MANIAC Challenge: The Wolf-pack strategy

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Abstract

MANIAC Challenge is a problem of game theory, different players strategies intertwine and the success of any player is dependent on the actions of all the other players. A truly fair scenario is when all the strategies are identical, all the nodes co-operate and they all equally share the rewards and risks that come with every transfer. A successful strategy is one that tries to diverge from the equilibrium to maximize its own gains and it manages to do so. We propose the wolf-pack strategy. Unlike standard game-theory based strategies, our strategy does not penalize the nodes that diverge from fairness or from equilibrium, as we believe most nodes will do so. The wolf-pack strategy will try to always find the most successful node or nodes and penalize them. We believe that just like in nature a number of small predators can take down the bigger, more profitable ones.

Keywords: game theory, trust, ad-hoc networks, fairness.

1. Introduction

The MANIAC Challenge raises a number of interesting problems for ad-hoc networks: Is an ad-hoc network a viable alternative for the currently used infrastructure-based networking? If infrastructure owners will use an ad-hoc network to off-load some of its traffic to have a more efficient overall network, how will the nodes in the ad-hoc network respond? What is a fair payment method for the nodes in the ad-hoc network? What are the risks that some nodes will abuse this new network to maximize its own profit?

In such a game, with every node trying to maximize its own profit the used strategies will intertwine making the end result extremely difficult to predict.

Based on previous competitions and the rules offered the following assumptions can be made: Most nodes, if not all will act in a rational way, trying to maximize its individual profit while still playing in a fait way so that they will not be eliminated from the network; Most nodes will try to stay as close as possible to the Nash Equilibrium [1, 2] while still trying to manipulate the numbers in their own favor; The entire network topology is known at all times through the OSLR protocol; At all times at least one node will be connected with the wired backbone; Nodes will want close to complete fairness both in the rewards offered and the risk taken in the form of fines.

2. Fairness in the Ad-Hoc Network

We strongly believe that all nodes participating in forwarding will act in a rational manner based on the Nash Equilibrium [1, 2] and as such the nodes in te network will behave fairly.

We define fairness [3] in the case of the MANIAC Challenge as the state when all nodes from source to the destination will equally split the profit and the fine needed to be paid if the packet is not delivered. In the case of bidding fairness would be achieved by always letting the node that is part of the shortest path win. As such the overall profit of all the nodes in the network will be maximized, extracting the largest possible amount from the back-bone infrastructure. Small deviations from fairness are accepted as this would permit differentiation in the bidding process.

If all nodes are expected to act fair it is easy to observe that the nodes that are unfair, or bad, will be penalized both through packet drop and forcing them to pay part of the fine or through refusal to let them win bids, even if their offer is a lot better than others.

In our proposed strategy we take advantage of this behavior by assisting bad nodes and penalizing rich nodes.

3. The Wolf-pack strategy

We propose the Wolf-pack strategy, a novel way to approach the MANIAC Challenge. In this strategy we observe 2 key features and make decisions based on them: the network topology and the individual node behavior based on the network topology.

The network topology can be obtained through OSLR and it is available at any moment. It is important to be aware of the network topology, as it directly affects the reward each node should receive if the transactions are completely fair. By taking the node topology into consideration certain advantageous positions can be recognized and exploited, such as being the only node that can bid for a packet and thus modifying the strategy accordingly.

Individual node behavior is extremely important for our strategy. We need to make assumptions about how rich a node is and we do this by observing all transactions and calculating its profit at every point. We also need to observe how each node behaves, since a bad node can prove extremely useful. Information about individual nodes should be exchanged between our 2 friendly nodes to get a more accurate image of the entire network. We presume we can make our observations by packet sniffing but a solution in the case this is not possible is offered in section 4.

We believe that bad or unfair nodes will be penalized by all other nodes and as such their chances to win the challenge are greatly diminished. This nodes do not prove to be a direct challenge for us as such we will help them: if such a node bids for our packet and does not have an extreme tendency to drop packets discovered in the past we will prefer it as the next hop; If it has a package and wants to forward it, we will offer bids that give him a larger reward then and thus winning the bid and receiving the packet. As such we will increase our own number of delivered packages as we will take advantage of nodes other would not consider and we make sure the distribution of reward is spread across more nodes. This helps us in assuring that no node will collect a large number of rewards.

Next we will penalize the rich nodes. By observing the network we decide which are the nodes that manage to make a big profit so far and we chose other nodes to forward our packets. This is where the wolf-pack name comes in, we share the value of the profit we believe all other nodes have and directly attack the nodes with the most profit by not choosing them as forwarders and by dropping packets in an attempt to force them to pay big fines.

By applying the 2 rules we prefer bad and poor nodes over rich and fair nodes in both bidding and forwarding, in the case of bidding we can go to the extra length of making a good bid and dropping the packet just to force the rich node to pay part of the fines. Based on this observations we order the bids we get based on the price offers we receive, the level of profit the node has and the node behavior from the past and we choose the most advantageous for us to disseminate the total network profit as equally over as many nodes as possible while keeping ourselves just a bit more above anyone so we do not become a clear target for other nodes.

4. Discussion

In the case we cannot sniff the network to obtain data of what bids other nodes have made or who won a bid we propose the following strategy: We keep a history of all bids; when we find ourselves in a bid against the same other nodes we apply a binary search method. We bid the center between the lowest possible bid and the highest, if we win the next time we bid the center between the highest possible bid and the previous center; if we do not win we bid the center between our bid and the possible lowest. We continue to bid as such until we find the bid each other node makes and the strategy they play. We compare each bid with the strategy we believe the other nodes can play in an attempt to find the strategy and the level of fairness they are at.

5. Conclusion

In this paper we presented the wolf-pack strategy. This strategy aims to win the MANIAC Challenge by attacking the rich nodes and helping the poor and even the bad nodes in the network. We believe that by applying such a strategy we will spread the total profit of the network to most nodes, we will not permit a node to get excessively rich and we will manage to make just a bit more profit than everyone else.
We believe this is possible because rational nodes will prefer to attack bad nodes and help fair ones.

6. References

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