Energy Efficient Cooperative Approach For Multichannel Mac Protocol

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Abstract: Media access control is an essential part of wireless communication. To achieve higher communication throughput multi-channel MAC has been studied. Adhoc wireless network's performance is always measured corresponding to the power consumption of the nodes. The overall network connectivity depends on the energy of the nodes. Researchers have proposed many energy efficient MAC protocols to resolve this problem. Altruistic protocol uses the concept of distributed information sharing to reduce power consumption and at the same time improve the throughput. Distributed Information Sharing(DISH) is a new cooperative approach to design multi-channel MAC protocols. It aids nodes in their decision making process by sharing information through neighboring nodes. It share control information with each other so that nodes can make decisions during communication. In a multi-channel network, DISH avoids collisions by notification from neighboring nodes about channel conflict and deaf terminal problem. Energy efficient strategy altruistic DISH is used. It uses multi-hop communication. Data retransmission is avoided with the assist of intelligent node. Priority is given to the nodes if it chooses the busy receiver. Altruistic protocol is compared with In-situ DISH, and find that altruistic protocol significantly outperforms. It conserves energy without compromising the throughput performance. Through simulations it shows that altruistic protocol conserves better energy compared to other. The experimental results confirm the viability of altruistic protocol and the idea of DISH. Hence by using DISH energy efficiency for cooperative multi-channel MAC is achieved.

Index Terms: Adhoc networks, multi-channel MAC, energy efficient, DISH, channel conflict problem, deaf terminal problem.

I. INTRODUCTION

A adhoc network is a decentralized type of wireless network. The network is adhoc because it does not rely on pre-existing infrastructure, such as routers in wired networks. Nodes are also routers in adhoc networks. Most of the nodes are battery powered in wireless adhoc networks. Energy consumption is an important issue since nodes are battery powered. Even if a node fails the overall network capacity is reduced. MAC protocol is a protocol that ensures proper communication between the nodes. It resolves conflicts between different nodes. MAC protocol gives better performance in factors like network throughput and energy consumption. The knowledge inefficiency of a node in a multichannel network is categorized as multichannel coordination problem(MCC). It has two variants. One is called a channel conflict problem and the other is called a deaf terminal problem. Channel conflict problem arises when a node chooses busy channel for data transmission. It may result in data collision. Deaf terminal problem arises when a node initiate communication with another node on a different channel. In this paper distributed information sharing(DISH) is used which is a new cooperative approach for designing multichannel MAC protocol. Distributed information sharing is a distributed flavor of control-plane cooperation, it is applied to multichannel MAC to solve the multichannel coordination problem. Neighboring nodes share control information with each other, so that nodes can make decisions during communication. It clearly separates control-plane and data-plane mechanism. It helps in relaying data for source-destination pairs during data-plane mechanism. By applying DISH to multichannel adhoc networks, neighboring nodes that identify multichannel coordination problem notify the transmitter-receiver pair about the problem in order to avoid collisions and retransmissions. Based on the idea of DISH, altruistic DISH protocol is designed for multichannel adhoc networks.

II. ENERGY EFFICIENT STRATEGIES

The main challenge in achieving energy efficiency for DISH is information sharing and gathering. By using distributed information sharing nodes can share and gather information from neighboring nodes. Nodes should stay awake for overhearing, which presents a challenge for nodes to switch off when idle. There are two strategies in-situ and altruistic DISH, which provides energy efficiency for multichannel MAC protocol. Both the strategies uses distributed information sharing, and provides mechanisms for nodes to be in sleep mode when idle. The strategies mentioned below meet this challenge and provide a qualitative analysis.

In-Situ Energy Conscious DISH

In this strategy source-destination pair chooses the best neighbor to cooperate. The source-destination pair look for a free channel to access. If a node chooses a busy channel for data transmission channel conflict problem occurs. If a node initiate communication with another node on a different channel deaf terminal problem occurs. so, the nodes tries to choose free channel in order to avoid channel conflict problem and deaf terminal problem. When it chooses the channel for data transmission, all the existing nodes are responsible for information sharing. Neighbors share control information with each other. Nodes without the responsibility of information sharing can sleep when idle. There are two methods to implement this strategy, probabilistic method and voting method. In probabilistic method, each node decides whether to cooperate or not according to a probability. In voting method, nodes periodically elect a subset of nodes to cooperate. It introduce considerable complexity and

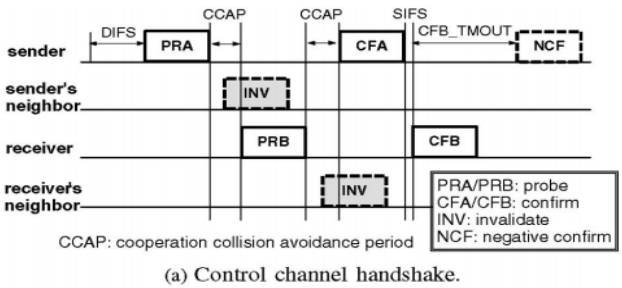
overhead. Considering the complexity and overhead of in-situ energy conscious DISH would consume considerable resource and eventually negate its possible performance gain.

Altruistic DISH

In this strategy network environment split into number of regions. All the nodes are covered by each altruistic node in the region. Altruistic node density must be greater than peer nodes in the adhoc network. The routing can be done by multi-hop. Each altruistic node updates the information of each peer node. Altruistic node take over the responsibility of information sharing. Altruistic DISH clearly separates the data plane and the control plane. In order to cooperate, nodes have to stay awake during idle periods in order to gather and share channel usage information which prevents them from sleeping to save energy. By this method we avoid MCC problem. Peers can sleep when idle. Intelligent node avoid data retransmission. Altruistic DISH is advantageous due to the following reasons. First , simple strategy to implement. Second, does not have multichannel broadcasting problem. Third, robust to network dynamics. Each altruistic node react to every MCC problem it identifies and cooperate. Fourth, data traffic is carried by peers. It can adopt a sleep-wake scheduling algorithm. Cooperative nodes are always available and altruistic DISH provides cooperation in a guaranteed manner.

III. PROTOCOL DESIGN AND ANALYSIS

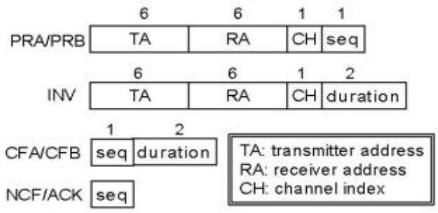
In the protocol design process, specific channel selection strategies is not assumed. Two channel selection strategy is considered, RAND and most recently used(MRU). In RAND selection, node selects any one of the channels from the list of channels available. In MRU selection, node always selects the most recently used data channels. A node can cooperate(if it is idle and overhears the control channel handshake that creates an MCC problem)otherwise, does not. There are two channels control channel and data channel. One channel is designated as the control channel and the other channels are data channels. If a node wants to communicate with other node, it performs a control channel handshake to setup communication. Data channel is chosen to perform DATA/ACK handshake. The control channel handshake is shown in Fig.3. A sender node sends a PRA and its receiver node responds with PRB. On receiving PRA/PRB , each neighbor checks for an MCC problem. If identifying an MCC problem sends an INV message to invalidate the handshake. Sender node receives PRB correctly if no MCC problem occurs. CFA is sent to all its neighbors to confirm the validity



(a) Control channel handshake.

Fig. 3 Control channel handshake

of PRA. The receiver node sends CFB to confirm the validity of PRB. This represents the end of the control channel handshake. When the transmitter fails to receive CFB, NCF is used by the transmitter to indicate its neighbors that the PRA and CFA are invalid. If multiple neighbors send INVs simultaneously, INV collisions may occur and it is mitigated by using cooperative collision avoidance period. A possible set of frame formats is shown in Fig. 3. PRA+CFA and PRB+CFB carries the channel usage information of the communication being established. INV carries the channel usage information of an established communication. The adhoc network environment split into number of regions. All nodes are



covered by each altruistic node in the region.

Fig. 3 Frame format

Altruistic node density must be greater than peer nodes in the adhoc network. The sender selects the control channel when it's free in order to send the request to Altruistic node. Altruistic node when receive this request, it inform to all sender's neighbor node for forwarding the data packets. Altruistic node indicates to sender node about which data channel is allocated to sender. Sender sends the data packets to their neighbor node. When the data forwarding is complete all nodes goes to sleep mode. Then the Altruistic node receives the acknowledgement from the sender, and then frees the data channel. . Intelligent Node collects the data from the sender and delivers to the receiver directly if the data is lost.

Protocols To Investigate

In-situ and altruistic, which are the two protocols made by applying energy efficient strategies to CAM-MAC. Throughput-energy trade-off is the key issue to investigate.

In-situ: Energy efficient strategy In-situ energy conscious DISH is applied. The best neighbor is chosen to cooperate upon each occurrence of an MCC problem. Other nodes goes to sleep state.

Altruistic: Energy efficient strategy altruistic DISH is applied. Altruistic node stay awake all the time to gather and share information. Other nodes which do not cooperate and idle goes to sleep state.

IV. SIMULATION RESULTS AND DISCUSSIONS

We evaluate and compare two protocols, In-situ and altruistic. Simulation results are presented in this section. This section inspects the throughput and energy consumption. Both of the two energy efficient strategies can preserve the throughput benefit of DISH. Energy trade-off under high and low traffic loads is shown in Fig. 4. Total energy consumption of In-situ

and altruistic is shown in Fig. 4.1. Altruistic saves considerable amount of energy(40-80 percent).

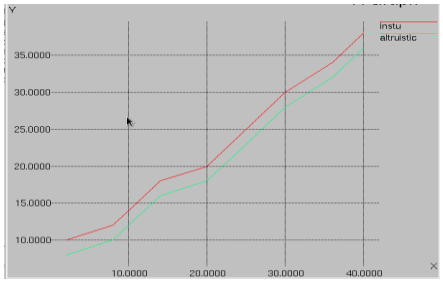


Fig. 4 Energy consumption under light traffic.

Throughput graph is shown in Fig. 4.2 . Altruistic outperforms than In-situ. Altruistic node always stay awake. Energy saved by altruistic protocol becomes more significant under higher traffic. Traffic generation rate is 160kbps. In summary, altruistic protocol conserves considerable amount of energy without compromising the throughput performance. Altruistic protocol becomes less effective when there are only few nodes. It is still desired to reduce the overhead. An alternative method for altruistic protocol is to add one more altruistic node on few nodes. Altruistic node may be overburdened as it is always awake. Fairness might be a problem and thus merit future study.

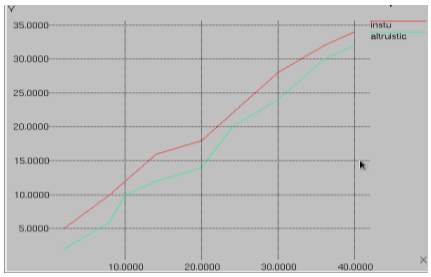


Fig. 4 Energy consumption under heavy traffic.

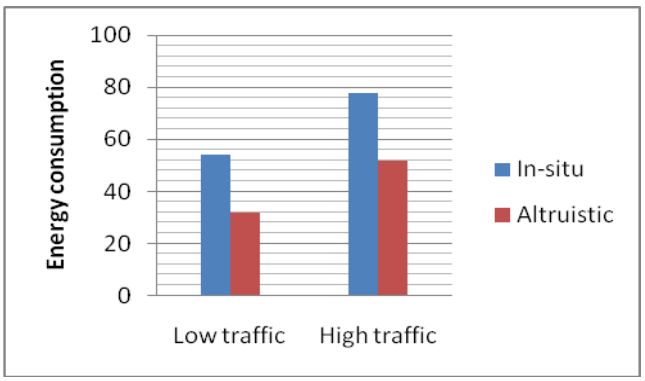


Fig.4.1 Total energy consumption

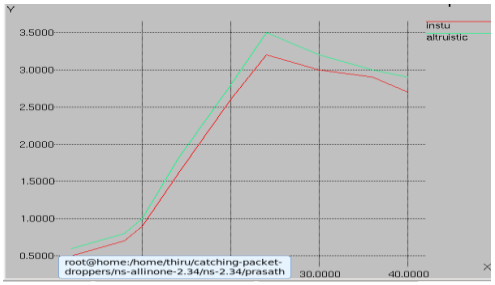


Fig. 4.2 Throughput(No of nodes vs data rate(Mbps))

V. CONCLUSION

In this paper DISH is used as a new cooperative approach for designing multichannel MAC protocol. Nodes can exchange control information and make decisions during communication. Energy efficient strategy In-situ and altruistic is applied to DISH protocol. By using DISH nodes can store channel usage information and can be retrieved when needed. It clearly separates control plane and data plane. Simulation results show that altruistic DISH, reduces energy consumption, does not incur additional runtime overhead. In altruistic DISH nodes cooperate in a guaranteed manner, altruistic node is responsible for control-plane cooperation, nodes are responsible for data forwarding. Data retransmission is avoided with the assist of intelligent node. Different routing techniques to altruistic node can be used in future.

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