# Penalty Mechanism based Free Riding Reduction in Peer To Peer File Sharing Network

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***Abstract*—The peer-to-peer (P2P) communications networks are getting popular as a widely deployed alternative to the general client-server network model for many distributed systems. We have worked on a P2P system where each node is governed and initiated by an independent user, and the all the nodes collection form a self-organizing as well as self-maintaining network framework with no central authority. The model is simulated by Matlab based algorithm for P2P system having the performance which is highly dependent on the population of voluntary resource contribution by the user client nodes. In the simple conventional system design it is assumed that the users are obedient hence the users who adhere to a protocol without consideration of their own utility. But in the current context for live P2P systems this obedience assumption appears unrealistic in P2P settings where individual participants may interact with one another with varying degrees of collaboration and competition. Therefore, we have focused on an algorithm development for a P2P communication network having different type of users in which some are those who act to increase their own utility, including deviating from the protocol specification if they could increase their utility by doing so they are not following the way of honest users. 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*— *Free Rider, Peer to Peer system, WAN, penalty mechanism.***

## 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 { 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 [3] 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 [14; 6], selfish routing [8] and interconnection [13], congestion control [5], multicast cost sharing [10], and selfish caching [7], 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.

In this work, we focus on pure P2P systems, i.e., systems which do not have any central nodes. In pure P2P systems, unlike those with servers, we cannot dictate the behavior of a peer. Free-riding is a serious problem in P2P. Free-riding may be motivated in part by the asymmetric nature of network connections provided by many broadband ISPs: these networks provide relatively low bandwidth for outgoing traffic. However, one case study shows that nearly 90% of peers in Gnutella were either sharing nothing or were sharing files that were never wanted by other users. In other words P2P traffic is entirely concentrated on a few contributors. This suggests that free-riding is not simply the result of a lower outgoing bandwidth. If free riders open their resources, we may increase throughput significantly.

## 2. Related Work:

Levente Buttyan et.al. (2002), [11] in this work, they address the problem of service availability in mobile ad-hoc WANs. They present a secure mechanism to stimulate end users to keep their devices turned on, to refrain from overloading the network, and to thwart tampering aimed at converting the device into a "selfish" one. Our solution is based on the application of a tamper resistant security module in each device and cryptographic protection of messages. In this work, they addressed the problem of service availability in terminode networks (mobile ad-hoc WANs). We have presented a secure mechanism to stimulate end users to keep their terminodes turned on, to refrain from overloading the network, and to thwart tampering aimed at converting the device into a "selfish" one.

Bram Cohen (2003), [12] they work on the Bit Torrent file distribution system uses tit for tat as a method of seeking pareto efficiency. It achieves a higher level of robustness and resource utilization than any currently known cooperative technique. We explain what Bit Torrent does, and how economic methods are used to achieve that goal.

Miguel Castro et. al. (2003), [9] they worked on tree-based multicast systems, a relatively small number of interior nodes carry the load of forwarding multicast messages. This works well when the interior nodes are highly available, dedicated infrastructure routers but it poses a problem for application-level multicast in peer-to-peer systems. Split Stream addresses this problem by striping the content across a forest of interior-node-disjoint multicast trees that distributes the forwarding load among all participating peers. For example, it is possible to construct efficient Split Stream forests in which each peer contributes only as much forwarding bandwidth as it receives. Furthermore, with appropriate content encodings, Split Stream is highly robust to failures because a node failure causes the loss of a single stripe on average. We present the design and implementation of Split Stream and show experimental results obtained on an Internet test bed and via large-scale network simulation. The results show that Split Stream distributes the forwarding load among all peers and can accommodate peers with different bandwidth capacities while imposing low overhead for forest construction and maintenance.

Nicolas Christin et.al. (2005), [1] 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 may face. We conclude by outlining some of the open questions this research has raised.

Michal Feldman et.al. (2005), [2] they worked on a wide variety of interactions on the Internet are characterized by the availability of cheap pseudonyms, where users can obtain new identities freely or at a low cost. Due to the availability of cheap pseudonyms, incentive schemes that are based on reward and punishment are vulnerable to the whitewashing attack, where users continuously discard their old identity and acquire a new one to escape the consequences of their bad behavior. In this work, we study the implications of the whitewashing attack from an evolutionary perspective. Not surprisingly, the whitewashing attack degrades the evolutionary stability of strategies that are otherwise stable. In particular, the Tit-for-Tat strategy and its variant, probabilistic TFT, are not stable against whitewashers, unless identity costs are sufficiently large. In addition, we extend the indirect reciprocity model and find that discriminators can defeat whitewashers only if the probability to cooperate with strangers is small enough, which in turn degrades social welfare.

## 3. Methodology:

### 3.1 Performance Measure:

The contribution level, x, is the fraction of users whose generosity (type) exceeds the current contribution cost, 1=x. Thus, the fraction of users who contribute is derived by solving the following xpoint equation:

$$x = \text{Prob}(ti >= 1/x) \qquad (2)$$

To solve this equation, we need to make assumptions about the type distribution. In this section, we consider the following distribution:

- Fraction a of the users: ti~U(0, tm)
- Fraction 1-a/2 of the users: ti = 0
- Fraction 1-a/2 of the users: ti = tm

The parameter a 2 [0; 1] determines the degree of bimodality of the distribution, with a = 0 corresponding to an extreme bimodal distribution and a = 1 corresponding to a uniform distribution. tm is the maximum willingness to contribute resources, and the expected type is always tm=2, independent of the value of a. tm is thus an important parameter of the system, as it reects the societal "generosity" (it is twice the expected type). For a = 1, a user's type is uniformly distributed between 0 and tm. Under a uniform distribution, we derive the fraction of contributors as follows:

$$x=prob(t_i \geq 1/x) = 1-1/xt_m$$

which yields:

$$x1,2 = \frac{tm \pm \sqrt{tm2-4tm}}{2tm}$$

The larger root x1 is the stable equilibrium (attractor, see Figure 1) while x2 is unstable. For tm < 4, there is no intersection between the curves, thus the contribution level becomes 0 and the system collapses. The contribution level varies depending on the type distribution and range (reflected by a and tm) as shown in Figure 2. It increases in tm and converges asymptotically to:

$$Xm=(1+a)/2$$

On the other hand, the contribution level falls to zero when tm falls below the threshold $t_{min}{}^{m}$ , as shown in Figure 3

$$t_m{}^{min}=max(1,(16a)/(1+a)^2 )$$

For a uniform distribution, $t_{min}{}^{m}$ = 4, whereas for the extreme bimodal distribution, $t_{min}{}^{m}$ = 1. This means that when the societal generosity level is low, a bimodal type distribution can better sustain the system than a uniform type distribution. On the other hand, when the societal generosity level is high, a uniform type distribution can realize a higher contribution level and system performance. For analytical tractability, we use the uniform type distribution
in the remainder of this paper. We leave a more thorough analysis of other type distributions for future work.

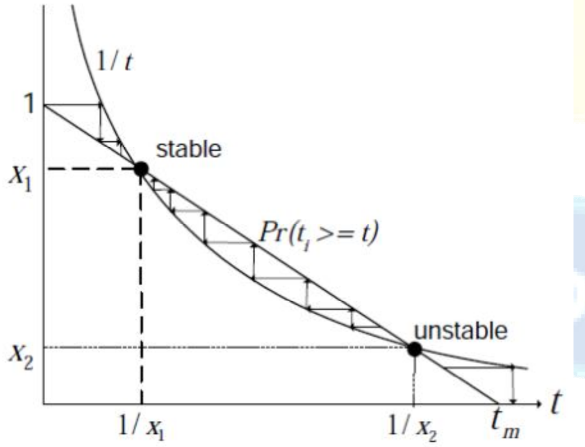



**Fig. 1. The intersection points of the two curves rep resent the two equilibria of the system. The curve x = 1=t represents the contribution cost, and Pr(ti >= t) repre sents the generosity CDF, assuming ti U(0; tm). The higher equilibrium (contribution level x1) is stable.**

**3.2 System Model:**

We model the P2P streaming system as a graph G{s; p1; p2; ...... ; pxh(t); q1; q2; ......; qx(t)g}, where s denotes the streaming server, and pi denotes an honest downloader and xh(t) is the number of honest downloaders in the system at time t, and qj denotes the free rider and xf (t) is the number of free riders at time t. We assume that honest downloaders who have finished downloading the whole buffer size of data become the seeders, and the number of seeders in the system at time t is denoted as y(t). For simplicity, we only consider a strong server homogenous scenario, where the peers are with the same uploading bandwidth up and the server uploading bandwidth us is much larger than peer uploading bandwidth, i.e., us up. We assume that the bandwidth bottleneck exits only at the uploading bandwidth, that is, peer downloading bandwidth cp is greater than the video streaming rate r, i.e., cp > r. We model the arrival process of the new honest downloader and free rider as a Poisson process with arrival rate h and f , respectively. The parameter is used to indicate the utilization efficiency of peer uploading bandwidth, and it is obvious that the utilization efficiency of free riders is 0. At time t, the total uploading bandwidth of the system is upxh(t) + upy(t) + us. The notations and parameters used in our model are summarized in Table I. As discussed before, we take BitTorrent's Tit-for-Tat mechanism as basic incentive mechanism in our model. In the Tit-for-Tat mechanism, an honest downloader simultaneously uploads to neighbors from which it has the highest downloading rate, and also uploads to another downloader regardless its downloading rate by optimistic unchoking to find better neighbors and bootstrap the newcomers. In this way, a free rider can obtain up
+1 downloading rate from an honest downloader. Based on the analysis in [4], the total expected downloading rate that free riders in G can obtain from the honest downloaders is

$$E\{D(t)\}= \frac{1}{\mu+1} \cdot \frac{\mu pxh(t)xf(t)}{xh(t)+xf(t)}$$

Let (t) be the ratio of the total expected downloading rate of free riders from the honest downloaders to the total uploading rate of honest downloaders at time t, we have

$$\rho(t) = \frac{E[D(t)]}{\mu pxh(t)} = \frac{1}{\mu+1} \cdot \frac{xf(t)}{xh(t)+xf(t)} \qquad (1)$$

In the Tit-for-Tat incentive mechanism, the server or the seeder uniformly assigns its bandwidth to every peer no matter if it is the free rider or not. Hence the server or the seeder
uploading bandwidth assignment criterion for free riders is

$$k(t) = \frac{xf(t)}{xh(t)+xf(t)} \qquad (2)$$

Therefore, the total downloading rate of free riders is (t)upxh(t)+(t)(upy(t)+us), and the total downloading rate of honest peers is (1(t))upxh(t)+(1(t))(upy(t)+ us). As the total downloading rate of honest peers and free riders cannot exceed cpxh(t) and cpxf (t), respectively, we represent the total downloading rate of free riders Df (t) and honest downloaders Dh(t) as

$$D_f(t) = \min\{c_p x_f(t), \rho(t)\eta u_p x_h(t) + k(t)(u_p y(t) + u_s)\}$$

$$D_h(t) = \min\{c_p x_h(t), (1- \rho(t)\eta u_p x_h(t) + (1-k(t))(u_p y(t) + u_s)\} \quad (3)$$

In our model, we assume that the streaming server never leaves the system which is realistic because all the peers cannot obtain new video data packets once the streaming server leaves the system, and that the downloaders and the seeders leave the system with random abort rate and respectively. Fig. 2 shows the transition model of three states in P2P streaming system. Therefore, the transition rate of the numbers of honest downloaders, free riders and seeders is

$$dxh(t)/dt = \lambda_h - D_h(t) - \theta_{xh}(t)$$

$$dxf(t)/dt = \lambda_f - Df(t) - \theta_{xf}(t)$$

$$dy(t)/dt = D_h(t) - \Upsilon_y(t) \quad (4)$$

**4 Simulation Results:**

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.2) 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.

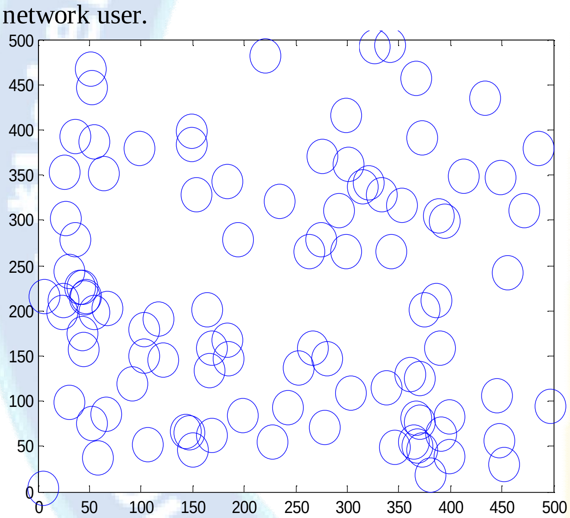


**Fig. 2.Network with distributed unknown user nodes.**

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 .3) where we can seen that 24,17,14,…… are the yellow circles representing 30 honest downloaders, using the peer to peer network, with the change in time as some of the downloaders finished the downloading will leave the network and work as 'seeders' and some new users is also added in the network.

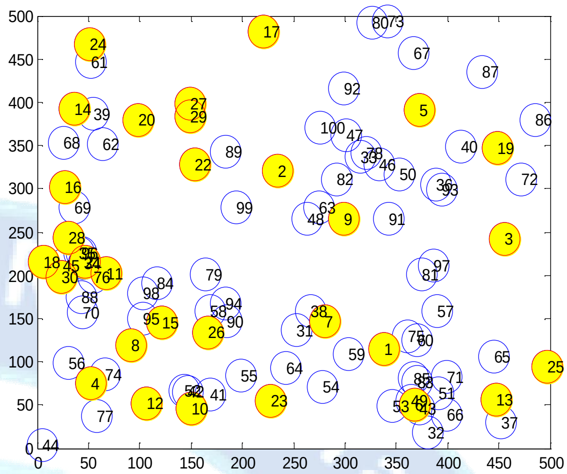


**Fig. 3.Active Honest Users in network shown as yellow circle.**

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 4ehaviour , 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:**

seedrer id honest:17 14

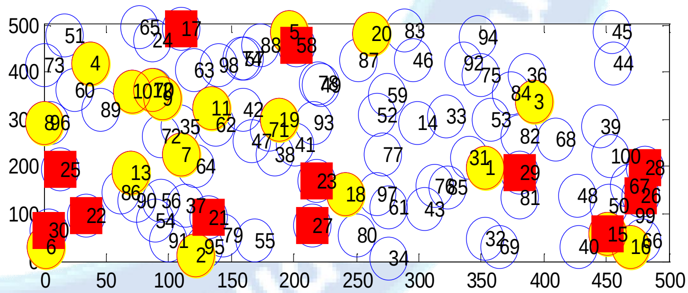
None of the user has been free riding for a long time

seederidf = 4

free rider left: 4

new honest user id;

new free reiders id: 58 17 15



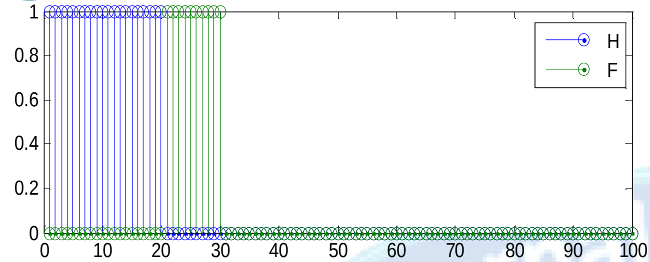



**Fig. 4.Honest user as yellow circle and free rider as red square at an arbitrary time slot(top).Number of times user entered as honest(H) or as free reider(F) out of total 100 user without penality mechanism(bottom).**

**Penality:**

None of the user has been free riding for a long time
None of the user has been reported as malicious free rider
seedrer id honest:
free rider left: 10   1  10
new honest user id;
new free reiders id: 79  54  89

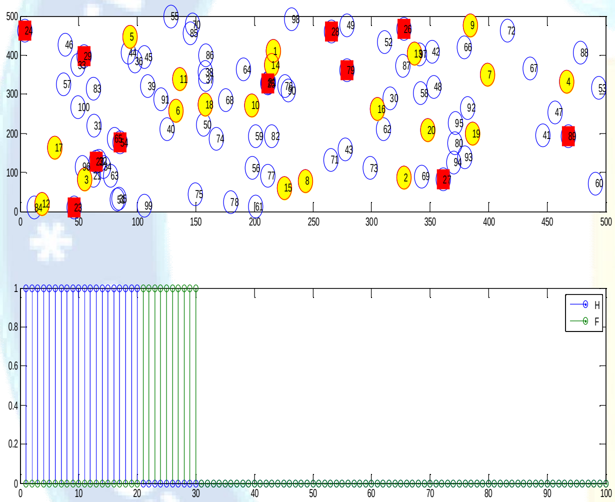


**Fig. 5. Honest user as yellow circle and free rider as red square at an arbitrary time slot(top).Number of times user entered as honest(H) or as free reider(F) out of total 100 user with penality mechanism(bottom).**

## 5. Conclusion:

In this work we have develop a matlab 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 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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