Event Dissemination Protocol for SNS inspired P2P Games

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Abstract-Changing network dynamics is a critical issue in many overlay networks especially in peer-to-peer systems. Previously these network formations were approached in two ways. Firstly by implementing practical heuristics for cooperative peers, and later performing game theoretic analysis for selfish peers. Selfish Neighbor Selection (SNS) game theory is designed and implemented in overlay routing that unifies the aforementioned ways. SNS limits number of neighbors for each peer. This approach reduces link monitoring overhead in overlay networks from O(n2) to O(n). Best response wirings increases the utility of Overlays and Simple heuristic wirings benefits non-selfish nodes. With that regard we highlight the fact that in a frequent Event Dissemination systems such as a multi-player P2P games, users(players) generate game events at a rate that can be approximated using some (game dependent) probability distribution. For an optimized performance especially considering p2p gaming we propose a threefold event dissemination model using gossip schemes that increases the contributions of a selfish peer toward the entire network.

According to the first one, upon reception of a stimulus from a neighbor, a peer increases its dissemination probability towards that node irrespectively from the sender. In the second, a peer increases only the dissemination probability for a given sender towards all its neighbors. Finally, the third step takes into consideration both the sender and the neighbor in order to decide how to increase the dissemination probability. These three steps are implemented in the form of an event dissemination protocol implemented in an SNS driven P2P overlay network for offering a better p2p gaming experience.

1. INTRODUCTION

An overlay network is a virtual network of nodes and logical links that is built on top of an existing network with the purpose to implement a network service that is not available in the existing network. Overlay networks are used for a variety of popular applications including routing[3], content distribution, peer-to-peer (P2P) file sharing and streaming, data-center applications, and online multi-player games. Connectivity management is a foundational issue in overlay network applications. Establishing Connection to newcomer into existing mesh or re-establishing links between nodes is known as connectivity management. Overlays consist of nodes that are distributed across multiple administrative domains, as such, by utilizing knowledge about the network; these nodes may act selfishly and deviate from the default protocol to maximize the benefit. Selfish behavior creates additional incentives for nodes to rewire, not only for operational purposes, but also for seizing opportunities to incrementally maximize the local connection quality to the overlay. The impact of adopting selfish connectivity management techniques in real overlay networks has been an open problem.

In overlay network, a fixed number (k) of immediate overlay neighbors must be selected by a node for routing traffic. Above problem are considered from two perspectives: By providing underlying fundamental neighbor selection problem abstractions and by implementing *practical heuristics* for specific applications in real deployments. Main results in this area have centered on strategic games where edges are undirected, access costs are based on hop-counts, and nodes have potentially unbounded degrees. While this existing body of work is extremely helpful for laying a *theoretical* foundation and for building intuition, it is not clear how or whether the guidance provided by this prior work generalizes to situations of practical interest, in which underlying assumptions in these prior studies are not satisfied. Aspect not considered in previous work is the consideration of settings in which some or even most players do not play optimally – a setting which we believe to be typical.

Dissemination protocols or rumor-mongering protocols

These use gossip to spread information; they basically work by flooding agents in the network, but in a manner that produces bounded worst-case loads:

Event dissemination protocols use gossip to carry out multicasts. They report events, but the gossip occurs periodically and events don't actually trigger the gossip. One concern here is the potentially high latency from when the event occurs until it is delivered.

Background data dissemination protocols continuously gossip about information associated with the participating nodes. Typically, propagation latency isn't a concern, perhaps because the information in question changes slowly or there is no significant penalty for acting upon slightly stale data.

In this paper, we are showing that Firstly by implementing practical heuristics for cooperative peers, and later performing game theoretic analysis for selfish peers. Selfish Neighbor Selection (SNS) game theory is designed and implemented in overlay routing that unifies the aforementioned ways. SNS limits number of neighbors for each peer. This approach reduces link monitoring overhead in overlay networks from O(n2) to O(n). Best response wirings increase the utility of Overlays and Simple heuristic wirings benefits non-selfish nodes. With that regard we highlight the fact that in a frequent Event Dissemination systems such as a multi-player P2P games, users(players) generate game events at a rate that can be approximated using some (game dependent) probability distribution. For an optimized performance especially considering p2p gaming we propose a threefold event dissemination model using gossip schemes that increases the contributions of a selfish peer toward the entire network. According to the first one, upon reception of a stimulus from a neighbor, a peer increases its dissemination probability towards that node irrespectively from the sender. In the second, a peer increases only the dissemination probability for a given sender towards all its neighbors. Finally, the third step takes into consideration both the sender and the neighbor in order to decide how to increase the dissemination probability. In this paper, a new dissemination protocol is implemented that is SNS driven P2P overlay network for offering a better p2p gaming experience.

II RELATED WORK

The study of overlay routing networks has received considerable attention in the past few years [Andersen et al. 2001, Chu et al. 2000, Chawathe 2000]. These references assume that the participants are completely obedient to the pre-defined policies, regardless of the incentives to attain to those policies. However, more recent works [Fabrikant et al. 2003, Chun et al. 2004] suggest that nodes may actually behave selfishly, acting only towards their goals and self-interests. In the absence of a central authority that prescribes how nodes should set up links to each other, and the possible rewards and costs coming from the establishment of each new connection, it is up to the nodes to assign rewards and penalties to each link and then choose the best connections. In this sense, selfish nodes have been modeled as rational players from a game theoretic perspective. They are viewed as players who wish to maximize their benefits when utilizing network services and to minimize their incurred costs when providing resources to other nodes. The benefits expected by a node may be conveniently translated to a utility function, that represents the anticipated payoff of each player, given a selected strategy. In [Chun et al. 2004] for instance, the utility function is given in terms of expected perceived latency, but other metrics such as bandwidth allocation, reliability or number of hops can be used as well. Although it is possible to use classical game theory [Qiu et al. 2003, Gollapudi et al. 2005] in this context, this approach only approximately describes a competitive game in overlay networks, since it requires that each player has the same game-relevant information as every other player. In this manner, all private strategies from the nodes should be public disclosed, which is clearly not a realistic assumption. The problem of creating a selfish overlay network through a noncooperative incomplete-information game was introduced in [Fabrikant et al. 2003], and further scrutinized in [Chun et al. 2004]. They investigated the overlay topologies reached in the Nash equilibrium, and their properties, such as attack and failure resilience.

III. THE EGOIST OVERLAY ROUTING SYSTEM

In previous work, it is not clear; what is the average performance gain when SNS wiring strategies are used in highly dynamic environments, whether such overlays are robust against churn, and whether they scale and whether it is practical to build overlays to support best response and how to incorporate additional metrics other than delay, *e.g.*, bandwidth. In order address the problems, we implemented EGOIST, an SNS-inspired prototype overlay routing network, serves as a building block for the distributed construction of efficient and resilient overlays where both individual and social performance is close to optimal.

A. Basic Design

EGOIST is a distributed system which allows the creation and maintenance of an overlay network. Here every node selects and continuously updates its k overlay neighbors in a selfish manner—namely to minimize its (weighted) sum of distances to all destinations under shortest-path routing. For ease of presentation, Instead of bandwidth ad node utilization, we will assume that *delay* is used to reflect the cost of a path.

In EGOIST, a *newcomer* overlay node v_i connects to the system by querying a *bootstrap* node, from which it receives a list of *potential* overlay neighbors. The newcomer connects to at least one of these nodes, enable link state routing protocol as a result, after some time, v_i obtains the full residual graph G_{-i} of the overlay. By running all-pairs shortest path algorithm on G_{-i} , the newcomer is able to obtain the pair-wise distance (delay) function d_{G-i}. In addition to this information, the newcomer estimates d_{ij}, the weight of a potential direct overlay link from itself to node v_i, for all v_i€ V_{-i}. Using the values of d_{ij} and d_{G-i} , the newcomer connects to G_{-i} using one of the wiring strategies. There are also two threads, one for estimating d_{ij} , and one responsible for estimating the newwiring and propagating the wiring to the immediate neighbors. In order to minimize the load in the system, a node propagates its wiring to its immediate neighbors only if this changes.

B.Neighbor Selection Policies in EGOIST

The default neighbor selection policy in Egoist is the Best-Response (BR) strategy. Using BR, a node selects all its k neighbors so as to minimize a local cost function, which could be expressed in terms of some performance metric. In addition to BR, we have also implemented the following neighbor selection policies in order to perform a comparative evaluation.

k-Random: Each node selects k neighbors randomly. If the resulting graph is not connected, we re-wire some links to enforce a cycle upon it.

k-Closest: Each node selects its k neighbors to be the nodes with the minimum link cost (e.g., minimum delay from it, maximum bandwidth, etc.). Again, if the graph is not connected, we enforce a cycle.

k-Regular: In this case, all nodes follow the same wiring pattern dictated by a common offset vector o = {o1, o2, . . . , ok}, used as follows: node i connects to nodes i + oj mod n, j = 1, . . . , k.

C. Dealing with Churn

EGOIST's BR(best response) neighbor selection strategy assumes that existing nodes never leave the overlay. Therefore, even in an extreme case in which some nodes are reachable through only a unique path, a node can count on this path always being in place. Overlay routing networks (e.g., RON[3]) are not inherently prone to churn to the extent that file-sharing P2P networks. Nonetheless, nodes may occasionally go down, or network problems may cause transient disconnections until successive re-wirings establish new paths. One could re-formulate the BR objective function used by a node to take into account the churning behavior of other nodes. This, however, requires modeling of the churn characteristics of various nodes in an overlay, which is not feasible in large networks .

In EGOIST, we follow a different approach. We introduce a hybrid wiring strategy (HybridBR), in which each node uses k_1 of its k links to selfishly optimize its performance using BR, and "donates" the remaining $k_2 = k - k_1$ links to the system to be used for assuring basic connectivity under churn. As donated links are monitored aggressively so as to recover promptly from any disconnections in the connectivity backbone through the use of frequent heartbeat signaling. We call this wiring "hybrid" because, in effect, two wiring strategies are in play – a selfish BR strategy that aims to maximize local performance and a selfless strategy that aims to maintain global connectivity by providing redundant routes. The monitoring and upkeep of the remaining BR links could be done lazily, namely by measuring link costs, and recomputing BR wirings at a pace that is convenient to the node—a pace that reduces probing and computational overheads without risking global connectivity.

To differentiate between these two types of link monitoring strategies (aggressive versus lazy), in EGOIST we allow rewiring of a dropped link to be performed in one of two different modes: *immediate* and *delayed*. In immediate mode, re-wiring is done as soon as it is determined that the link is dropped, whereas in delayed mode re-wiring is only performed (if necessary) at the preset *wiring epoch* T. Unless otherwise specified, we assume a delayed re-wiring mode is in use.

D. Cost Metrics

The choice of an appropriate "cost" of traversing a link depends largely on the application. In EGOIST we consider the following metrics:

Link and Path Delays: Major natural cost metric is delays for many applications, including real-time ones. To obtain the delay cost metric, each and every node needs to estimates for its own delay to potential neighbors, and for the delay between pairs of overlay nodes already in the network. In EGOIST, for estimating the directed (one-way) link delays two different methods are used: an active method based on ping, and a passive method using the pyxida virtual coordinate system. Using ping, one-way delay is estimated to be one half of the measured ping round-trip-times (RTT) and produce more accurate results. Using pyxida, delay estimates are available through a simple query which produces less accurate estimates, but consumes much less bandwidth.

Node Load: For many overlay applications, performance of the nodes along that path is the primary determinant of the cost of a path. In EGOIST, we did this by querying the CPU load of the local node, and computing an exponentially-weighted moving average of that load calculated over a given interval In EGOIST, we allow the use of a variation of the delay metric in which all outgoing links from a node are assigned the same cost, which is set to be equal to the measured load of the node..

Available Bandwidth: This ia another important cost metric which is based on content delivery applications, is the available bandwidth on overlay links. In EGOIST, To compute this metric we used pathChirp, a light-weight, fast and accurate tool, which fits well with specific constraints, mainly it does not impose a high load on nodes since it does not require the transmission of long sequences of packet trains, and it does not exceed the maxburst limits of AWT-SWINGS.

IV PROBLEMS IN PREVIOUS WORK

1. Uses practical heuristics for cooperative peers and performing game theoretic analysis for selfish peers

2. The previous results have shown that no simple heuristic strategy can keep up with the performance of best response across the entire range of scenarios.

3. Considers practicality of building overlays to support best response and fails to incorporate additional metrics other than delay, e.g., bandwidth

4. Assumes average performance gain when SNS wiring strategies are used in highly dynamic

environments, whether such overlays are robust against churn, and whether they scale.

V PROPOSED APPROACH

1. Uses Selfish Neighbor Selection (SNS) game theory, an unified approach for handling cooperative peers and selfish peers alike.

2. EGOIST's implementation (SNS prototype) could well be used to account for cost, including bandwidth and node utilization.

3. Reduces link monitoring overhead

4. EGOIST prototype implementation that captures the traffic generated by an online multi-player P2P game validates the presence of a selfish peer is actually beneficial to network performance.

Event Dissemination Protocol for SNS inspired P2P Games

The following three steps are implemented in the form of an event dissemination protocol implemented in an SNS driven P2P overlay network for offering a better p2p gaming experience.

1. With that regard we highlight the fact that in a frequent Event Dissemination systems such as a multi-player P2P game, users(players) generate game events at a rate that can be approximated using some (game dependent) probability distribution. Hence, as soon as a given node experiences a reception rate, for messages coming from a given peer, who is lower than expected, it can send a stimulus to the neighbor that usually forwards these messages, asking it to increase its dissemination probability.

2. In such a case, presence of best response selfish peers can offer a decent gaming experience to the end user, but the fact remains that the peers in the network remain selfish for their own operations in the network.
3. So for an optimized performance especially considering p2p gaming we propose a threefold event dissemination model using gossip schemes that increases the contributions of a selfish peer toward the entire network.

VI CONCLUSION

In this paper, Selfish neighbor selection in a richer model that captures the nuances of overlay applications more faithfully than previous work and strictly enforced neighbor budgets and has come up with a series of findings with substantial practical value for real overlay networks. Best-Response neighbor selection strategies can indeed be realized, that they provide a substantial performance boost when compared to currently used heuristics, and that they scale much better than full- mesh approaches which require intensive monitoring of $O(n^2)$ links. First, when compared with simple random and myopic heuristics, we have shown that a best response (*i.e.*, selfish) selection of neighbors leads to the construction of overlays with much better performance. Secondly, through the development, implementation, and deployment of EGOIST, we have established that Best-Response neighbor selection strategies that they scale much better than simple heuristics. And finally the three steps are implemented in the form of an event dissemination protocol implemented in an SNS driven P2P overlay network for offering a better p2p gaming experience.

- According to the first one, upon reception of a stimulus from a neighbor, a peer increases its dissemination probability towards that node irrespectively from the sender.

- In the second, a peer increases only the dissemination probability for a given sender towards all its neighbors.

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