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Impact of Free-Riders in Peer-to-Peer Systems

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Abstract

The fame of Peer-to-peer (p2p) systems was mainly centered on the importance of the distribution of a huge file to various nodes, since they proffer a less expensive alternative to customary client-server based distribution. Since p2p is self-organizing, the greatest advantage of a P2P environment is scalability. With such great advantages, p2p systems face a major risk that can cause their collapse. Free-riding is the chief concern relating to p2p systems. The free-riding peers also recognized as free-riders act selfishly because they merely desire to download files but are not willing to upload to other peers in return. Bit-Torrent, that is the utmost popular p2p system over the previous years, gives incentives for peers to upload by enforcing a tit-for-tat strategy. This strategy enables peers that upload chunks, to receive better download speeds in return. Though it is agreed that free riding is unwanted, it is not researched in detail how the quantity of free-riders affect a p2p system, especially regarding download times and peer load. This paper deliberates free riding by gazing at its impact over the lens of a simulator. Content distribution in a P2P network focuses mainly on large systems consisting of hundreds, thousands, or even millions of nodes hence making simulation the only choice of studying them.

Key Words: Peer-to-peer, free-riders, content distribution.

1. Introduction

Seventy percent of the recent internet traffic is attributed to file sharing in p2p systems [11, 27], such systems are general among several users. Examples of the content shared on these networks include: movies, music, pictures, books in the type of PDFs and documents with various software. In any given file sharing network, nodes join this network and offer their resources for download to other nodes. Additional users can only query for files utilizing keywords and then download the files which are offered on the system. Some common instances of popular applications for file sharing include: Napster, eDonkey [9] and Gnutella2 [14]. Although the main use for such networks in the recent times has been copyright infringing sharing of files, newer systems have also fully legal uses.

One among the systems new in the area of P2P distribution of content is BitTorrent [6]. With respect to file sharing systems, one network is built for every file which is shared in content distribution systems. Nodes joining this particular network are fascinated in one file, and if any node desires to download two diverse files, then this node basically have to join two different networks. One other difference betwixt content distribution and file sharing is that file sharing system users search for the file they are interested in, while in content distribution networks each network is exclusively associated with exactly one file. Content distribution using P2P systems is extensively utilized for the software distribution i.e. Linux [15] and patches [28].

Content distribution in P2P systems has authenticated to be an efficacious way of sharing huge files with numerous users [8, 13, 30]. Research has focused mainly on how files can be shared effectively in a P2P environment of content distribution [3, 5, 10, 18, 19, 24, 26]. The commonest approach is modeling the system analytically using several simple simulations or by mainly simplifying assumptions. Despite the mentioned studies having their own advantages, the world at large would benefit greatly from a joined evaluation framework, so as to allow an objective difference of algorithms and ideas. With the rising need for very large evaluations, a considerable effort is needed to set up test systems in the real world. With this, simulations appear to be our only best option for the work stated above.

All P2P systems have to tackle free-riding as a problem. Peers that are free-riding act selfishly because they only desire to download files, but are not willing to upload in return. If all peers behaved in this manner, the whole notion of P2P would not work. Bit-Torrent addresses this problem by giving incentives for peers to upload to all the other peers by enforcing a tit-for-tat strategy. That means peers are motivated to upload to the peers they desire to download from, because doing so will give them with better download speeds in return.

It has been researched, that merely a small fraction of peers provides the bulk of files. Thus, a great fraction of peers stands as the free-riders. But how does the quantity of free-riders affect a P2P system? When is it going to have a big influence? A simulator is presented here that is particularly designed for simulating a P2P content distribution system. There are some other P2P simulators for instance [22,23] in existence, which do not conform to the content distribution specifics of P2P. This is credited to the fact that they endeavor to model overlay networks but when it comes to the distribution of content in P2P the details of the network are basically irrelevant. It is thus important that a new distribution strategy be added alongside node selection strategies among others.

2. The Free-Rider Problem

One among the features of the technology is the fact that clients are not monitored. Once the clients are not monitored they do not feel controlled by some central authority. Therefore users of p2p clients have some sort of feeling of freedom to do whatever they wish. Statistics are not maintained therefore they can never be traced. As a consequence, when the user community gets large, the users stop uploading and sharing of files and start to download files only. Think about this logically, why do persons pay for services or goods? This is simply on account of the fact that they have to. The goods along with the people are controlled in a store. When a consumer exit the shopping store with a product without making payment for it, the security alarm goes off.

How then do people pay inside the framework of P2P networks? The download of a file creates a certain kind of benefit for the consumer. Alternatively, the uploading and sharing of files create certain costs for the client. The simple fact is that not every user bears those costs. When it is possible to exit the shop with a product without making payment paying for it, many people if not everyone will do that. When users are provided with a choice whether to bear costs or not, people tend to reap profits without sharing or uploading files. They are not controlled or monitored and as well have the freedom to do what they like. This situation is mentioned to as the social dilemma.

The dilemma for each individual is whether to give to the common good or else to avoid along with the free ride on the effort of others. Owing to the simple fact that it is rational for every individual to get the most out of its utility, the danger exists that the system's performance can degrade considerably. Therefore everybody will be worse off .

Let's consider a given network with a group of peers (G) that possesses the same uploading bandwidth which is denoted as α. Take the number of peers in a particular group (G) to be N .let us now presume that every peer has $n\alpha$ uploads. When another peer j with zero (0) uploading bandwidth joins the network, another peer $i \varepsilon G$ will randomly choose a peer which is not currently uploading to as the target. Peer i on average $1/N - n\alpha$ of the time, it will upload to peer j optimistically. As there are a total of N peers in G, the total average downloading rate of peer j will be as follows when N is large.

$$1/N - n\alpha, \alpha / n\alpha + 1 \approx \alpha / n\alpha + 1 \tag{1}$$

A shown above one can perceive that peer j contributes nothing to the system but it still gets an average downloading rate of $\alpha / n\alpha + 1$. In this developed simulator, $n\alpha = 4$ and so a free rider acquires 20% of the possible maximum downloading rate.

3. Collected Data

The simulator will collect several sorts of data before, amid the simulation and also after the simulation. The primary configuration should be saved afore simulation and also the succeeding items is part of it: list of the entire nodes and their attributes, list of the complete file types, a full list of the entire files in the system and a list of nodes and also the initial copies of files placed on them.

In the progression of the simulation, logs of each block are transferred by noting the time when the block started and completed, and the identities of the receiving and sending nodes. For each completed file download, the starts and also end times are noted with a node that downloaded the file and also the file identifier. Additional records are also documented as per a node going offline and errors. Errors in this instance mean that nodes wanted to download a block but the block was not available on any node that is now online. This simulator can be extended by letting the peers return online after going offline which would help in the resolution of such errors.

Once the simulation is ended, the simulator will write a list of the entire nodes with the files they possess. By performing a comparison of this list with that given at the start, we can determine which nodes have downloaded which files.

A window with progress information and statistics is displayed once the simulator is begun from the graphical interface as displayed in Figure 1. The advancement of the simulation is displayed here both as a percentage and as an estimated time to finish the simulation. Graphical views of how many block transfers are going on in the system at a given time, how many file downloads are active and how many downloads are incomplete are also displayed here. This interface also provides the ability to set the update frequency of the display and a pausing and resuming button to the simulation.

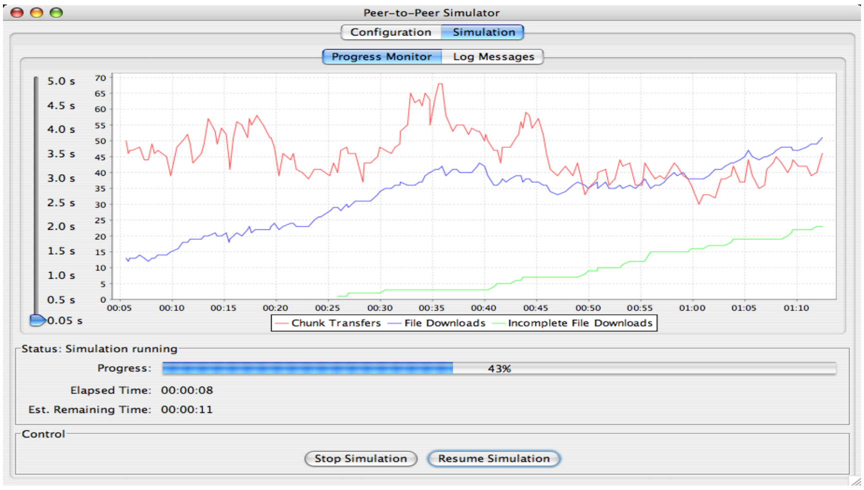

Figure 1: Simulation Control

Before the Simulation

After the objects and data structures are created, which are needed for the simulation, their relevant contents for later analysis are written to several log files.

PrefixGroupList.csv lists all peer groups by their attributes. Example:

```
#GroupID,Name,Members,Freeriders,DisconnectAfterDownloadProbability
    ,Upstream,Downstream,MaxUploads,MaxDownloads
2,Modem␣User,0020,0005,0.80,0048,0056,02,02
```

PrefixTypeList.csv lists entire file types by their attributes. Example:

```
#TypeID,Name,NumberOfFiles,NumberOfCopies,ChunkSize,ChunkCount
2,MP3␣File,0070,03,0512,00003
```

PrefixFileList.csv lists all created files by their ID and the corresponding ID of their type. The extent of chunks, the file encompasses of, is also contained. Example:

```
#FileID,TypeID,Chunks
0051,2,00153-00155
```

PrefixPeerListBefore.csv lists all created peers by their ID and also the corresponding ID of their group. It contains whether or not the peer is a free-rider and a list of the entire files (separated by a colon) the peer provides for upload when the simulation starts.

Example:

```
#PeerID,GroupID,Freerider,Files
0014,2,false,0013:0016:0028:0063
0015,2,true,
```

During the Simulation

During the simulation, all completed chunk and file transfers along with miscellaneous events are logged. The first value of each log file is the simulation time in milliseconds when the event did happen. The log files prefixChunks.csv and prefixFiles.csv are the most notable ones, as they are the basis for later analysis (e.g. download times, peer load).

PrefixChunks.csv lists all completed chunk transfers. Example:

```
#EndTime,StartTime,SenderPeerID,ReceiverPeerID,ChunkID
0001294394,0001169229,0022,0028,00478
```

PrefixFiles.csv lists all completed file transfers. Example:

```
#EndTime,StartTime,PeerID,FileID
0000239429,0000020000,0003,0067
```

PrefixMisc.csv lists all miscellaneous events. Example:

```
#Time,Event,Info
0000298667,OFFLINE,Peer=0067
0000564000,CHUNK␣UNAVAILABLE,Peer=0052␣Chunk=00280
```

After the Simulation

PrefixPeerListAfter**.csv** has the same format as prefixPeerListBefore.csv. It encloses the list of the complete peers and also the file distribution after the simulation. Example:

```
#PeerID,GroupID,Freerider,Files
0014,2,false,0013:0016:0028:0063:0417:2271:0824:2517
0015,2,true,0787:1212:2531
```

4. Effects of Free Riding in P2P Systems

Few of the utmost familiar p2p applications, for instance, Bit-Torrent, Napster and Gnutella posses' incentive mechanisms that handle the free riding issue but this problem however still poses a great risk to the survival of p2p systems. Pertaining to the influence of free riders, these counts on the network since it differs on every network. This problem can prompt the entire system being incapacitated counting on the networks [25]. A glance at [29], it is researched that free riding tempers with the robustness of p2p networks. The authors further state that a network without a measure to manage the free riders will not survive the test of time. This conclusion is supported in [20], where it is debated that if the degree of free riding exceeds the profits of contribution, the system can be fetched to a standstill.

Further, a report in [21] states that if the problem of free riding is not assessed, the p2p system is most probably to die leading to it functioning as a client/server system. A networks performance becomes poor as the number of free riders keeps increasing; this is owing to the increase in traffic generated by free riders to the networks. In [17], authors argue that without external inducement the level of contribution might be below the socially desirable optimum. This is to say that p2p networks can keep up with a level of free riding due to the unselfishness of some peers. In conclusion, the free riding effect in p2p networks cannot be overlooked as its evident in related research which in summary can be stated as: performance degradation [31], which increases system stress, denial of service [32, 33], degrades scalability [34, 35], and destroys the entire concept in the working of p2p file sharing networks [36].

5. Incentive Mechanisms to Reduce Free Riders in P2P Systems

In [12], a peer incentive mechanism designed and built to minimize free riding in a decentralized system. It's termed CoDiP2P platform [5, 16]. This platform's incentive mechanism applies a nonnegative credit function to prevent ID change cheating with a historic term utilized to differentiate betwixt newcomers and old collaborative peers. Reinvestment of the credits attained by the local proprietor of the zones, termed area "manager", augments system throughput extremely, this being the chief contribution of this work. An enhanced throughput is attained owing to reinvesting and discouraging free-riding through the credit like mechanism.

The paper [7] proposes an incentive mechanism centered on relative probability to effectively limit the gain of free riders. Factors that decide how a peer would be treated when it sends a download request are based on not just the historical record of the peer, but also the competitor. Here a peer can send several requests at a period with limited out connections. The ratio of a peer being served is controlled by all the competitors but not a single peer that will make incentive mechanism more robust.

In Here [4], work on semi distributed p2p network is researched. A query request is transmitted only to a super node which dispatches the query request to a suitable leaf node. prior to a node is selected in a p2p network, it first has to sort out the threshold of a common node and get an alternative super node. The threshold is sorted as per a peer's computing ability, trust degree, bandwidth, and the number of neighboring nodes. Selection is grounded upon overall trust degree of a node that is the weighted average values of directed trust and also the recommendation trust degree.

- Direct Trust: If a peer has a record of a trusted transaction of another peer is known as direct trust.
- Trust degree is calculated by the reward and penalty.
- Reward: If peer has a trusted transaction then it will be rewarded.
- Penalty: If peer has an untrusted transaction then it will have a penalty.

In [1], authors propose a free riding filtering algorithm. This algorithm identifies and also isolates free riders. Every peer upholds a black list in this algorithm. Every time a source peer interacts with a trustworthy target peer, two things can occur. One is that if the target peer stands trustworthy, the source peer globally posts an appraisal. This global posting can be effortlessly established in structured P2P infrastructures such as P-Grid [2] and the information is kept by a third-party peer, e.g., the storage peer. Two is that, if the target peer stands untrustworthy, the source peer will not post anything into the global list but it will mark the untrustworthy peer on its blacklist. Put differently, a source peer can evaluate but it cannot complain. Using its black list, a source peer will not interact with a black listed target peer. The algorithm uses an activity set model to screen the activeness of each peer. By activeness, this denotes the trustworthy contribution of a peer.

6. Conclusion

It is clear that free riding in p2p systems exists and research shows some significant results. Free riding has some mentioned consequences and potential pitfalls. But still, p2p systems are not killed by the phenomenon of free riding. Still, many systems are online and work properly. When contribution to the network is distributed more equally among peers the systems have enormous potentials. Generating incentives to contribute is the main issue. Especially with the attacks of certain instances on the networks lately, it will be difficult to maintain the systems in the upcoming years. Most of the systems namely are utilized to transfer illegal files. The development of the sharing of illegal content is something which has to be scrutinized meticulously in the upcoming years. Namely systems without valuable content are useless. The fact that p2p is mostly related to illegality is a shame. The notion of p2p has so many opportunities. To convince companies to get into p2p is a challenge for the future.

The simulator presented here accomplishes the purpose it was designed for. The impact of the number of free riders on the other peers especially concerning the download times can be analyzed from the collected data. Other parameters can likewise be simulated such as block and peer selection strategies. In summary, this simulator is intended as a tool to research the influence of various options, especially the number of free riders, on p2p systems. Prospective developers have the chance to change and also expand its functionality.

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