ENERGY CONSTRAINT AND RELAY ASSIGNMENT COMMUNICATION IN MANET

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Abstract: Mobile ad-hoc networks are constructed without the infrastructure. All the MANET operations are planned with the consideration of the energy and bandwidth limitations. Cooperative communication utilizes nearby terminals to relay the overhearing information to achieve the diversity gains and improve the transmitting efficiency in wireless networks. Cooperative Medium Access Control (CMAC) protocol is constructed to achieve the medium access interactions with relay model. We propose DEL-CMAC that focuses on the network lifetime extension, which is a less explored aspect in the related work. By considering the overheads and interference due to cooperation, as well as the energy consumption on both transceiver circuitry and transmit amplifier, DEL CMAC can significantly prolong the network lifetime.A distributed energy-aware location-based best relay selection strategy is incorporated, which is more reasonable for MANETs comparing with the existing schemes based on channel condition.

Keywords: MANET, CMAC, DEL-MAC

I.INTRODUCTION

Mobile Ad Hoc Network (MANET) is a collection of two or more devices or nodes or terminals with wireless communications and networking capability that communicate with each other without the aid of any centralized administrator also the wireless nodes that can dynamically form a network to exchange information without using any existing fixed network infrastructure. In the near future, a pervasive computing environment can be expected based on the recent progresses and advances in computing and communication technologies[1]. Next generation of mobile communications will include both prestigious infrastructure wireless networks and novel infrastructure less mobile ad hoc networks (MANETs)[2]. Cross-layer distributed energy-adaptive location-based CMAC protocol (DEL-CMAC) is designed for Mobile Ad-hoc networks (MANETs). The design objective of DEL-CMAC is to improve the performance of the MANETs in terms of network lifetime and energy efficiency. A practical energy consumption model takes the energy consumption on both transceiver circuitry and transmit amplifier into account. A distributed utility-based best relay selection strategy selects the best relay based on location information and residual energy. Network allocation vector setting is provided to handle the varying transmitting power of the source and relay terminals. The DEL-CMAC scheme is enhanced to monitor and reduce the control message overhead in relay selection process. Shadow terminals problem is also solved in the improved DEL-CMAC protocol. The system tuned to handle the large scale network size and high mobility conditions.

The DEL-CMAC protocol is integrated with cross layer cooperative diversity aware routing algorithm to increase the throughput and minimize the delay.

II. PROBLEM STATEMENT

To deal with the presence of relay terminals and dynamic transmitting power, we provide an innovative NAV setting to avoid the collisions and enhance the spatial reuse.Extensive simulation results reveal that DEL-CMAC can significantly extend the network lifetime under various scenarios at the cost of relatively low throughput and delay degradation, compared with IEEE standard DCF and throughput-aimed scheme Coop MAC. The mobile ad-hoc network data transmission operations are carried with the intermediate or relay nodes. The Cooperative Medium Access Control scheme is used for the cooperative data communication models. The (DEL-CMAC) scheme is adapted for the relay selection process[3]. Energy and location constraints are considered in the relay selection process. The following drawbacks are identified from the existing system. High scalability and mobility conditions are not handled by the system and Control message overhead is high in relay selection process[4]. Shadow terminals are not managed by the system and Transmission delay is increased with minimum throughput levels.

III. RELETED WORK

1. Energy-Efficient Topology Control in Cooperative Ad Hoc Networks

The cooperative communication techniques can also be used in topology control to further reduce the transmission energy consumption or to improve the network connectivity[3]. In first studied the topology control problem under CC model which aims to obtain a strongly connected topology with minimum total energy consumption.

They first showed that this problem is NP complete and then proposed two algorithms that start from a connected topology (the output of a traditional topology control algorithm) and further reduce the energy consumption using CC model. In applied CC model in topology control to improve the network connectivity as well as reduce transmission power. Their algorithm first constructs all candidates of bidirectional links using CC model to connect different disconnected components, then generates MST structure to further reduce the energy consumption. Even though the proposed solutions can guarantee the network connectivity and reduce the energy consumption by constructing a sparse structure under CC model, they do not consider the energy efficiency of paths among nodes in the constructed structure. In addition, we assume that there is no CC transmission possible due to the value of maximal transmission power and the signal-to-noise ratio (SNR) threshold.

2. NCAC-MAC: Network Coding Aware Cooperative Medium Access Control for Wireless Networks

In order to enable a relay node to forward the data for the source node, while delivering its own data simultaneously, an innovative protocol named Phoenix has been proposed. The basic idea in Phoenix is to employ the Network Coding (NC) technique in the cooperative retransmission process, thus achieves a win-win profit. To realize that, MIMO NC is utilized in the physical layer, by which the original packets can be retrieved by the corrupted and redundant packets. One primary issue is that the relay node is selected randomly[4]. When the transmission fails, the node sensing free medium at the end of a random backoff time, wins the contention and performs the retransmission on behalf of the source node. This approach depends on chance basically, thus has the following drawbacks. (i) The coding opportunity is not guaranteed. (ii) The multi rate capability of the network is not exploited. (iii) The packet queuing conditions at different relay candidates are not considered. To address the above issues and facilitate CC and NCAC-MAC comprises a relay-involved cooperative retransmission process, and a network coding aware utility-based best relay selection strategy. To the best of our knowledge, this is the first study on relay selection that takes the coding opportunity, achievable throughput and estimated delay into consideration.

3. Cross-Layer Cooperative MAC Protocol in Distributed Wireless Networks

We address issues of node cooperation in a fully-connected wireless network, from a cross-layer protocol design perspective. Our goal is to devise an efficient and effective MAC protocol that can exploit beneficial node cooperation. To this end, we emphasize the impact of a link layer protocol on the efficiency of conveying information among nodes at the physical layer by integrating signaling overhead control with the protocol design[5]. The main contributions and significance are three-fold: First, considering the MAC layer overhead, we propose a crosslayer cooperative MAC protocol that can distinguish beneficial cooperation from unnecessary cooperation. Effective helper selection is integrated into the MAC protocol to achieve and increase cooperation gain, based on optimal grouping of helpers; Second, different from we introduce a concept of *cooperation region* (CR) in the MAC-layer design, to identify beneficial cooperative rate allocations that offer higher link utilization than the direct transmission; Third, the probabilities of successful cooperation and direct transmission in the network with our cooperative MAC protocol are derived. Simulation results verify the accuracy of the analysis, and show that the proposed approach with beneficial cooperation outperforms its non-cooperative counterpart in terms of throughput and delay performance.

4. Optimal Relay-Subset Selection and Time-Allocation in Decode-and Forward Cooperative Networks

To the best of our knowledge, channel resource allocation for arbitrarily connected networks and dedicated multiple access has not been addressed. Works in the area of multi-relay systems with arbitrary links generally neglect the bandwidth penalty arising from multiple hops by assuming full-duplex nodes, a bandwidth-unconstrained system, or the availability of channel phase information at the transmitter[6]. These assumptions, however, are not realistic for practical wireless networks, where nodes are likely to be half-duplex, phase information is very difficult to obtain at the transmitter, and bandwidth is a scarce resource. To fill this void, in this paper we investigate the problem of resource allocation in a bandwidth-constrained, cooperative, decode-and-forward (DF), wireless network, and consider the most general setting where multiple relays can transmit and cooperate with each other. We address the joint problem of optimal selection of a relaying subset and allocation of time resources to the selected relays. The problem is framed in the context of mesh networks of relatively simple and inexpensive nodes. We concentrate on resource allocation in terms of transmission time only, removing power allocation from the optimization; furthermore, to reduce implementation complexity, we consider time orthogonal transmissions.

5. Conflicts and Incentives in Wireless Cooperative Relaying: A Distributed Market Pricing Framework

Cooperative relaying takes advantage of the broadcast nature of the medium and provides additional diversity against link outages (caused, e.g., by dynamic fading or shadowing effects) by allowing nearby nodes that overhear the transmitted signal to make additional transmissions to assist in delivering the data to its destination [7]. This conflict arises since, if a relay node takes a cooperative action (transmission) to assist a packet on one link, then it cannot do the same on another link at the same time. Moreover, the additional transmissions by the relay node(s) increase the interference for other links and thus adversely impact their capacities, even if the other links do not employ cooperative relaying directly. Such interactions among flows between different source/destination pairs in the presence of cooperative relaying, and distributed mechanisms for efficient allocation of cooperative relay nodes among the different flows (which may have different requirements and utilities), remain not yet well understood. Several mechanisms are proposed to encourage selfish nodes to declare their true costs and actions in order for the routing algorithm to choose the optimal paths, and a distributed protocol that uses cryptographic techniques to enforce the forwarding is described.

IV.PROPOSED WORK

1. Del-CMAC Protocol

In this section, with the objective of prolonging the network lifetime and increasing the energy efficiency, we present a novel CMAC protocol, namely DEL-CMAC, for multi-hop MANETs. When cooperative relaying is involved, the channel reservation needs to be extended in both space and time in order to coordinate transmissions at the relay. To deal with the relaying and dynamic transmitting power, besides the conventional control frames RTS, CTS and ACK, additional control frames are required. DEL-CMAC introduces two new control frames to facilitate the cooperation, i.e., Eager-To-Help (ETH) and Interference Indicator (II). The ETH frame is used for selecting the best relay in a distributed and lightweight manner, which is sent by the winning relay to inform the source, destination and lost relays. In this paper, the best relay is defined as the relay that has the maximum residual energy and requires the minimum transmitting power among the capable relay candidates.

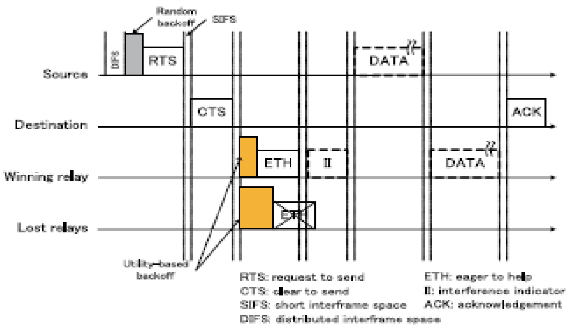

Figure 1: The frame exchanging process of DEL-CMAC.

The II frame is utilized to reconfirm the interference range of allocated transmitting power at the winning relay, in order to enhance the spatial reuse. Among all the frames, RTS, CTS, ETH and ACK are transmitted by fixed power. And the transmitting the power for the frame and data packet are dynamically allocated. We denote the time durations for the transmission of RTS, CTS, ETH, ACK and II frames by TRTS, TCTS, TETH, TACK and TII , respectively.

1.1 Operations at the Source

i.)When a source wants to initiate the data transmission with payload length L bytes, it first senses the channel to check if it is idle. If the channel is idle for DIFS, the source chooses a random backoff timer between 0 and CW[9]. When the backoff counter reaches zero, the source sends out a RTS to reserve the channel. Notice that different from DCF, the location information of the source is carried in the RTS, which is used in the optimal power allocation.

ii.)If the source does not receive a CTS within $T_{RTS} + T_{CTS}$ + SIFS, a retransmission process will be performed. Otherwise, in the case that FLAG_P of CTS is 0, the DEL-CMAC is reduced to DCF protocol, and we omit its operations in the following. In the case that FLAG_P is 1, the source waits for another $T^{max}_{Backoff} + T_{ETH}$ + SIFS, where $T^{max}_{Backoff}$ is the maximum backoff time for the relay. If ETH is not received, which means that no capable relay exist, the source sends the data by direct transmission with data rate R.

iii.) If both CTS and ETH are received, after waiting for T_{II} + SIFS, the source initiates a cooperative transmission with data rate 2R using the optimal transmitting power P^C_s which is piggybacked in the ETH.

Notice that in order to maintain the end-to-end throughput, doubled data rate is employed in the cooperative transmission mode. We assume that the terminal can support two transmission rates by different coding and modulation schemes.

iv.)If an ACK is not received after $16(L + L_h) / 2R + T_{ACK}$ + 2SIFS, where L_h is the header length (in bytes), the source would perform a random backoff same as DCF. Otherwise, the transmission process succeeds and the source handles the next packet in the buffer if any. Notice that the unit for L and L_h is byte, and the unit for data rate is bits per second, thus the transmission time for one data frame is $8(L) + L_h=2R$.

1.2 Operations at the Destination

i.)Upon receiving the RTS, the destination sends a CTS back after SIFS. The CTS contains the location information of the destination, the FLAG_P, and the transmitting power for the direct transmission PD s (in the form of dB m, occupying 4 bytes), which is used for the possible relay contention.

ii.)In the case that FLAG_P is 1, if the destination has not heard any ETH within $T^{max}_{Backoff}$ ($T_{CTS} + T_{ETH}$) SIFS, it assumes that the direct transmission will be performed and waits for the data packet from the source.

iii.)Otherwise, the destination waits for the data packets from the source and winning relay. If the destination can decode the combined signals correctly, it sends back an ACK. Otherwise, it just lets the source timeout and retransmit.

1.3 Operations at the Relay

i.)Any terminal that receives both RTS and CTS (with FLAG_P equals 1) and does not interfere with other transmissions in its vicinity can be regarded as a relay candidate[10]. Upon receiving the CTS, each relay candidate checks whether it is able to reduce the total energy consumption by

$(2p^D_s – P^C_s – P^C_r – 2P') \ X \ (L+L_h) \ / \ 2R – (P^Cr +P') \ X \ T_{II} - (P+3P') \ x \ T_{ETH}> 0$ (1)

P^C s and PC r refer to the transmitting power in the cooperative transmission mode for source and relay PD s and P refer to the transmitting power in the direct transmission mode for source and the fixed transmitting power respectively.

Term $(2P^D_s - P^C_s - P^C_r - 2P') \ X \ (L + L_h) =2R$ denotes the saved energy consumption in transmitting the data by CC, term $(P^C_r + P') \ X \ T_{II}$ and $(P + 3P')$ _X T_{ETH} denotes the additional energy consumption on control overhead. By Eq. (1), the relay checks whether CC can reduce the total energy consumption both on transmitting and receiving, compared to direct transmission. Every capable relay candidate (satisfies Eq. (1)), starts a backoff timer after SIFS interval.

ii.)Intuitively, the backoff at a better relay expires earlier, hence the best relay will send out an ETH first. The lost relays give up contention when sensing the ETH. The ETH contains the optimal transmitting power PC s for the source (in the form of dBm, occupying 4 bytes).

iii.)After SIFS, the winning relay broadcasts the II message using power PC r . II message is used to reconfirm the interference range of the relay with the objective to enhance the spatial reuse. Then, the winning relay waits for the data packet from the source to arrive. Upon receiving the data packet, the winning relay forwards it to the destination with data rate 2R using transmitting power P^C_r.

IV. CONCLUSION

The mobile ad-hoc network data communication tasks are carried out with the intermediate nodes.

The data values are retransmitted by the relay nodes. The relay nodes are selected with reference to the coverage information. The Cooperative Medium Access Control(CMAC) protocol is used to assign the retransmission terminals.The system increases the network lifetime and energy consumption is reduced by the system then high throughput is achieved with minimum delaycontrol message overhead is reduced by the system.

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