Mobile Adhoc Offloading

Di Li (li@umic.rwth-aachen.de)
Comsys group, RWTH-Aachen University

I. Introduction and Notations

This problem appears to be repeated recursive auctions where each round of recursive auction is different because network topology and AP pair are renewed. The huge strategy space of relay nodes makes the formulation to a game very difficult. In this draft, we give a brief qualitative analysis, and propose a sketch of strategies, we will go on working on this parallelly with software development.

Both AP and Handhelds auction off the traffic load forwarding service with the same elements: budget, fine and timeout, they appear to identical auctioneers to corresponding neighbouring handhleds, thus downstream entity [1] adapts strategies without caring the auctioneer being AP or handheld. For convenience of analysis, we generalize a recursive auction process as shown in following figure,

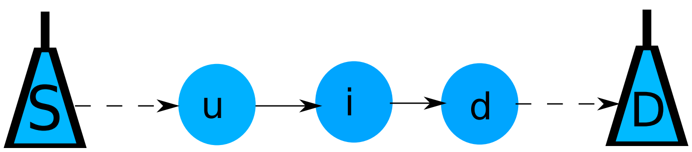

Fig. 1. A recursive auction chain

S and D are APs, which denote source and destination respectively. u, i, and d represent upstream node, the node we are discussing, and the downstream node respectively. note that it may happen that u and S, and d and D are the same entity, thus figure 1 shows a generalized situation. We denote the bid to upstream node, budget and fine for advertised auction of a entity x with b_x, B_x, and f_x respectively.

Some facts:

The tablets are mobile.

II. Qualitative analysis

We now analysis the behavior of node i. According to rules, when there is a routing request heart, node i must bid. Clearly, there are two possible outputs, node i wins the bid, or not. We use a function P_{winBid} to represent the result of auction. P_{winBid} has output of 1 and 0, which denote i gets and losses the bid respectively. P_{winBid} is influenced by the i's bid, and the bids from the other neighbors of the auctioneer u, so P_{winBid} can be written as $P_{\text{winBid}}(b_i, b_{-i})$, where b_{-i} means the biding strategies taken by the neighbors of u except for i. Note that according to rules, the nodes are mobile, so as to the the set of $\{-i\}$ is different in each round.

[1]we use entity or node to denote either AP or handheld

The wise act for handled is to win the favoured bid, and avoid the challenging bid. After this bidding process, if node i wins the bid, it starts to consider how to forward the packet. We use P_{taskFail} to denote whether the packet is successfully transmitted, whose 1 and 0 correspond to success and fail.

Now we can express the balance of node i as following:

$$u = P_{\text{winBid}}[(b_i - b_d) - P_{\text{taskFail}}(f_u - f_i)] =$$

$$\begin{cases} b_i & \text{if } P_{\text{winBid}} = 1,\ i \text{ is neighbor of } D \\ b_i + f_i - b_d - f_u & \text{if } P_{\text{winBid}} = 1, P_{\text{taskFail}} = 1 \\ b_i - b_d & \text{if } P_{\text{winBid}} = 1, P_{\text{taskFail}} = 0 \\ 0 & \text{if } P_{\text{winBid}} = 0 \\ b_i - B_S & \text{if } P_{\text{winBid}} = 1, \text{ then piggyback} \\ b_i - f_u & \text{if } P_{\text{winBid}} = 1, \text{ then do nothing} \end{cases} \tag{1}$$

Let along the simplest situation (the first condition) where i can get the *easy money*, we briefly analyze the outcomes out of the other situations in the following. Obviously, in the third case, $b_i - b_d \geq 0$. [2] As $f_u \geq f_i$, there is $b_i - b_d \geq b_i - b_d + f_i - f_u$. Besides, it is fairly safe to say $b_i - b_d + f_i - f_u \geq b_i - B_S$. [3] The case where i gets the bid but then drop later, i can gain $b_i - f_u$.

From the above possible outcomes of different situations, we can see that the third scenario where i wins bid and afterwards successfully transmit the packet is the most profitable case for i. Besides, the last case is also preferred when f_u is not very high. In order to achieve this, node i needs good strategy to struggle for the bid, and then wisely choose the next hop which helps transmit the packet successfully with a higher possibility. We assume the other competitors have the same conclusions as us.

III. Sketch of Strategy

A. Bid

As the network is not partitioned, all the neighbours of node i are potential candidates. Note that these neighbours have different distance (difficulty) to reach AP destination[4], but this difficulty is not know by i. The auction is mainly decided by the prices of bids, but not relevant with the nodes. It is easy to see that lower bid leads to bigger chance to win the bid. Although the network topology is dynamic and the

[2]as i is rational to control B_i below b_i and there is $B_i \geq b_d$.

[3]i is able to set f_i very close to f_u, and consider $b_d \leq b_i \leq B_i \leq B_S$, note we discuss this under the condition that $P_{\text{winBid}} = 1, P_{\text{taskFail}} = 0$, as to how to make this happen, we will discuss in the later part.

[4]Assume hop counts are used as OLSR metric

source/destination of AP are changing, we still maintain a record of the ability of each each node (or record of a group of nodes, depends on whether the rules reveal the winer of a auction to people) to reach each AP.

We regard the construction of record as a *calibration* phase. After each auction, i inputs entry $\{nodeID, destID, timeout, OK\}$ into the record, where *nodeID* is the bid winer(s), *destID* is the ID of destination AP in the previous transmission, *timeout* is the time left for transmission when the previous auction goes on, *OK* is a bool, which denotes whether the transmission is completed before the timeout ends. After several rounds of data transmissions, i builds a entry vectors for all its neighbours. With this records, i has better knowledge about the the ability of each its neighbour to reach each AP, and will choose the next-hop neighbour not only by the bid, but their forwarding ability.

When one bid competitor is close to the destination, it will fight for the bid with very low price. In this case, we will be aware of that there could exit a neighbour who is in the range of that AP, then we should bid a lot lower next time and record that these neighbors are close to the destination. We will set price of our bid as the same with advertised fine f_u in the initial rounds.

B. Auctioning

The bidding phase of a node is not separated completely with its latter auction (if it wins the bid). If i suspects certain neighbors of it is also neighbors of destination AP based on its records (these neighbors may not be bidding competitors), then i will set a fairly low budget in its auction, the reason is these neighbors will definitely go into this bid as they can get money easily.

C. Cooperation Encourage

Revenue comes from cooperation between node and its upstream/downstream nodes. Decreasing fine could be attractive to the interested next hop nodes, and lower bid could increase the opportunity being chosen by upstream node.

IV. NOTES

We are still trying to map the possible strategies of nodes into a closed form expression.