an IS packet with an end-of-stream instruction. In the beginning of its frame, each CH calculates the available data slots and includes this information in its Beacon packet. This information is utilized both in the dynamic channel allocation and the cooperative load balancing algorithms.

### **MH Trace Dynamic Channel Allocation**

The first mechanism proposed is a dynamic channel allocation (DCA) algorithm similar to the ones that exist in cellular systems. Under non-uniform loads, it is crucial for the MAC protocol to be flexible enough to let additional bandwidth be allocated to the controllers in the heavily loaded region(s). Dynamic channel allocation systems in cellular systems depend on higher bandwidth back-link connections available to cell towers. The cell towers are coordinated using these back-link connections in order to provide dynamic channel allocation and spatial reuse simultaneously. On the other hand, in MANETs, the channel coordinators can only communicate by sharing common channel resources, reducing the resources available for data transmission. In addition to this, the interference relationships between channel coordinators are highly dynamic. Hence, implementing a tight coordination would be too costly for a MANET system.

Instead, a dynamic channel borrowing scheme that utilizes spectrum sensing. is adopted In dynamic channel algorithm, the channel controllers continuously monitor the power level in all the available channels in the network and assess the availability of the channels by comparing the measured power levels with a

threshold. If the load on the channel controller increases beyond capacity, provided that the measured power level is low enough, the channel coordinator starts using an additional channel with the lowest power level measurement. Once the channel coordinator starts using the channel, its transmission increases the power level measurement of that channel for nearby controllers, which in turn prevents them from accessing the same channel. Similarly, as the local network load decreases, controllers that do not need some channels stop the transmissions in that channel, making it available for other controllers. In dynamic channel allocation algorithm, channel coordinators react to the increasing local network load by increasing their share of bandwidth. Although being effective in providing support for non-uniform network loads, the reactive response taken by the channel coordinators increases the interference in the entire system.

In MH-TRACE, each CH operates in one of the frames in the super frame. Since the number of data slots is fixed, the CH can only provide channel access to a limited number of nodes. Due to the dynamic structure of MANETs, one CH may be overloaded while others may not be using their data slots. In that case, although there are unused data slots in the super frame, the overloaded CH would provide channel access only to a limited number of nodes, which is equal to the number of data slots per frame, and the CH would deny the channel access requests of the others. Thus, the system needs a dynamic channel allocation scheme to provide access to a larger number of nodes. DCA-TRACE lets CHs operate in more than one frame per superframe, if they are overloaded. Instead of choosing and operating in the least noisy frame as in MH-TRACE, in DCA-TRACE, based on the load level, CHs decide on the number of frames they require and opportunistically choose that many frames from the least noisy frames.

DCA-TRACE includes two additional mechanisms on top of MH-TRACE (i) a mechanism to keep track of the interference level from the other CHs in each frame; and (ii) a mechanism to sense the interference level from the transmitting nodes in each data slot in each frame. These mechanisms make use of existing messages and do not add complexity other than slightly increasing memory requirements to store the interference levels. The MH-TRACE structure provides CHs the ability to measure the interference from other

CHs in their own frame and in other frames through listening to the medium in the CA slot of their own frame and the Beacon slots of other frames. In MH-TRACE, CHs use this mechanism to choose the minimum interference frame for themselves. DCA-TRACE makes use of the same structure. However, in order to accommodate temporary changes in the interference levels that may occur due to CH resignation or unexpected packet drops, an exponential moving average update mechanism is used to determine the current interference levels in each frame.

In DCA-TRACE, CHs mark a frame as unavailable if there is another cluster that uses the frame and resides closer than a certain threshold,  $Tr_{intf}$ , measured through the high interference value of that frame. Even under high local demand, CHs refrain from accessing these frames that have high interference measurements, in order to protect the stability of the clustering structure and the existing data transmissions. At the end of each super frame, CHs determine the number of frames that they need to access,  $m$ , based on the reservations in the previous frame. Depending on the interference level of each frame, they choose the least noisy  $m$  frames that have an interference value also below a common threshold,  $Thintf$ . If the number of available frames is less than  $m$ , the CHs operate only in the available frames.  $Thintf$  prevents excessive interference in between co-frame clusters that can potentially destabilize the clustering structure. Channel sensing and assignment in DCA-TRACE is similar to cognitive radio systems. However the primary CH of the frame and the CH that borrows a channel is not distinguished but treated them equally in having access to the available data slots in any frame.

## COOPERATIVE LOAD BALANCING

The DCA algorithm approaches the problem of non uniform load distribution from the perspective of the channel coordinators. The same problem can also be approached from the perspective of the other nodes in the network. Using cooperative nodes smoothes out mild non-uniformities in the load distribution without the need for the adjustments at the channel coordinator side. The load on the channel coordinators originates from the demands of the ordinary nodes. Many nodes in a network have access to more than one channel coordinator. The underlying idea of the cooperative load balancing algorithm is that the active nodes can

continuously monitor the load of the channel coordinators and switch from heavily loaded coordinators to the ones with available resources. These nodes can detect the depletion of the channels at the coordinator and shift their load to the other coordinators with more available resources. The resources vacated by the nodes that switch can be used for other nodes that do not have access to any other channel coordinators. This increases the total number of nodes that access the channel and hence increases the service rate and the throughput.

In the TRACE protocols, nodes contend for channel access from one of the CHs that have available data slots around themselves. After successful contention, they do not monitor the available data slots of the CHs around them. Due to the dynamic nature of the network load, a cluster with lots of available data slots may become heavily loaded during a data stream. In order to tackle this issue, nodes should consider the load of the CH not only when they are first contending for channel access but also after securing a reserved data slot during the entire duration of their data stream. In DCA-TRACE, once CH1 allocates all of its available slots, it triggers the algorithm to select an additional frame. However, accessing one additional frame might not always be possible, if the interference levels on all the other frames are too high. Moreover, accessing additional frames increases the interference in the Beacon and Header slots of these frames and may trigger CH resignations and reselections in the rest of the network that temporarily disturbs ongoing data streams on the resigned CHs. Finally, accessing additional frames increases interference on the IS and data slots of the new frame and decreases the potential extent these packets can reach. In order to overcome these difficulties, CMH-TRACE and CDCA-TRACE, is proposed which add cooperative CH monitoring and reselection on top of MHTRACE and DCA-TRACE, respectively. In CMH-TRACE and CDCA-TRACE, nodes continuously monitor the available data slots at the CHs around themselves announced by the Beacon messages. When all the available data slots for a CH are allocated, with a probability  $p$ , the active nodes attempt to trigger the cooperative load balancing algorithm. When the cooperative load balancing is triggered, the node that is currently using a data slot from the heavily loaded CH contends for data slots from other nearby CHs while keeping and using its reserved data slot until it secures a new data slot from another CH.

The additional contention overhead introduced to neighboring CHs by the cooperative load balancing is limited. It is important to note that only the active nodes that have access to another CH with free resources can trigger cooperative load balancing algorithm. Probabilistically triggering the algorithm further reduces this load. Considering the fact that TRACE already has a low contention overhead thanks to its automatic channel reservation algorithm for active nodes, the slight increase in the contention overhead does not have a significant effect on protocol performance.

## SIMULATION & RESULT



The above simulation shows the effective load balancing scheme in the network.



The above graph shows the energy consumption for the number of nodes deployed.

## CONCLUSION

Light weight dynamic channel allocation and cooperative load balancing algorithm is proposed to support non uniform load distribution. By combining the dynamic channel allocation and cooperative load balancing algorithm CDCA-TRACE protocol is proposed that has the highest bandwidth. All these are investigated in MAC layer which improves energy consumption, inter packet delay variation, and throughput. Energy Aware Clustered Algorithm will be enhanced in routing layer in order to improve the performance of the system.

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