COMPARISON OF DIFFERENT ALGORITHMS TO COMPUTE THE CAPACITY OF WIRELESS NETWORK AND TO OPTIMIZE THE ENERGY CONSUMPTION

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ABSTRACT

A mobile ad-hoc network is a kind of wireless ad-hoc network, and is a self-configuring network of mobile routers connected by wireless links – the union of which forms an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Today wireless network has been evolved in a large number of applications, which rely on multi-hop. It is a self-organizing and rapidly deployable in which neither a wired backbone nor a centralized control exists. The node communicate message with others using wireless channels in a multi-hop fashion. A new paradigm of wireless wearable devices enabling instantaneous person-to-person, person-to-machine or machine-to-person communication. This paper examines and computes three different algorithms Minimum Energy Algorithm, An Expanding Ring Search Algorithms and New Power Routing Algorithm to compute the capacity of network for saving Energy.

Keywords: Efficient Energy Consumption, Mobile Ad hoc Network, Ring Search, Power Routing.

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1. INTRODUCTION

A wireless ad hoc network is a decentralized wireless network. The network is ad hoc because it does not rely on a preexisting infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity.

The decentralized nature of wireless ad hoc networks makes them suitable for a variety of applications where central nodes can't be relied on, and may improve the scalability of wireless ad hoc networks compared to wireless managed networks, though theoretical and practical limits to the overall capacity of such networks have been identified. Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural disasters or military conflicts. The presence of a dynamic and adaptive routing protocol will enable ad hoc networks to be formed quickly.

2. ALGORITHMS TO COMPUTE THE CAPICITY OF THE NETWORK AND TO OPTIMIZE THE ENERGY

Different algorithms have been used to compute the capacity of the network and to optimize the energy. In this paper we have picked three among them.

I. MINIMUM ENERGY FUNCTION

This function investigates the minimum energy function of the cell partitioned network under consideration. In our network model, each user either uses zero power or full power. Furthermore, packets can be transmitted from the sender to the receiver in the same (adjacent) cell if the sender uses full power. Furthermore, R1(R2) packets can be transmitted from the sender to the receiver in the same(adjacent) cell if the sender uses full power.

The minimum energy function Φ (λ) is defined as the minimum time-average energy required to stabilize an input rate λ per user, considering all possible scheduling and routing algorithms that conform to the given network structure. We exactly compute this function for our network model. Specifically, we assume that all users receive packets at the same rate i.e., $\lambda_i = \lambda$ for all.

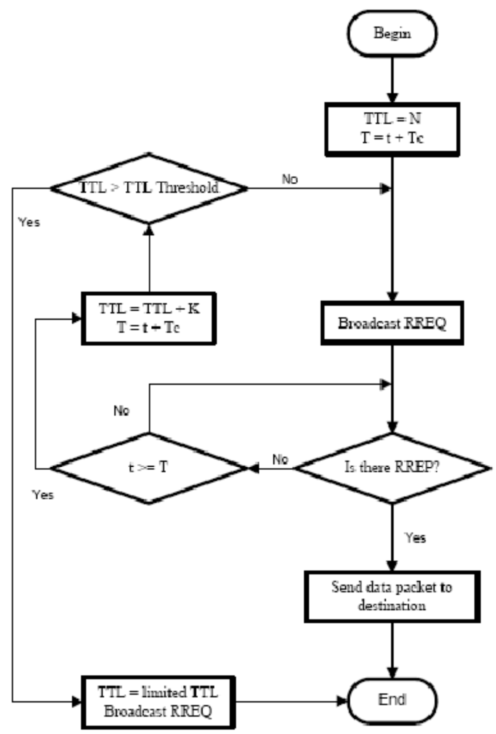
The minimum energy function Φ(λ) per user for the cell-partitioned network with R1≥2R2 is a piecewise linear curve given by the following:

$$\Phi(\lambda) = \begin{cases} \frac{\lambda}{R1}, & \textbf{if C1} \\ \frac{p}{q} + \frac{2}{R1}\left(\lambda - \frac{R1(p+q)}{2\theta}\right) & \textbf{if C2} \\ \frac{p}{q} + \frac{1}{R2}\left(\lambda - \frac{R1(p+q)}{2\theta}\right), & \textbf{if } C3 \\ \frac{p+q'}{\theta} + \frac{2}{R2}\left(\lambda - \frac{R1(p+q)+2R2q'}{2\theta}\right), & \textbf{if C4} \end{cases}$$

where C1 Ξ $0 \le \lambda < \frac{R1q}{\theta}$, C2 Ξ $\frac{R1q}{\theta} \le \lambda < \frac{R1(p+q)}{2\theta}$, C3 Ξ $\frac{R1(p+q)}{2\theta} \le \lambda < \frac{(R1(p+q)+2R2q')}{2\theta}$, and C4 Ξ $\frac{R1(p+q)+2R1q'}{2\theta} \le \lambda < \mu$. Thus, the network can stably support users simultaneously communicating at any rate with an energy cost that can be pushed arbitrarily close to Φ(λ).

Minimum Energy Algorithm: Every time slot, for all cells, do the following:

1) If there exists a source–destination pair in the cell, randomly choose such a pair (uniformly over all such pairs in the cell). If the source has new packets for the destination, transmit at rate. Else remain idle.
2) If there is no source–destination pair in the cell, but there are at least two users in the cell, then with probability β_p, decide to use the same-cell relay transmission opportunity as described in the next step. Else remain idle.
3) If decide to use the same-cell relay transmission opportunity in step 2), randomly designate one user as the sender and another as the receiver. Then with probability (1-δ)/2 (where 0< δ<a and δ= δ(β)) perform the first action below. Else perform the second.
    a. *Send new Relay packets in same cell:* If the transmitter has new packets for its destination, transmit at rate R_1 Else remain idle.
    b. *Send Relay packets to their Destination in same cell:* If the transmitter has packets



for the receiver, transmit at rate $R_{1...}$ Else remain idle[1].

II. AN EXPANDING RING SEARCH ALGORITHM

The second way in which power savings can be achieved is by the Expanding Ring Search (ERS) algorithm to optimize the energy consumption caused by broadcasting redundance messages. Simulation results show that the required message packages for routing by using our algorithm is significantly reduced in comparison with that required by using the ERS method. In this we concentrate in designing a routing protocol that uses energy in an efficient way. The discovery process is optimized to reduce the number of route request packet, so nodes only process necessary packets and discard duplicate packets. Therefore, nodes will save their energy for later uses. The routing protocol introduced below is basically developed from the Ad hoc On -Demand Distance Vector (AODV) routing protocol. AODV is a combination of both the Dynamic Source Routing protocol (DSR) and the Destination- Sequenced Distance Vector routing protocol (DSDV). It has the basic route-discovery and route-maintenance of DSR and uses the hop-by-hop routing, sequence numbers and beacons of DSDV. In this the source node generates a RREQ message with TTL= N and $T=t+T_c$. The symbol t denotes the real time of the network, and T_c is period of time that the source node could wait the RREP message before rebroadcasting the RREQ message. If the source node receives the RREP message within this time, the route is successfully found and the packet can be sent to the destination. In other cases, the source node will increase TTL value by K, and the set T to $t+T_c$. If the TTL value is greater than the threshold value, TTL value will be set to limited value and the RREQ message will be broadcast to entire network. When an intermediate node receives a RREQ message, it will look into its buffer to find route information. If the route information is found, the intermediate node will reply to source node. If not, it will check the TTL value equal to zero, the intermediate node will drop the RREQ message, otherwise, the TTL value is subtracted by 1, and this node will broadcast the message to another node[7].

III. NEW POWER ROUTING ALGORITHM

The Third way in which power savings can be achieved is by the model called a power-aware routing algorithm for MANET using gateway node. Focus of this work is to minimize number of control message packets, energy consumption and increase the throughput. This scheme presents an algorithm which minimizes energy consumption in the MANET, while forwarding the packets. The objective of this algorithm is whenever source node wants to transmit the packets it uses gateway node and then it transmits to destination.

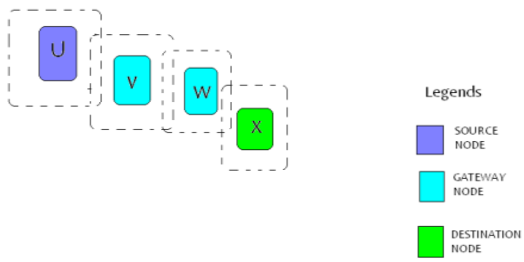


Figure 1: MANET Using gateway Protocol

Let us consider an example in Fig.1. Here, *U* is the source node, X is the destination node, V and W are the gateways nodes. The gateway node has enough battery power to route the packets. Initially, U forwards the route-request packet to over the network for making communication through support node.

The proposed model assumes that the packet '*m*' is transmitted though nodes U,V_s,...,*W, X*. Let *P*(V,W) denotes the energy consumption of transmitting the packets through link V, W. We have derived energy consumption equation as follows:

$$B_m=\sum_{j=1}^{d-1} P(n_j,n_j+1) \qquad (1)$$

In this model, it has considered an area of 1000X1000m^2 with different number of nodes in the MANET using Network Simulator. The traffic of source and destination node is randomly distributed [13].

The simulation parameters are shown in Table1.

Table I. Simulation parameters.	
Topology size	1000X1000m^2
Routing protocol	ZRP
Total simulation time	2000s
Traffic type	CBR
CBR packet size	500 bytes
Hello_packet_interval	1s
Node pause time	1s
Frequency	2.4Ghz
Channel capacity	2Mbps
Transmission range (gateway node)	250m
Transmission range (ordinary node)	100m

Algorithm for Power Aware-Routing

Begin

If there is data to be sent to destination then create packets

If the destination node is Gateway node then

Send packet to destination

Else

Use selective broadcasting to Gateway nodes

If destination node is destination neighborhood then

Send packet to destination

Else choose another Gateway nodes

Get Ack packet from destination

End if

End If

End

3. RESULTS

Study and Analysis of three algorithms have been conducted implemented to calculate the capacity of the network. The energy consumed by each network is also calculated for these algorithms. Following results have been observed during complete analysis:

1. The delay of the Minimum Energy Algorithm is analyzed using this procedure. This delay bound is then obtained using the Lyapunov Drift Lemma. Specifically, we first evaluate bounds on the expression by computing the steady-state service rates which is achieved by the Minimum Energy Algorithm.

2. In the Ring Search algorithm, the number of routing packets are reduced, so that the energy for all nodes in networks can be efficiently used.

3. New Power-Aware routing algorithm is developed to save energy consumption of nodes. This system delivers more than 95% of the packets with low end-to-end delay, but it fails to specify the loss of packets.

4. CONCLUSION

In this paper we have considered three different algorithms to compare their network capacity and consumption of energy. Each algorithm has some advantages and some drawbacks but the New Power Routing produces better results compared to the other two.

REFERENCES

[1] Rahul Urgaonkar "Network Capacity Region and Minimum Energy Function for Delay-Tolerant Mobile Ad Hoc Network." , pp 8,11-13, in IEEE, 2011.

[2] R. Urgaonkar and M. J. Neely, "Capacity region, minimum energy, and delay for a mobile ad-hoc network," in Proc. WiOpt, pp. 1–10, Apr. 2006.

[3] P. Gupta and P. R. Kumar, "The capacity of wireless networks," Trans. Inf. Theory , vol. 46, no. 2, pp. 388–404, Mar. 2000.

[4] M. Grossglauser and D. Tse, "Mobility increases the capacity of adhoc wireless networks," IEEE/ACM Trans. Netw., vol. 10, no. 4, pp. 477–486, Aug. 2001.increases the capacity of adhoc wireless networks," IEEE/ACM Trans. Netw., vol. 10, no. 4, pp. 477–486, Aug. 2001.

[5] M. Garetto, P. Giaccone, and E. Leonardi, "Capacity scaling in ad hoc networks with heterogeneous mobile nodes: The super-critical regime," IEEE/ACM Trans. Netw. , vol. 17, no. 5, pp. 1522–1535, Oct. 2009.

[6] A. F. Dana, R. Gowaikar, R. Palanki, B. Hassibi, and M. Effros, "Capacity of wireless erasure networks," IEEE Trans. Inf. Theory, vol. 52, no. 3, pp. 789–804, Mar. 2006.

[7] Duy Ngoc Pham and others "An Expanding Ring Search Algorithm For mobile ADhoc Networks", pp 39-41, 43-44, In IEEE, 2010.

[8] Clifton Lin, "AODV Routing Implementation for Scalable Wireless Ad-Hoc Network Simulation (SWANS)"

[9] Mohammed Ilyas "The Handbook of Ad Hoc Wireless Networks", 2003.

[10] Duy Ngoc Pham, Hyunseung Choo, "Energy Efficient Ring Search for Route Discovery in MANETs", IEEE ICC, 2008.

[11] Kavin Fall, Kannan Varadhan, The NS Manual", 2008.

[12] Michel Barbeau and Evangelos Kranakis-Carleton University, Canada, "Principles of Ad-hoc Networking".

[13] G.Varaprasad, "New Power Routing for MANETs Using Gateway Node,2007.

[14] B.Chen, K.Jamieson, H.Balakrishnan, and R.Morris, "Span:An Energy- Efficient Co-ordination Algorithm for Topology Maintenance in Adhoc Wireless Networks", In Proc.of ACM MOBICOM, pp.85-96, 2001.

[15] A.Misra, S.Banerjee, "MRPC: Maximizing Network Lifetime for Reliable Routing in Wireless Environments", In Proc. of IEEE Wireless Communications and Networking Conference, pp.800-806, 2002.

[16] W.Rabiner, H.Balakrishnan, "Energy Efficient Communication Protocol for Wireless Micro-sensor Networks", In proc. of 33rdAnnual Hawaii International Conference on System Sciences, pp.3005-3014, 2000.

[17] S.Banerjee and A.Misra, "Minimum Energy Paths for Reliable Communication in Multi-hop Wireless Networks," In Proc. of ACM MOBICOM, pp. 146-156, 2002.

[18] M.Maleki, K.Dantu and M.Pedram, "Power-aware Source Routing in Mobile Adhoc Networks," In Proc. of International Symposia on Low Power Electronics and Design, pp.72-75, 2002.