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Energy efficient approach in MANETs Using CACO

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Abstract —

Although establishing correct and efficient routes is an important design issue in mobile ad hoc networks (MANETs), a more challenging goal is to provide energy efficient routes because mobile nodes' operation time is the most critical limiting factor. A recent trend in ad hoc network routing is the reactive on-demand philosophy where routes are established only when required. Most of the protocols in this category, however, use single route and do not utilize multiple alternate paths. This paper proposes an analytical analysis of energy parameters, their usage and their evaluation in ad hoc networks. The scheme is incorporated with the AODV protocol and the performance has been studied through simulation. The main purpose of this paper is to facilitate the research efforts in combining the performance of ACO with Cuckoo search algorithm to offer a more energy efficient routing mechanism.

Keywords— MANETs; AODV; Energy; Cukoo;ACO

I. INTRODUCTION

As the importance of computers increases, it also sets new demands for connectivity. Number of Solutions using Wired has been around for a long but there is increasing demand on working wireless solutions. Wireless communication between mobile users is growing more popular than ever before. This growth is due to the technological advancements in the field of computers and communicating devices. Technology has enabled computers and communicating devices (like laptops, wireless modems, tablets etc) to be equipped with radio interfaces to communicate. Wireless networking enhances the utility of carrying a computing device. It provides the mobile user with versatile and flexible communication and continuous access of networked services.

A mobile ad hoc network (Manet) is a group of mobile &wireless nodes which cooperatively form a network independent of any fixed infrastructure or centralized administration. In a particular, a Manet has no base stations, a node directly communicate with nodes within wireless range. Mobile Ad Hoc Networks (MANETs) represents the decentralized paradigms where clients themselves sustain the network in the absence of a central infrastructure. Nodes in Manet network are basically battery operated and thus have access to a limited amount of energy. Each device in a MANET is free to move independently in any direction, and therefore change their links to alternate devices. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. This type of networks may operate by them or may be connected to the larger Internet.

Features of MANET

- Rapidly deployable, self configuring.
- No need for existing infrastructure.
- Wireless links.
- Nodes are mobile the topology can change dynamically.
- Nodes must be able to cope with the traffic since communicating nodes might be out of range.

II. ROUTING PROTOCOLS IN MANETS

2.1 Reactive Protocols

Reactive protocols seek to set up routes on-demand. In this, if a node wants to initiate communication with a node to which it has no route then this routing protocol will try to establish such a route.

Pros and cons:

- Does not use bandwidth except when needed (when finding a route)
- Network overheads in the flooding process
- when querying for routes
- Initial delay in traffic

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Examples:

- Admission Control enabled On demand Routing (ACOR)
- Ad hoc On-demand Distance Vector.
- Dynamic Source Routing (RFC 4728)
- Dynamic Manet On-demand Routing (RFC 4728)
- Power-Aware DSR-based

2.2 Proactive Protocols

A proactive protocol approach to MANET routing seeks to maintain a constantly updated topology. Whole of the network should be known to all nodes. It results in a constant overhead of routing traffic, but not any initial delay in communication.

Pros and cons:

- Constantly overheads are created by control traffic
- Routes are always available

Examples:

- B.A.T.M.A.N. – Better approach to mobile adhoc networking.
- Babel, a loop-avoidance distance-vector routing protocol RFC 6126.

2.3 Hybrid Protocols

Hybrid protocols are the protocols which combine the proactive and reactive approaches. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice of method requires predetermination for typical cases.

Examples:

- ZRP (Zone Routing Protocol) ZRP uses IARP as pro-active and IERP as reactive component.

2.4 Ad-hoc On-demand Distance Vector (AODV)

The well known protocol which uses distance vector algorithm is Ad-hoc On-demand Distance Vector designed for MANET which is an updated version of DSDV protocol.

Routing Mechanism in AODV

AODV uses DSDV mechanism for routing and consists of few key contents in the routing algorithm these are listed below,

- Sequence Number
- Route Request
- Route Reply
- Route Error
- Local Repair

Advantages of AODV

AODV avoids the ``*counting to infinity*" problem from the classical distance vector algorithm by using sequence numbers for every route.

The AODV protocol is only used when two endpoints do not have a valid active route to each other. Nodes keep a "precursor list" that contains the IP address for each of its neighbors that are likely to use it for a next hop in their routing table. Route table information must be kept for all routes even short lived routes.

The routing table fields used by AODV are:

- Destination IP Address
- Destination SequenceNumber
- Valid Destination Sequence number flag
- Other state and routing flags
- Network Interface
- Hop Count
- Next Hop
- List of Precursors
- Lifetime

III. ENERGY EFFICIENT ROUTING OPTIMIZATION USING CACO

AODV is a manet routing reactive protocol. Routes are determined and maintained for nodes that need to send data to a specific destination. Route requests (rreqs) and route replies (rreps) are two aodv defined message types. During route discovery, rreqs are flooded through networks to locate a route to destination. Each node maintains route table entries with destination ip address, next hop id, hop count, destination sequence number and life in aodv. This information is kept for temporary routes, like those created to track the reverse paths towards nodes originating rreqs.

A. Ant colony optimization(aco)

Aco was inspired by behavior of a real ant colony and is designed to solve problem in manets. Various aco based

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routing algorithms were proposed to tackle manet routing. Aco technique for manet routing uses stigmergy to determine best possible routes from source node to destination node. To find route,artificial ants are positioned at each node which marks their trails with pheromone when they move within a network. Pheromone concentration levels on trails depend on path quality.

The ACO heuristic is as follows:

SET PARAMETERS,INITIALIZE PHEROMONE TRAILS

WHILE TER MINATION CONDITION NOT MET DO

CONSTRUCT ANTSOLUTIONS

APPLY LOCALSEARCH

UPDATE PHEROMONES

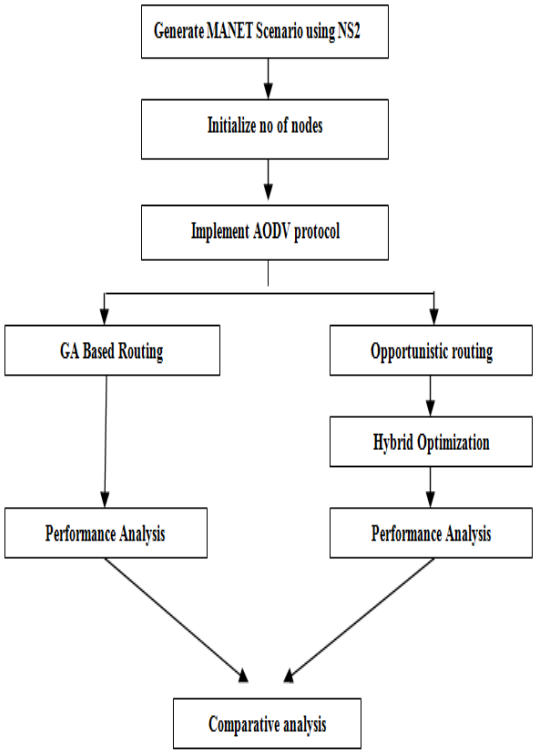
END WHILE

B. Cuckoo Search

Cuckoo Search (CS) algorithm is modeled based on the lifestyle and aggressive reproduction strategy the cuckoo species of birds. These birds lay eggs in nests of other bird species. The birds has the abilities like choosing recent spawned nests, and removing existing eggs to increase the hatching expectation of their eggs. But, some host birds combat this parasitic cuckoo's behavior by throwing out discovered alien eggs/building new nests in new locations. Pseudo code of Cuckoo Search (CS) algorithm explained as follows:

Begin
Objective function F(x),x=(x_1,x_2.....x_d)
Generate initial population of n host nests X_i(i=1,2,3,.....n)
While (t<MaxGeneration)
Get a cuckoo randomly by Levy flights
Evaluate its quality /fitness F_i
Choose a nest j among n randomly
If (F_i>F_j) replace j by the new solution;
End
A fraction (pa) of worse nests are abandoned and new ones are built;
Keep the best solutions
Rank the solution tofind the current best
end while
Post process results and visualization end

3.1 Basic Design of Proposed Work:



3.2 Proposed Algorithm:

Input: No of nodes, route information
Output: Energy efficient routes
Start
{
Initialize 'n' no of nodes and parameters
Initialize array heuristic and pheromone motion
While (stopping criteria)
{
Build solution
Apply local search
Pheromone update
}
End while
View best solution(k)
Generate initial population of k host nest,
While(+<Max generations)
{
Get a cuckoo randomly (i)
Evaluate quality fitness Fi
Chose a nest among 'k' randomly (j)
If (Fi>Fj)
Replace j by new solution;
End if
Keep the best solution;
Rank the solution and find the current best;
Pass the current best solution to next generation

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IV. IMPLEMENTATION

To implement this proposed solution we used Network Simulator 2. We test this proposed algorithm to different network scenario but here only discussed the scenario of 50 nodes with 500x500 areas. Manet scenario is generated by using NS-2 with this defined configuration using AODV protocol and comparison of AODV with CACO based routing is analyzed by using different network parameters. The network setup is defined below in table 1.

Table 1: Simulation Setup

Network Parameters	Values
Channel	Wireless
Radio propagation model	Two ray ground
Network interface type	Physical/wireless physical/802_15_14
MAC type	802.15.4
Interface Queue Type	Droptail/Priority queue
Link Layer Type	LL
Antenna Model	Omni Antenna
Queue length	50
No.of nodes	25,50
Routing protocol	AODV,Hybrid(ACO+Cukoo)
Area	500*500
Simulation time	100s

Implementation in ns-2

NS-2 is used to simulate the real moving behaviours of the nodes in a mobile ad hoc network. The evaluation will be conducted with some specific number of nodes that will be randomly scattered in a specific region with specific number of connections. Figure 4.1 shows the MANET Environment generated by using NS-2.

Route request

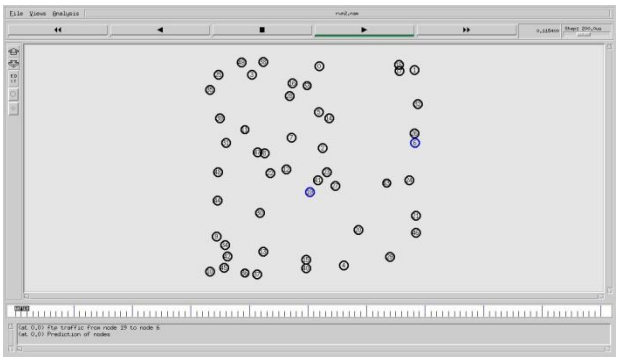

Figure 4.1 This shows how routes are requested in ns-2

Route discovery

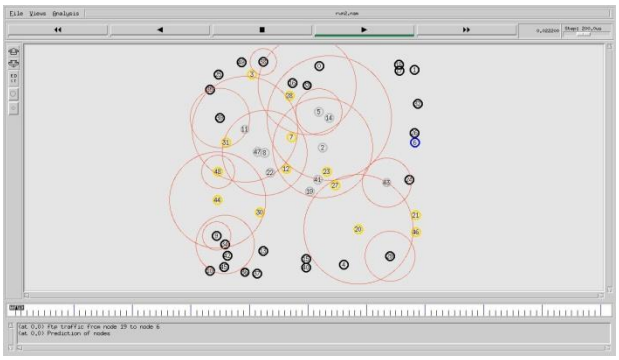

Figure 4.2 This shows how routes are discovered in ns-2

Packet transmission

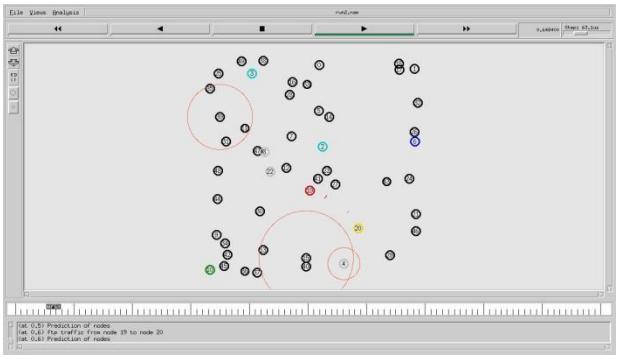

Figure 4.3 shows how packet can move or how data can be move from one node to another node by using NS-2.

5. Results & Discussion

To simulate the real moving behaviours of the nodes in a mobile ad hoc network a simulation tool will used. The evaluation will be conducted with some specific number of nodes that will be randomly scattered in a specific region with specific number of connections. This simulation evaluates the protocol using the following performance metrics:

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a) Throughput
b) Energy efficiency
c) End to End Delay

Packet Sent: It is the number of packets sent by the application layer of source nodes.

Packet received: It is the number of packets received by the application layer of destination nodes.

Routing Overhead: The total number of routing control packets generated by all nodes to the total data packets during the simulation time.

Network Load: It is the total traffic received by the network layer from the higher MAC that is accepted and queued for transmission. It is measured as bits per second.

Packet delivery Ratio (PDR): It is the ratio of all the received data packets at the destination to the number of data packets sent by all the sources. It is calculated by dividing the number of packet received by destination through the no. of packet originated from the source.

PDR = $(P_r / P_s) * 100$

Where, P_r is total packet received and P_s is total packet sent.

Throughput: It is the average at which data packet is delivered successfully from one node to another over a communication network. It is usually measured in bits per second.

Throughput = (no of delivered packets * packet size) / total duration of simulation

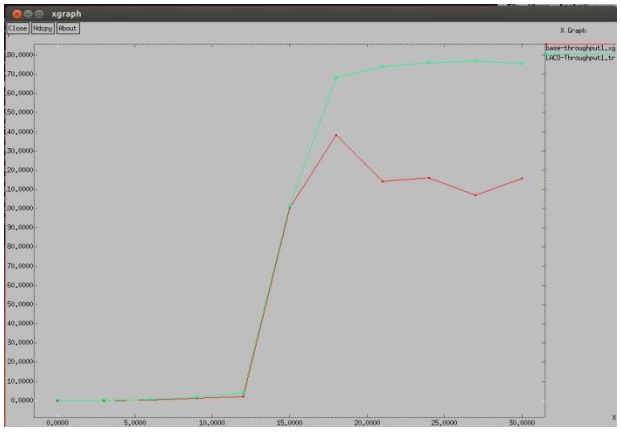

Figure 5.1:Throughput is more in Improved CACO

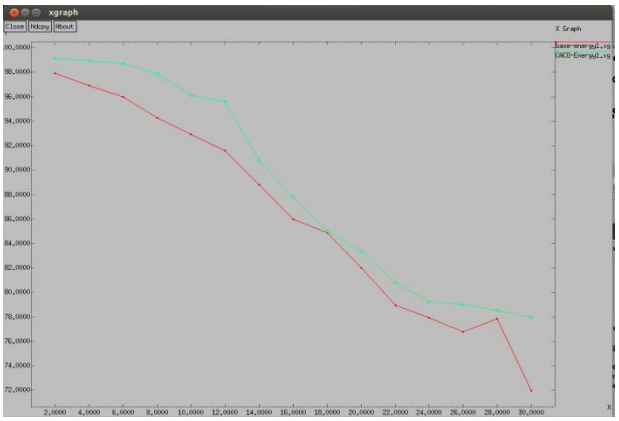

Figure 5.2:Energy efficiency is more in Improved CACO

End to End Delay: This includes all possible delays caused by buffering during route discovery, latency, and retransmission by intermediate nodes, processing delay and propagation delay. It is calculated as

D = $(T_r - T_s)$

T_r is receive time and T_s is sent time of the packet.

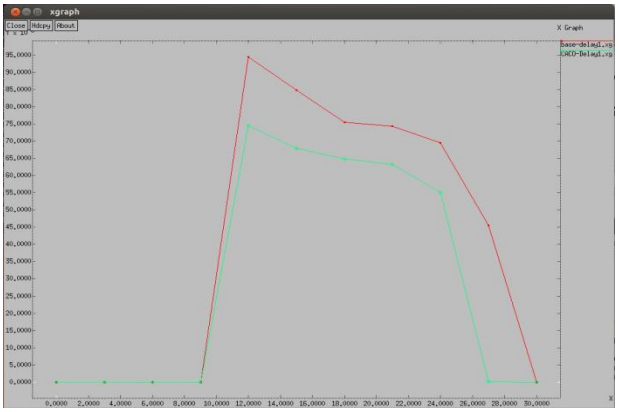

Figure 5.3: Delay is less in Improved CACO

V. CONCLUSION

A mobile ad hoc network (MANET) consists of autonomous, self-organizing and self-operating Data ready at a source node Advertising beacons from server node(s) Data comm. starts Data comm. ends The source waits Server Listen Server Listen Server Listen 22 nodes, each of which communicates directly with the nodes within its wireless range or indirectly with other nodes via a dynamically computed, multi-hop route. Due to its many advantages and different application areas, the field of MANETs is rapidly growing and changing. While there are still many challenges that need to be met, it is likely that MANETs will see wide-spread use within the next few years. In order to facilitate communication

within a MANET, an efficient routing protocol is required to discover routes between mobile nodes. Energy efficiency is one of the main problems in a MANET, especially in designing a routing protocol. In this paper, we used two optimizing algorithms and classified a number of energy aware routing schemes. In many cases, it is difficult to compare them directly since each method has a different goal with different assumptions and employs different means to achieve the goal. In this paper, CACO algorithm is used to achieve better results in the network of nodes. This is achieved by using the nodes first, which have less residual energies left. As you can see in the graphs our approach has given better results in terms of Delay, Throughput and energy efficiency.

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