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RESEARCH ARTICLE

Energy Conservation in MANET Using Power Saving Protocol BECA/AFECA

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Abstract— The recent years have seen a tremendous increase in the number of Wi-Fi enabled mobile devices sold to consumers. Devices such as high-end cell phones, PDAs, portable gaming devices, tablet PCs etc. all have wireless networking capabilities. By participating in mobile ad-hoc networks (MANETs) these devices may extend their capabilities, e.g., to reach the Internet when no Wi-Fi base stations are within range, or to communicate with each other over multiple hops when no other networking infrastructure is available. One problem with continuous participation in a MANET is energy consumption. All of the mentioned devices are battery powered and energy is a rare resource and it is made even more rare by the fact that the devices must be mobile, i.e., they must be small and can therefore not be fitted with large battery packs. To overcome this problem, different power saving protocols are needed that allow the devices to preserve as much energy as possible while to keep network connectivity.

Key Terms: - MANET; BECA; AFECA; Energy/Power saving protocol; Ad hoc network

I. Introduction

In mobile Ad hoc network (MANET) there is no central infrastructure and the mobile devices are moving randomly, they may give rise to various kinds of problems, such as energy efficiency and power consumption within a network. Mobile nodes self-organize to form a network over radio links. These include military battlefields, emergency search, rescue operations, classrooms and other conventions, where people share information dynamically using their mobile devices or places where people wish to quickly share information, like meetings etc. Communication in ad hoc networks depends upon the batteries of the participating nodes, and eventually results.

In the failure of nodes due to lack of power, Mobile adhoc networking to bring up much research in the area of efficient routing protocols like Dynamic Source Routing (DSR) protocol, Ad Hoc On-Demand Distance Vector routing protocol (AODV), Temporally Ordered Routing Algorithm (TORA), Zone Routing Protocol (ZRP), Wireless Routing Protocol (WRP) etc. While these protocols perform to praise under many different conditions, most of them focus on network performance, and do not take energy efficiency into consideration. In this thesis, we define energy/power saving algorithm as protocols that maximize the lifetime of the entire network. This thesis is concerned with two such approaches towards energy efficiency and how they may be combined and modified to fit into the network setting, since the goal of an ad hoc network is to conserve some desired communication energy techniques. As a consequence of mobility, nodes in MANET are generally portable, and hence are low powered, with limited and removable energy resources like batteries. This is exacerbated by the fact that the nodes spend extra energy while handling traffic for other nodes as well as while just listening for packets. So Energy conservation is thus critical in such networks. Energy conservation can be accomplished in one of two ways:

- Saving energy while active communication is done and
- Energy saving during idle times in the Communication

II. RELATED TO WORK

The recent years have seen a tremendous increase in the number of Wi-Fi enabled mobile devices sold to consumers. Devices such as high-end cell phones, PDAs, portable gaming devices, tablet PCs etc. all have wireless networking capabilities. By participating in mobile ad-hoc networks (MANETs) these devices may extend their capabilities, e.g., to reach the Internet when no Wi-Fi base stations are within range, or to communicate with each other over multiple hops when no other networking infrastructure is available. One problem with continuous participation in a MANET is energy consumption. All of the mentioned devices are battery powered and energy is a rare resource and it is made even more rare by the fact that the devices must be mobile, i.e., they must be small and can therefore not be fitted with large battery packs. to overcome this problem, different power saving protocols are needed that allow the devices to preserve as much energy as possible while to keep network connectivity.

We assume that mobile nodes operate as the IEEE 802.11 PSM for energy-efficient medium access and use AODV for discovering and maintaining routing paths. Section A summarizes the AODV routing protocol. It also discusses the stale route and load unbalance problem in AODV and argues that unconditional overhearing is the main reason behind them. Section B explains the IEEE 802.11 PSM.

III. RESEARCH AREA ANALYSIS

In this section we present an analysis of the three thesis that we studied to investigate BECA/AFECA, GAF, and Span.

3.1 BECA/AFECA

It proposed two simple protocols, the Basic Energy-Conserving Algorithm (BECA) and the Adaptive Fidelity Energy-Conserving Algorithm (AFECA), with AFECA being an extension of BECA. These algorithms attempt to turn off node radios as often as possible to improve power consumption. They use information from the application layer (e.g., whether or not traffic is being transmitted) to decide whether the radio should be on or off. With BECA, each node can be in one of three states: sleeping, listening, or active. Each state has a timer associated with it that determines how long it will be in that state: Ts is the sleeping time which determines how long a node will be asleep, Tl is the listening time which determines how long a node will listen for traffic, and Ta is the time which determines how long a node will stay active while no traffic is being transmitted to it.

Initially, all nodes are in the listening state. In the listening state, each node listens for any traffic for itself from its neighbors. If it receives no traffic within time Tl, it enters the sleeping state (and powers its radio down.) If it does receive traffic within time Tl, it enters the active state. While in the sleeping state, the node will sleep for time Ts before re-entering the listening state. While in the active state, the node will stay on and forward traffic. If the node has not received traffic within time Ta, it will go back into the sleeping state. With BECA, nodes should enter the active state when route request messages (RREQs) are flooded through the network. After a route is established, nodes that are not on this route will re-enter the sleeping state after Ta seconds and the nodes on the route will remain active until Ta seconds after receiving no traffic to route. In order to ensure that RREQ packets are received by at least one nearby node, a node flooding a RREQ must continually retry sending until at least one other node enters the listening state.

This means that we could add up to time Ts to the latency of our lookup request for each hop on the discovered route. Once the route is established, BECA adds no additional latency to the data traffic sent along that route. AFECA is an extension of BECA that takes advantage of node density to allow nodes in dense areas to sleep for longer periods of time. Each node learns about the density of its area by adding every node that it happens to overhear sending traffic to a list of neighbors.

AFECA uses an additional timer, Te, to determine how long to keep neighbors in the neighbor set from the time that the node last overheard them. Let N be the number of neighbors in a node’s neighbor set. The observation that leads to AFECA’s design was that the denser the local area of nodes, the more nodes there are to handle routing. Since there are more nodes that can handle routing, any individual node can sleep for a longer period of time on average. Rather than using a constant Ts to determine sleeping time as with BECA, AFECA sleeps for a variable amount of time, called Tsa, which is set to Random(1, N) x Ts. This makes it likely that at any given time one nearby node will wake up soon to hear RREQs while all nodes will sleep for longer on average.

Simulations with BECA show that at any given time individual nodes have saved between 40-50% of their energy over nodes that use no power save protocol. The downside to BECA is that it causes a minor amount of packet loss (which is negligible since wireless networks are lossy by their nature) and that it causes higher latency for setting up routes. With a 50 node network, latency is highly variable and can be quite high. With sleeping times set over a few seconds, route set up latency is usually several seconds as well.

Once the route is actually set up, however, BECA adds no latency to data traveling over that route. Simulations with AFECA show that it does not save much energy over BECA on a pernode basis but it greatly extends the lifetime of the overall network. While BECA extends the lifetime of the network by 20%, AFECA extends it by 55%. Network lifetime in this thesis is defined as the amount of time between when the simulation begins and when the last node dies. The downside to AFECA is that it has even more latency and packet loss over BECA. To summarize, both AFECA and BECA offer substantial energy savings over networks that do not use power save protocols, but this comes at a cost of higher latency in route setup and higher packet loss.

IV. POWER-AWARE ROUTING PROTOCOLS

Nodes in an ad hoc wireless network are powered by batteries. During transmission, to maintain an acceptable signal-to-noise ratio (SNR) at the receiver, the power consumed by the transmitter depends on the distance between the transmitter and the receiver. If a radio transmitter can dynamically adjust its transmission power either continuously or by using discrete power levels, it becomes more energy efficient by adjusting the transmitter power so that the resulting signal is just strong enough to reach its intended destination.

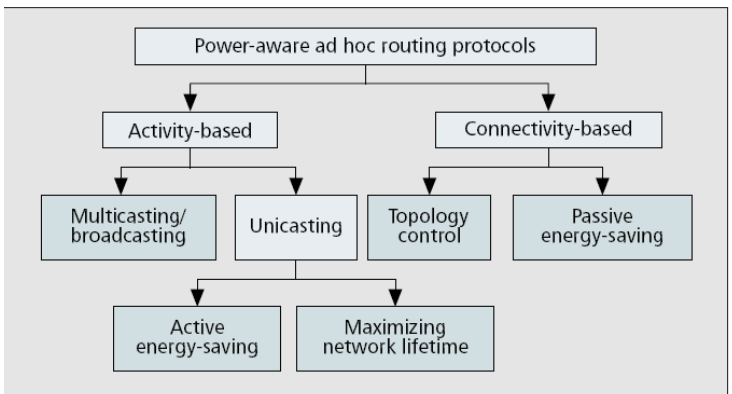


Fig: Categorization of power aware ad hoc routing protocols

We broadly divide power-aware routing protocols into two classifications: activity-based and connectivity-based protocols. Activity-based protocols address the issue of power consumption as it relates to network activity, i.e. the actual transmission of data between nodes in the network. These protocols focus on making intelligent, power-aware routing decisions that govern the actual transmission of data. We further divide activity-based protocols into two classifications based on different routing tasks: unicasting and multicasting/broadcasting.

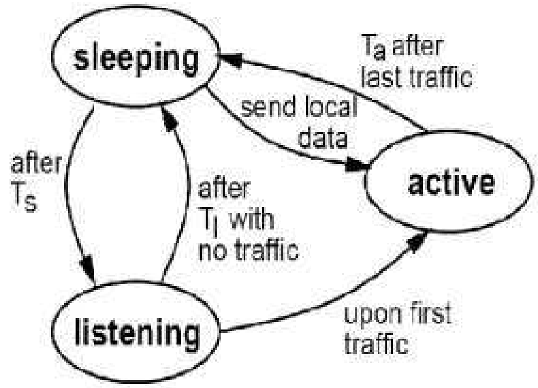
V. BECA PROTOCOL

The Basic energy-conserving algorithm (BECA) and an extended version called the adaptive fidelity energy-conserving algorithm (AFECA). These approaches entail dynamically switching the nodes between sleeping, listening, and active states. The nodes switch between these states with fixed intervals, and in order to ensure the successful forwarding of messages, the active nodes may have to retranmit messages a number of times before the receiving node is listening or active. Actively communicating nodes stay awake. so there are three basic states are described

1. Active state
2. Sleeping state
3. Listening state

The time intervals used in BECA are the following: Tl is a time at which node is in listening state

TS is time at which node is in sleeping state. Ta is time at which a node remains active



when no messages are being processed i.e., when the node is in not active, An inactive node listens for activity for Tl seconds, and if no activity is seen during that period of time it sleeps for Ts seconds before listening again.

It is important to note here, that activity is not just receiving any message a node only stays awake if it is needed for forwarding data or routing information. The difference between BECA and AFECA is that AFECA takes node density into consideration when determining the length of the interval in which a node may sleep. The sleep time in AFECA is then increased by a factor proportional to the number of nodes in its neighborhood, and the new sleep time is thus chosen as TSa. Both BECA and AFECA are purely power saving algorithms and not routing protocols.

They therefore need to be combined with some existing MANET routing protocol. BECA is a simple power-save approach that has the potential for large energy savings especially in low traffic. Each node wakes up every Ts seconds and listens for traffic for Tl seconds. If no traffic for this node is received within Tl seconds, go back to sleep for another Ts seconds. If traffic is received, go into the active state and Transition back into the sleep state when no traffic is received for Ta seconds.

VI. CONCLUSIONS

In this thesis, we presented a survey of energy conservation protocols for mobile ad hoc network at both routing and MAC layer respectively. The article starts with the detailing of the causes for power drain in MANETs and various methods that have been adopted to reduce power consumption. We identified various performance demands of these protocols and showed the effect of optimizing energy consumption against these performance parameters through available proposals. We conclude that no single protocols can deliver the overall performance demands for MANET without having to trade-off other performance metrics to achieve high energy conservation. This conclusion is based on the simulation results of protocols under review. However, many of these simulations were performed in completely different conditions, in non-realistic scenarios and in some cases even with different simulators/implementations.

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