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Implementation of Free Riding Tendency Minimization in the Peer to Peer Network

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Abstract: In P2P systems, where cooperation may incur significant communication and computation costs such rational users may refuse to contribute their fair share of resources. As a result such individual rationality is in conflict with social welfare. In this work we have develop a mat lab program for demonstrating the behavior of free riding phenomenon in peer to peer network. we have consider that we have taken users of different type on the basis of their decision of their contribution to the system are behaving as a 'free rider'. We have shown a mechanism that provides a penalty and exclusion mechanism of free rider if they do not changes their behavior on receiving repetitive warnings of their free riding behavior. We have considered a threshold value that will imposed on free rider if any user entered in the network, as a free rider more than or equal to three times.

Keywords: P2P, Free Rider, Penalty, Network Model

1. Introduction:

The peer-to-peer (P2P) communications model has emerged a widely deployed alternative to the traditional client-server model for many distributed systems. In a typical P2P system, each node is owned and operated by an independent entity, and the nodes collectively form a self-organizing, self-maintaining network with no central authority. As a result, P2P system performance is highly dependent on the amount of voluntary resource contribution from the individual nodes. Traditional system design assumes obedient users who adhere to a specified protocol without consideration of their own utility. However, this obedience assumption appears unrealistic in P2P settings where individual participants may interact with one another with varying degrees of collaboration and competition. Therefore, researchers have turned in recent years to a model of rational users - users who act to maximize their own utility, including deviating from the protocol specification if they could increase their utility by doing so. In P2P systems, where cooperation may incur significant communication and computation costs, rational users may refuse to contribute their fair share of resources. Thus, individual rationality is in conflict with social welfare.

Users who attempt to benefit from the resources of others without offering their own resources in exchange are termed "free-riders." In 2000, a measurement study of the Gnutella le-sharing network found that approximately 70% of peers provide no les and that the top 1% of the peers provide approximately 37% of the totalles shared. Similar patterns have been observed in subsequent studies of Napster and Gnutella networks. In 2005, found free-riders have increased to 85% of all Gnutella users.

The free-riding phenomenon is by no means unique to P2P systems. However, the characteristics of P2P systems present interesting challenges and opportunities for the design of incentive-compatible systems. Some of these characteristics include: lack of central authority, highly dynamic memberships, availability of cheap identities ("pseudonyms"), hidden or untraceable actions, and collusive behavior. This work surveys different approaches, e.g., based on payments or reciprocity, to alleviate or overcome this free-riding problem.

While free-riding is the focus of this work, rational behavior manifests itself in many other distributed system settings, including strategic network formation, selfish routing and interconnection, congestion control, multicast cost sharing, and selfish caching, just to name a few. At the conclusion of this work, we will outline some of the important open questions and fruitful areas of research in this area.

We develop a model to study the phenomenon of free-riding in peer-to-peer (P2P) systems. At the heart of our model is a user of a certain type, an intrinsic and private parameter that reflects the user's willingness to contribute resources to the system. A user decides whether to contribute or free-ride based on how the current contribution cost in the system compares to her type. When the societal generosity (i.e., the average type) is low, intervention is required in order to sustain the system. We present the effect of mechanisms that exclude low type users or, more realistic, penalize free-riders with degraded service. We also consider dynamic
scenarios with arrivals and departures of users, and with white washers: users who leave the system and

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rejoin with new identities to avoid reputational penalties. We find that when penalty is imposed on all newcomers in order to avoid whitewashing, system performance degrades significantly only when the turnover rate among users is high.

Why is free-riding widespread among users of P2P systems? How does free-riding affect system performance? What mechanisms discourage free-riding? How does white- washing affect the performance of P2P systems? These are the questions that motivate us. P2P systems rely on voluntary contribution of resources from the individual participants. However, individual rationality results in free-riding behavior among peers, at the expense of collective welfare. Empirical studies have shown prevalent free-riding in P2P file sharing systems [1]. Various incentive mechanisms have been proposed to encourage cooperation in P2P systems [4]. At the same time, it has been suggested that free-riding can be sustainable in equilibrium and may even occur as part of the socially optimum outcome [12].

2. Related Work:

Byung Gon Chun et.al. (2004), they analyze replication of resources by server nodes that act selfishly, using a game-theoretic approach. We refer to this as the selfish caching problem. In our model, nodes incur either cost for replicating resources or cost for access to a remote replica. We show the existence of pure strategy Nash equilibria and investigate the price of anarchy, which is the relative cost of the lack of coordination. The price of anarchy can be high due to undersupply problems, but with certain network topologies it has better bounds. With a payment scheme the game can always implement the social optimum in the best case by giving servers incentive to replicate.

Nazareno Andrade et.al. (2005), they collect BitTorrent usage data across multiple file-sharing communities and analyze the factors that affect users' cooperative behavior. We find evidence that the design of the BitTorrent protocol results in increased cooperative behavior over other P2P protocols used to share similar content (e.g. Gnutella). We also investigate two additional community specific mechanisms that foster even more cooperation.

Alice Cheng et.al. (2005), Due to the open, anonymous nature of many P2P networks, new identities - or sybils - may be created cheaply and in large numbers. Given a reputation system, a peer may attempt to falsely raise its reputation by creating fake links between its sybils. Many existing reputation mechanisms are not resistant to these types of strategies. Using a static graph formulation of reputation, we attempt to formalize the notion of sybilproofness. We show that there is no symmetric sybilproof reputation function. For nonsymmetric reputations, following the notion of reputation propagation along paths, we give a general asymmetric reputation function based on flow and give conditions for sybilproofness.

Joan Feigenbaum et.al. (2005), The routing of traffic between Internet domains, or Autonomous Systems (ASs), a task known as inter domain routing, is currently handled by the Border Gateway Protocol (BGP). In this work, we address the problem of inter domain routing from a mechanism-design point of view. The application of mechanism-design principles to the study of routing is the subject of earlier. In this work, we formulate and solve a version of the routing-mechanism design problem that is different from the previously studied version in three ways that make it more accurately reflective of real-world interdomain routing: (1) we treat the nodes as strategic agents, rather than the links; (2) our mechanism computes lowest-cost routes for all source-destination pairs and payments for transit nodes on all of the routes (rather than computing routes and payments for only one source-destination pair at a time; (3) we show how to compute our mechanism with a distributed algorithm that is a straightforward extension to BGP and causes only modest increases in routing table size and convergence time (in contrast with the centralized algorithms).

Nicolas Christin et.al. (2005), In this work, they propose a cost-based model to evaluate the resources that each node has to contribute for participating in an overlay network. Such a cost model allows to gauge potential disincentives for nodes to collaborate, and provides a measure of the "total cost" of a network, which is a possible benchmark to distinguish between different network architectures. We characterize the cost imposed on a node as a parametrized function of the experienced load and of the node connectivity, and express benefits in terms of cost reductions. We discuss the notions of social optimum and Nash equilibrium with respect to the proposed cost model. We show that the social optimum may significantly deviate from a Nash equilibrium when nodes value the resources they use to forward traffic on behalf of other nodes. Through analytical and numerical results, we then use the proposed cost model to evaluate some of the topologies recently proposed for overlay networks, and to exhibit some of the challenges systems designers

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may face. We conclude by outlining some of the open questions this research has raised.

3. Methodology:

Peer-to-peer (P2P) networks have attracted a significant amount of attention in the press as a popular network architecture for the sharing of information goods. Popular P2P sites for sharing consumer information goods, including Napster, Kazaa, and Morpheus Music City, have attracted millions of global users to share their songs, films, software, and computer games. At the same time, a variety of entrepreneurs are developing commercial applications of P2P technology. Notable examples include Allcast, Blue Falcon Networks, Kontiki, and Uprizer for the distribution of streaming media content; Groove Networks for enterprise collaboration; and Bad Blue and Nextpage for enterprise information sharing. While P2P networks vary in their architectural design and application domain, in all P2P networks files are transferred directly between the computers of users (a.k.a. peers) connected to the network. Further, once these files have been delivered, the user accessing the file becomes a provider of that content by default. Thus, in an ideal case, the provision of content on the network will scale to match the level of demand for the content. This characteristic also means that P2P networks can be modeled in the context of the economic concept of public goods. In contrast to private goods, public goods have the characteristics of non-excludability in supply (individuals can't be excluded from consuming the product) and non-rivalry in demand (one individual's consumption does not diminish another user's value of the product).

3.1 Steady State Analysis:

We present the steady state analysis of free riding problem in P2P streaming systems. We first consider the scenario where there are no seeders in the system, and then we consider the scenario where there are seeders in the system. Note that by steady state, we mean $\lim_{t\to\infty} xh(t) = \bar{x}h$, $\lim_{t\to\infty} xf(t) = \bar{x}\bar{f}$, and $\lim_{t\to\infty} y(t) = \bar{y}$ exits, that is-

A. Without seeders

In this scenario, for simplifying the model, we assume that the downloaders will never leave the system and the seeders will leave the system once they finish downloading, i.e., $\theta = 0$ and $\gamma = \infty$. When the system is in steady state, we have when $t \to \infty$, $\frac{dxh(t)}{dt} = 0$, $\frac{dxf(t)}{dt} = 0$, and $\frac{dy(t)}{dt} = 0$. Thus, by applying the expression in (4) under the condition that $c_p\bar{x}_h \geq (1-\bar{\rho})\, \eta u_p\bar{x}_h + (1-\bar{k})u_s$ and $c_p\bar{x}_f \geq \bar{\rho}\eta u_p\bar{x}_h + \bar{k}u_s$ we obtain-

$$0 = \lambda_h - (1-\bar{\rho})\eta u_p\bar{x}_h - (1-\bar{k})u_s$$

$$0 = \lambda_f - \bar{\rho}\eta u_p\bar{x}_h - \bar{k}u_s \qquad (1)$$

Where $\bar{\rho} = \frac{1}{\mu+1}\frac{\bar{x}\bar{f}}{\bar{x}h+\bar{x}\bar{f}}$ is the equilibrium value of $\rho(t)$ and $\bar{\rho} \in [0,1]$, and $\bar{k} = \frac{\bar{x}\bar{f}}{\bar{x}h+\bar{x}\bar{f}}$ is the equilibrium value of $k(t)$ and $\bar{k} \in [0,1]$, Solving (5), we have

$$\bar{x}h = \frac{\lambda h}{\eta up}.\frac{1}{1-\alpha},\ \bar{x}f = \frac{\lambda f}{\eta up}.\frac{1}{\frac{1}{\mu+1}-\alpha} \qquad (2)$$

Where $\alpha = \frac{\lambda f - us}{\lambda h + \lambda f - us}$ and $\alpha < \frac{1}{\mu+1}$ if the system has the steady state value.

By applying Little's Law $\frac{\lambda - \theta\bar{x}}{\lambda}\bar{x} = (\lambda - \theta\bar{x})T$ (T is the average download time), the average download time of honest downloaders and free riders can be computed as

$$T_h = \frac{1}{\eta up}.\frac{1}{1-\alpha},\quad Tf = \frac{1}{\eta up}.\frac{1}{\frac{1}{\mu+1}-\alpha} \qquad (3)$$

B. With seeders

In this scenario, we assume that the downloaders will never leave the system, i.e., $\theta = 0$, and the seeders leave the system with random abort rate γ. When the system is in steady state, we have when $t \to \infty$, $\frac{dxh(t)}{dt} = 0$, $\frac{dxf(t)}{dt} = 0$), and $\frac{dy(t)}{dt} = 0$. Thus, by applying the expression in (4) under the condition $c_p\bar{x}_h \geq (1-\bar{\rho})\eta u_p\bar{x}_h + (1-\bar{k})(u_p\bar{y} + u_s)$ and $cp\bar{x}_f \geq \bar{\rho}\eta u_p\bar{x}_h + \bar{k}(u_p\bar{y} + u_s)$ we obtain

$$0 = \lambda_h - (1-\bar{\rho})\eta u_p\bar{x}_h - (1-\bar{k})(u_p\bar{y} + u_s)$$

$$0 = \lambda_f - \bar{\rho}\eta u_p\bar{x}_h - \bar{k}(u_p\bar{y} + u_s) \qquad (4)$$

$$0 = (1-\bar{\rho})\eta u_p\bar{x}_h - (1-\bar{k})(u_p\bar{y} + u_s) - \Upsilon\bar{y}$$

Where $\bar{\rho}$ and $\bar{k}$ are of the same meanings as in (5). Solving (8), we have

$$\bar{x}_h = \frac{\lambda h}{\eta up}.\left(\frac{1}{1-\alpha} - \frac{up}{\Upsilon}\right),\ \bar{x}_f = \frac{\lambda f}{\eta up}.\frac{1}{\frac{1}{\frac{1}{1-\alpha}-\frac{up}{\Upsilon}} - \left(1 - \frac{1}{\mu+1}\right)},\ \bar{y} = \frac{\lambda h}{\Upsilon} \qquad (5)$$

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where $\alpha = \frac{\lambda f - us}{\lambda h + \lambda f - us}$ and $1 - \frac{1}{\left(\frac{up}{\Upsilon}\right)} < \alpha < 1 - \frac{1}{\left(\frac{up}{\Upsilon}\right) + \frac{\mu+1}{\mu}}$ if the system has the steady state value. Also based on the Little's Law, we can compute the average download time of honest downloaders and free riders as

$$T_h = \frac{1}{\eta up} \cdot \left(\frac{1}{1-\alpha} - \frac{up}{\Upsilon} \right), T_f = \frac{1}{\eta up} \cdot \frac{1}{\frac{1}{\frac{1}{1-\alpha} - \frac{up}{\Upsilon}} - \left(1 - \frac{1}{\mu+1}\right)}$$

4. Result and Discussion:

In this work we have developed peer to peer network model, an area of 500*500 kms having about 100 users of online data resources.(as shown in fig.1.) where all users are shown as a circular points having random positions, where X-axis and Y-axis shown the area length and blue circles are the network user.

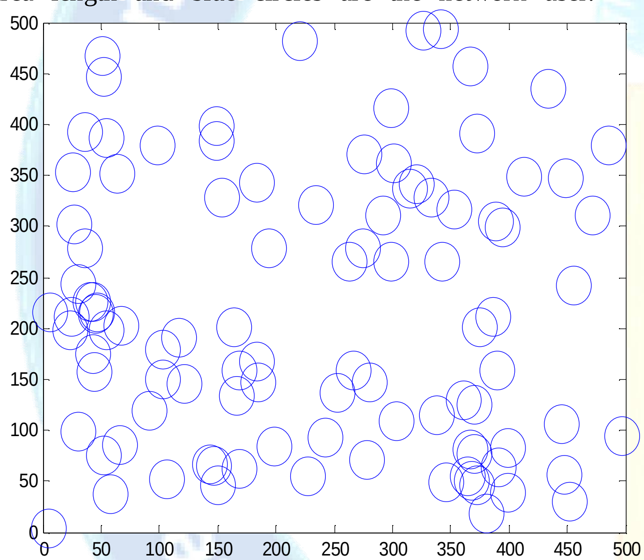

Fig (1)

Ideally, there are only honest users and we can assume that 30% are using the network at the time .These honest users are shown by 'yellow circles'.(in fig .2.) where we can seen that 24,17,14,…… are the yellow circles representing 30 honest downloader, using the peer to peer network, with the change in time as some of the downloader finished the downloading will leave the network and work as 'seeders' and some new users is also added in the network.

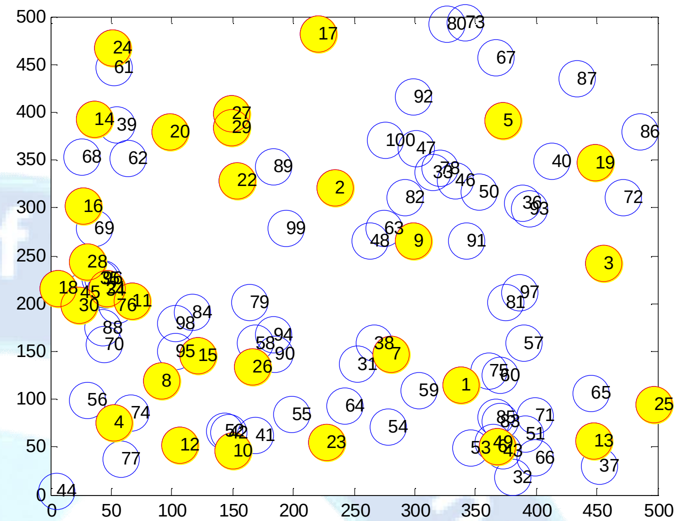

Fig (2)

Our algorithm is run for 10 iteration to check the status of user that how many times they have entered in network as a free rider and honest downloader .In each iteration we have considered new honest downloader, as a 'delh' added in the particular timeslot and free rider are 'delf'. Where delh=6 maximum six honest user can be added in the network and 'delf=delh/2'i.e. maximum 2 free rider can be added to a network in every time slots.

In each iteration the algorithm give the record of total number of free rider and honest user in the given peer to peer network. In the present case we have not considered any penality on the free rider for analyzing the behavior, time of utilization and number of free riding cases in our network. We have saved the total number of honest user as the sum(sh) and total free rider as a sum(sf) and upcoming figures we are shown the result for 10 rounds with the network by network diagram and number of honest users as 'blue line' and number of free riders as 'black line' .

Without penality:

seeder id honest:17 14
None of the user has been free riding for a long time
seederidf = 4
free rider left: 4
new honest user id;
new free riders id: 58 17 15
seeder id honest:17 10
None of the user has been free riding for a long time
seederidf = 1
free rider left: 1
new honest user id; 46 39 79 37
new free riders id: 72 88

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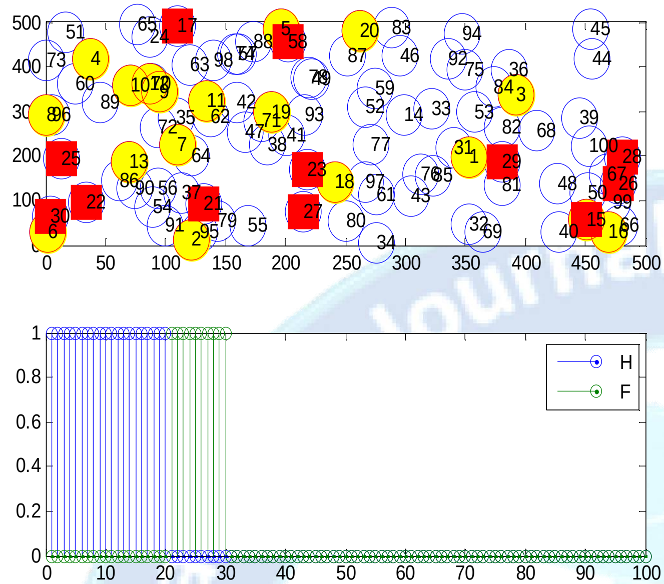

Fig (3a)

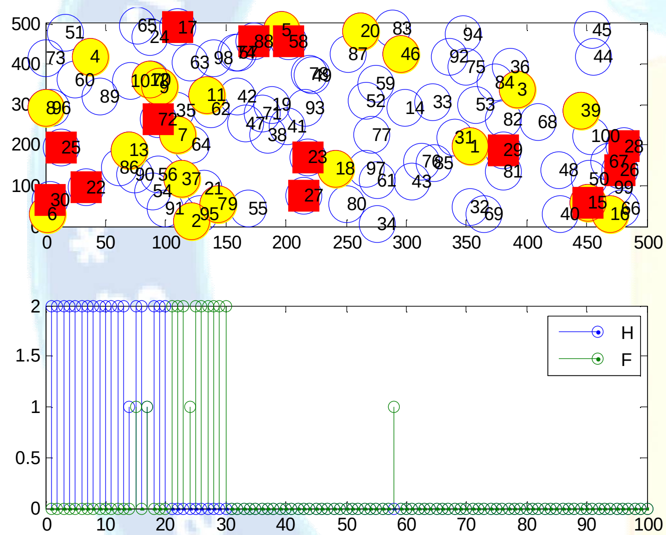

Fig (3b)

5. Conclusion:

We have shown a mechanism that provides a penality and exclusion mechanism of free rider if they do not changes their behavior on receiving repititive warnings of their free riding behavior. We have considered a threshold value that will imposed on free rider if any user entered in the network, as a free rider more than or equal to three times. we sends them a warning to give them a chance of changing their behavior and tries to mold his activities towards the user that can become a contributor to the data resource of the peer to peer network. Those users which do not stops their free riding behavior are blocked from the network uses if they have received the warning more than or equal to warning by imposing such types of exclusion mechanism we have shown that the number of free riders can be successfully reduce in the peer to peer network.

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