Paper

An Incentives Model Based on Reputation for P2P Systems

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Abstract—In this paper an incentive model to improve the collaboration in peer-to-peer networks is introduced. The proposed solution uses an incentives model associated with reputation issues as a way to improve the performance of a P2P system. The reputation of the all peers in the system is based on their donated resources and on their behavior. Supplying peers use these rules as a way to assign its outgoing bandwidth to the requesting peers during a content distribution. Each peer can build its best paths by using a best-neighbor policy within its neighborhood. A peer can use its best paths to obtain best services related to content search or download. The obtained results show that proposed scheme insulates the misbehaving peers and reduces the free-riding so that the systems performance is maximized.

Keywords—content distribution, incentive model, reputation, peer-to-peer networks.

1. Introduction

During the last years, content delivery over the Internet has gained significant popularity. Applications such as TV over IP, streaming and multimedia live streaming are examples of content distribution from one-source to multiple receiver-nodes. On the other hand, peer-to-peer (P2P) networks have attracted the attention from the research community who find in these systems a fast and efficient way to deliver movies, music or software files. A P2P communication infrastructure is formed by a group of nodes located in a physical network. These nodes build a network abstraction on top of the physical network, known as an overlay network, which is independent of the underlying physical network with regard to the P2P procedures. An important advantage of P2P systems is that all available resources are provided by the peers. In a P2P system each peer can take the role of both, a server and of a client at the same time. During content distribution, peers contribute their resources to relay the content to others. Thus, as a new peer arrives to the P2P system the demand is increased, but the overall capacity too. This is not possible in a client-server model with a fixed number of servers.

A challenge in peer-to-peer media streaming systems is how to select good peers in order to realize high quality streaming sessions. The selection of good peers can offer a manner to improve the quality of service via an optimal search or an efficient content delivery. However, this goal is difficult to be achieved because P2P systems can be affected by misbehaving peers and free-riding, which reduce the system performance. Reputation management systems have been proposed as promise methods to alleviate this problem [1]–[3]. A reputation management system allows individual peers to rate one to each other according to their past experience with each other. Reputation systems are proposed in [1], [4]–[6] with the purpose to ensure that peers obtain reliable information about the quality of the resources they are receiving.

On the other hand, locate a provider node does not guarantee that the service provided by it will satisfy user demands [7]. This is because some misbehaving peers may offer false information in order to maintain a cooperation impression. To minimize the effects of misbehaving peers, they must be detected and isolated from the system. In this paper an incentives model associated with a reputation scheme to reduce the negative impact of these peers in a P2P system is proposed. In a reputation management system, each peer can realize an optimal peer selection from which download a specific content. The goal in this work is to examine how incentives and reputation affect the performance of a P2P network. To reach this goal, both characteristics in order to obtain the following benefits is mixed. First, peers with high reputation can cooperate to realize an optimal search or a better content delivery. Second, an incentives-system can encourage the collaboration and exchange of data between peers [8], [9]. Finally, the isolation of misbehaving or non-cooperative peers can avoid the degradation of the system performance. In this way, the number of corrupted file downloads from malicious peers on the P2P network could be minimized, the number of cooperative peers increased and the number of success downloads improved. The author motivation to implement incentives and reputation issues on a P2P network are the following:

- selection of good peers could improve the content delivery services,
- simulate a P2P system that allows a fair distribution of the available resources in the networks,
- provide different access polices to the system resources,
- increase level of cooperation to provide high quality streaming to users in a large system,
- empirical validation of the effectiveness of our approach in a P2P network.

The rest of this paper is organized as follows. Section 2 gives a background about this work. The incentive and reputation schemes are introduced in Section 3. Then, the evaluation of proposed system and its results are described and discussed in Section 4. Section 5 concludes the paper.

2. Background

2.1. Media Content Delivery

Today, we witness an exponential rise in the number of Internet users. Many of these users generate contents that are accessed by other users interested in them. Multimedia contents has already become the most popular content to be distributed over Internet. This is due to the fact that multimedia contents are currently generated by a high number of applications such as videoconferencing, media broadcasting, e-learning, video streaming, etc.

Media can be transmitted in two different modes: download an streaming. In the download mode, the users have to download the entire media file before playing it. However, the media files generally are very large which require long transfer times and large storage capacities. The download mode requires patience from the users, who have to wait until the entire video has been downloaded before it can be viewed. Download also offers reduced flexibility, because the users must download the entire video before deciding if it is the wanted one [10]. In contrast, in the media streaming mode, the receiver can already consume the media file while part of it is being received and decoded. In others words, media streaming reduces the delay between the start of delivery and the beginning of playback at the viewer, and its requirements of storage are low, because only a small portion of the video needs to be stored by the viewer during media streaming. However, video streaming is sensitive to the delay [11], because the packets must arrive at the receiver before their play-out deadlines.

Media delivery can be realized using different communication techniques such as as: unicast, broadcast and multicast. Unicast represents a common communication form between two entities. Unicast communication also is known as point-to-point or one-to-one communication. Unicast communication can be simplex, half-duplex or duplex. Telephone conversations and video streaming over the Internet [12] are typical unicast examples. Broadcast means that the information emitted from a source will be received by all the other devices connected at the same network. Broadcast probably represents the most popular communication scheme due to its wide usage in broadcast television. Multicast is similar to broadcast except that the information emitted from a source is only received by a specific group of nodes in the network, which is called a multicast group. Multicast is an alternative to unicast that reduces the network traffic and optimizes the server resources. Multicast is a one-to-many communication scheme, while broadcast is an one-to-all communication. Videoconferencing is a multicast example, where a predefined group of devices/computers are involved to receive the same content.

2.2. P2P Content Delivery Topologies

The two most important types of technological solutions that have been proposed for content delivery on the Internet are Content-Delivery Networks (CDN) and Peer-to-peer (P2P) networks. A CDN is formed by content servers networked together across the Internet, which cooperate with each other to transparently distribute content to end-users. Typically, the content servers are located near the users, in order to be able to serve the requested content rapidly [13]. However, the CDN approach faces a number of problems such as single point of failure and costly access to high rate networks. In [14] is presented an extensive discussion about CDN. On the other hand, P2P networks has emerged as a promising infrastructure to the distribution of large-sized media content to a large population [15]. A P2P communication infrastructure is formed by a group of nodes located in a physical network. These nodes build a network abstraction on top of the physical network known as an overlay network, which is independent of the underlying physical network. The overlay network is established by each P2P system through TCP or HTTP connections. Due to the abstraction layer TCP protocol stack, the physical connections are not reflected by the overlay network [10]. Based on how the nodes in the overlay structure are connected to each other, P2P systems are classified mainly into two categories: unstructured and structured. Unstructured P2P systems can be further divided in [16]: centralized, pure and hybrid. Kademlia [17] is an example of pure P2P systems, while BitTorrent [18] is an example of hybrid P2P systems. Figure 1 shows this classification.

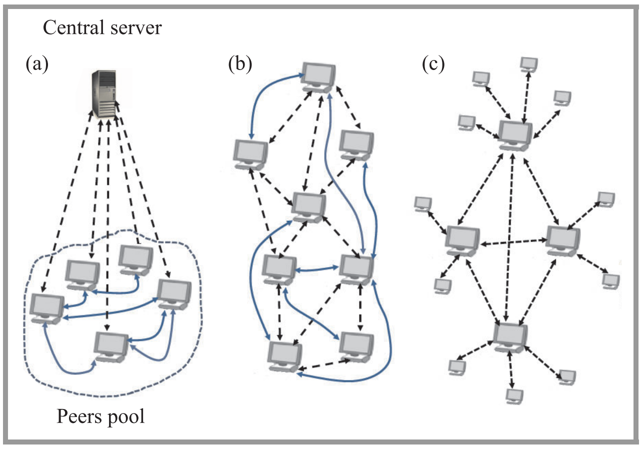

Fig. 1. A comparison among the different unstructured P2P architectures: (a) centralized, (b) pure, (c) hybrid.

Content delivery over P2P networks can be realized using three different schemes: tree-based, forest-based and mesh-based. These schemes are illustrated in Fig. 2. In a tree-based system, participating peers are organized in a hierarchical way in which source node is located at the root. The rest of peers are organized as interior nodes or leaf nodes into a single tree. Leaf nodes don't need to forward the receive packets [19]. In Fig. 1a, the source S sends the data to requesting peer R_1, which forwards the data to requesting peers R_2 and R_3. Then, a packet in this configuration is basically pushed from a parent node to their children node along a well-defined route. Thus, in Fig. 1a the upload capacity of peer R_1 is used by the multicast tree for content distribution, while the upload capacity of the leaf peers R_2 and R_3 is not used. Main drawback in a tree-based scheme is because all the burden generated by forwarding multicast messages is carried out by a relative small number of interior nodes.

Cooperation plays an important role in the P2P systems. However, content delivery based on a single tree does not match well for cooperative environments, because the forwarding multicast traffic is carried by a small number of interior peers, while the upload capacities of a large number of leaf peers is not used. To face these challenges, a forest-based overlay architecture for content delivery has been proposed. A forest-based overlay organizes participating peers into multiple trees [20], and distributes the forwarding load among them in an efficient manner. An example of a forest-based system is shown in Fig. 2b. Here, source S stripes its content and distributes the stripes using two separate trees T_1 and T_2. Each internal node in each distribution tree forwards any received stripe to all of their child nodes. However, the determination of the number of required trees to maximize the overall throughput of the system is a hard task.

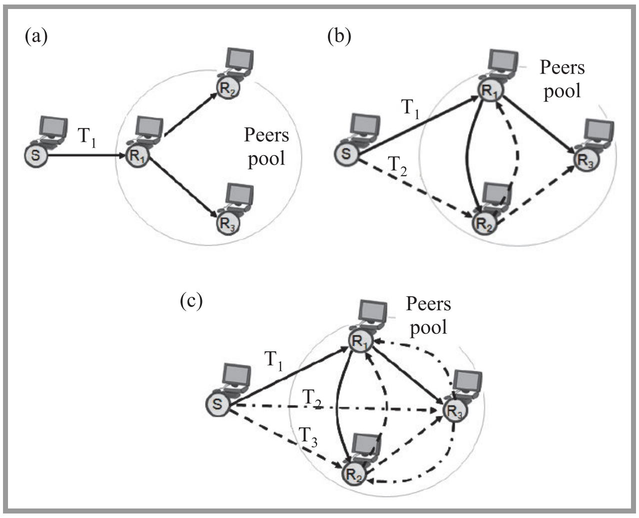

Fig. 2. P2P streaming delivery schemes: (a) tree-based overlay, (b) forest-based overlay, (c) mesh-based overlay.

Limitations of the forest-based systems have led to the emergence of a new approach called mesh-based systems. This type of P2P systems are formed by peers, which are interconnected via random connections. In this scheme each peer (except the source) tries to maintain a certain number of parent peers and also serves a specific number of child peers using a swarming mechanism for content delivery [21]. A mesh-based scheme is shown in Fig. 2c. In a mesh-based P2P topology, a peer can concurrently receive data from different sources, and send the received data to other requesting peers. Although mesh-based P2P systems are less vulnerable to network dynamic [13], they introduce long latency in media playback mainly due to periodic exchanges of buffer maps and transmission of data request.

2.3. Why Do We Need Reputation Management?

P2P networks are liable to be invaded by the malicious peer, this is due to the fact that any peer can join the network at any time to share or use any type of file. These malicious peers are computers that share inauthentic files or give false information about their resources (CPU, memory available, bandwidth, etc.). Examples of inauthentic files include corrupted files, virus-infected files or spam [22]. In order to minimize the effects of malicious peers on a P2P network, there is a need to isolate these peers from peers with good behavior who are sharing authentic files, which are high-quality, virus-free files. In addition, peers should be informed about the best sources from which download files. This information needs to have a way to be propagated through network so that all peers have a wide view of the reputations of all other peers in the network. In a P2P network with a reputation management system, each peer will be better able to make good decisions about which other peers are available to download files, thus minimizing the number of files downloaded from malicious peers on the network and increase the number of successful downloads.

2.4. Why Do We Need an Incentives Mechanism?

Most P2P systems are based on cooperation among interested users [19]. However, cooperation consumes user's resources and may degrade their performance, which could generate disincentives for cooperating in the users. As a result, each user's attempt to maximize its own utility effectively lowers the overall performance of the system. To avoid this scenario, there is a need to introduce incentives for the cooperation. To maintain satisfied peers in the system, the proposed strategy of upload allocation is to make that each peer's download rate be proportional to its upload rate (parity download/upload). The author used the reputation generosity rings to translate this approach in an incentive way to proposed model. To verify data integrity, there are many techniques, such as SHA1, which hashes all the pieces included in the file, and peers don't report that they have a piece until they have checked the hash. Selection of good choking algorithms in order to utilize all available resources, provide reasonably consistent download rates for all peers.

3. Related Work

P2P systems based on reputation have been proposed in several works [1], [2], [4], [5], [7]. In most of these

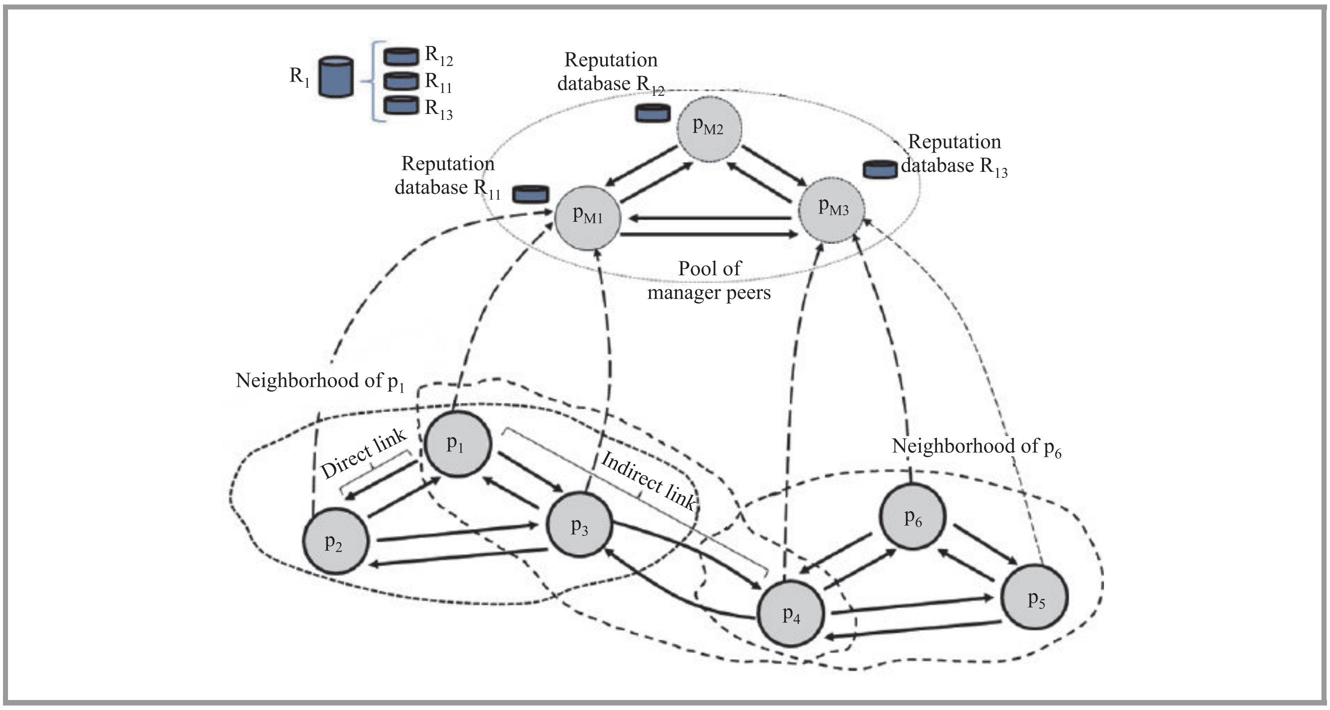

Fig. 3. The proposed reputation architecture with participating peers, neighborhood and pool of managers peers.

proposals, each node is associated with a reputation established based on the feedbacks from others that it has made transactions with. The reputation information helps users to identify and avoid malicious nodes [23]. On the other hand, independent mechanism or systems associated with reputation have been proposed in some recent works [23]–[29]. Authors in [24] show that a rank-based incentive mechanism achieves cooperation through service differentiation. In this framework, the contribution of a user is converted into a score, then the score is mapped into a rank, and the rank provides flexibility in the peer selection that determines the quality of a streaming session. The incentives mechanism reduces the data redundancy required during a streaming session to tolerate packet loss [24]. Without the incentive mechanism, it is required to send more redundant data to achieve the same QoS that the incentive mechanism can provided. In [25] is proposed a wage-based incentive mechanism for enforcing truthful report in self-interested P2P networks. Additionally, authors propose a set of incentive compatibility constraint rules including participation constraints and self-selection constraints. Incentive schemes have been used in the P2P systems to reduce free-riders and to encourage cooperative behavior in [27]. Transactions of a distributed P2P file-sharing system are modeled in [26], using feedback based on transaction outcomes and reputation issues, to encourage cooperation among peers. In [23] Zhan *et al*. propose a distributed incentive scheme called MARCH, which associates money and reputation parameters to each peer. In this scheme, peers can increase their reputation level by exchanging money for service. Since it is a scheme based on a business model, a central authority is used to settle disputes between peers when services offered by a peer are not satisfactory. Based on this rule peers can be classified as honest, selfish and malicious.

This paper presents an incentive model on P2P networks that isolates misbehaving peers. The goal is that by isolating these peers the system performance can be improved. Having peers with high reputation can cooperate to make an optimal search or a better content delivery. An incentive scheme can also help in collaboration and exchange of data between peers. Author evaluates proposed protocol in two different P2P infrastructures, which are Kademlia and BiTorrent. Kademlia [17] is a distributed hash table protocol designed for decentralized P2P networks, while BitTorrent is a hybrid P2P system based on super-peer.

4. System Overview

To introduce proposed incentives and reputation scheme, an overlay network is considered, which is formed by collaborating peers and free-riding peers. The proposed model introduces a special peer called manager peer, which manages the reputation of all peers in the system. Manager peer considers that each peer has reputation information of its neighbor-peers only. This reputation score is stored in a local table by each peer. Each peer exchanges its local table with any others peers located in its neighborhood, which is formed by 2 hops away. A peers establishes direct links with peers to be reached in one just hop. Contrary, indirect links are established if the number of hops between two peers is two. Figure 3 shows this scenario. The proposed model consists of two parts: reputation scheme and incentives scheme.

4.1. Reputation Scheme

Proposed reputation model considers that all peers contribute with their resources to the system. Two components to obtain the average reputation-score in each peer are used, which are its shared resources and its behavior in the system. Shared resources by a peer is used to define its reputation based on resources (RBR), while the behavior reputation is defined by the peer's behavior. In this work, the resources to be shared by each participating peer in the systems are: upload capacity, processing capacity, memory, storage capacity and number of shared files. Thus, reputation based on resources (RBR) can be computed as:

$$RBR = X_i(CPU) + X_i(HD) + X_i(BW) + X_i(SF)\,, \qquad (1)$$

where: CPU = donated CPU capacity, HD = donated hard disk capacity, BW = donated bandwidth capacity, SF = shared files, and

$$\sum_{i=1}^{4}(X_i) = 1\,.$$

The weight X_i for each donated resources are fixed by the manager peers in the system. X_i can be variable and different for each resource.
The behavior reputation is the second component to be evaluated. This value is based on the peer's behavior in a cooperation environment, from a cheating level to a transient level. The cheating level is assigned when a peer supplies a wrong content or when its donated resources do not match to promised resources. The transient level in a peer is determined by the average time that this peer remains in the system (service-time) and by the average time that it takes to return to the system after it has left. Users are satisfied when they received content from peers with abundant resources and good behavior. In the other hand, users have a bad experience when the participating peers offer low bandwidth, high error-rates, limited processing resources, or frequent disconnections. Each component in the reputation scheme contributes with its weight in the final score.
Initially, the reputation score of a peer is based on its donated resources only. After several rounds, if this peer is still available, stable and it does not cheat, then the behavior reputation score is increased in this peer. Otherwise this score is decreased. Behavior reputation evaluation considers that a transaction realized by any peer can be either, performed correctly or not. Chosen behavior reputation scheme is inspired by a reputation scheme introduced in [30]. Peers interact using a reputation approach.
A complaint message is evaluated in every peer and in the manager peer. Using this information, each peer builds a reputation matrix with information from its neighborhood or from the network. Each peer computes the reputation of another peer by evaluating to its neighbors. In general, this reputation is usually based on an aggregate of the feedback ratings issued by the diverse peers [2]. When a peer interacts with another peer, it may rate the transaction as satisfactory (+1) or unsatisfactory (–1). A transaction is satisfactory if the retrieval process requested by a peer is realized successful. In contrast, a transaction is unsatisfactory if the requested file is not authentic, promised resources are false or the download process is often interrupted. In this case, a peer is cheating and its reputation score must be penalized. A peer records the reputation score in the reputation matrix, as a local table, while the manager peer records the reputation score in a global reputation table. This global table is consulted by a peer when it wants to know the reputation of peers outside its neighborhood (see Fig. 3). A peer can exchange its local reputation table within its neighborhood in order to insulate the cheating peers.
When a new peer joins to the system, this peer has all its entries as undefined, which are updated as the peer interacts with each other. Every peer updates the reputation of its local reputation matrix, while the reputation information from remote peers are obtained from the manager peers.

To compute the behavior reputation in the P2P system, proposed protocol periodically runs a process in order to update the network. A reputation agent updates the reputation score and the incentives of every peer based on its behavior (cheating level and transient level). Initially, the global reputation score is based on resources only, and the behavior reputation is initialized in 0. The behavior reputation score of a peer is increased if it maintains a good service or it does not cheat. On the other way, the behavior reputation score is decreased.
Each peer has the following statuses: Up, Down and Cheating. These status define several scenarios for each peer such as reputation update of a peer, expiration of a round or beginning the update process. Up status means that peer does not cheat, then a reputation agent computes the average number of round that a peer remains connected to the network and its behavior reputation score. Down status means that peer is disconnected. If the peer status is Down and it does not cheat, then, to determine how many rounds a peer is in this status is needed.

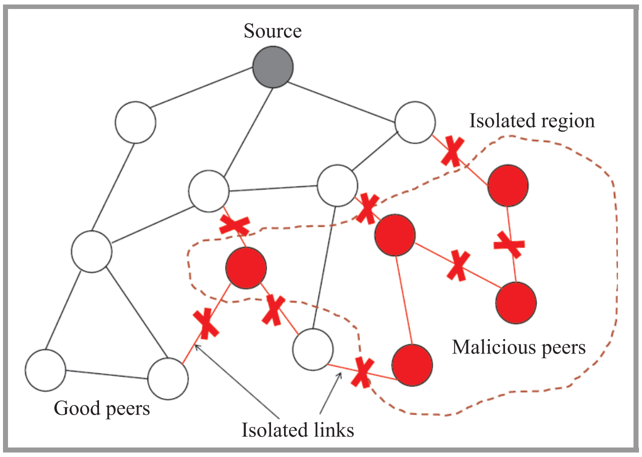

Fig. 4. Cheating peers are isolated by the system.

To calculate the behavior reputation, the author divides the simulation time in discrete rounds, where the network is updated. In this period the reputation values and incentives in each peer are revised and updated according with its behavior (e.g. connected time, stability, cheating, availability) and current resources. During the first round, the reputation score is zero for all peers. However, in the following rounds the reputation score of all peers is based on shared resources and their behavior. If the status of a peer is Cheating, then its reputation is decreased to 0 in all its neighbor peers and in the manager peers. All peers isolate the cheating peer, and they do not send, forward or receive any messages or data from it. An example of cheating peers isolated by the system is shown in Fig. 4.

4.2. Incentive Model

P2P systems are basically based on cooperation among interested users. However, many users of these systems have natural disincentives to cooperate because cooperation consumes their own resources and degrade their own performance [24], [31]. Consequently, each user attempts to maximize its own utility effectively lowers the overall utility of the system. Incentives have been used as a useful solution to motive the cooperation among peers in a P2P system. In this work, an approach based on the game theory is adopted. In particular, a choking algorithms model is used to capture the essential tension between individual and social utility, asymmetric payoff matrices to allow asymmetric transactions between peers, and a learning-based population dynamic model to specify the behavior of individual peers. Peers can continuously change its behavior.

Presented cooperation approach considers upload and download rates as a generosity factor, and translates the cooperation concept to earnings if peers cooperating or it loss if not. Generosity factor measures the benefit that an entity provides relative to the benefit it consumes. This is important because entities which consume more services than they provide, could cause the cooperation collapse. For some entity i, P_i and C_i are the services provided and consumed by i, respectively. Therefore, generosity of an entity i can be represented as:

$$Generosity(i) = P_i / C_i \,. \tag{2}$$

The generosity resumes the General Prisoner's Dilemma for an asymmetric payoff matrix [9], [32]. For our scheme, we define as a provided services unit to a packet transmitted successful. On the other hand, a consumed services unit is defined as a packet received successful. The range of the generosity factor comprises –1 to +1. The minimum value (–1) indicates a not cooperate behavior in which peer only receives packets and does not transmit any. The maximum value (+1) indicates an overall cooperate behavior in which a peer only transmits packets and does not receive any.

Each node builds a hierarchical structure of rings using its reputation table and the generosity factor. These reputation/generosity rings are used by a supplying peer to organize to the requesting peers, which wish to download any content from it. Each peer encloses each requesting peer in rings following a hierarchical organization. Thus, peers with highest reputation and generosity are allocated in the higher rings close to the source. This means that these peers receive more incentives than peers allocated in lowest rings. Figure 5 shows this scenario. In this case, eight requesting peers are distributed through three rings. The number of reputation rings and its reputation thresholds are values can be fixed by manager peers. In this work, if a requesting peer receives more incentives means that it receives more bandwidth to download contents. These reputation/generosity rings are used to implement proposed content distribution scheme. The incentives percentages can be fixed by each peer.

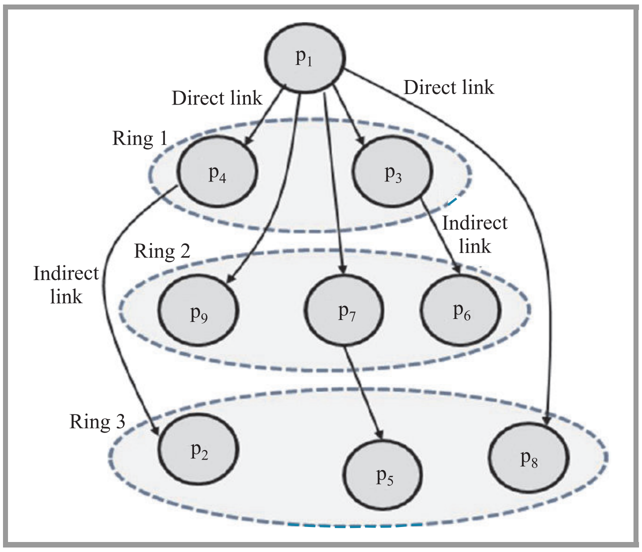

Fig. 5. Example of a distribution scenario with three reputation rings.

4.3. Operation Protocol

Presented protocol defines a set of communication messages to exchange data between peers. A set of rules are used to govern these communication messages. When new peer joins to a P2P network, it must contact with a manager peer and its neighbors. First, a new peer discovers its neighbors and builds its local table with its neighbors. Second, each new peer must deliver information about its local table to the manager peer. Third, the manager peer compares its global table with the local table received from the new peer in order to update the behavior of the peers in that neighborhood. Thereby, each peer has information about resources and reputation of its near neighbors (two hops). This information is stored and updated in a local table and in the general table of each manager peer. Once a peer is joined, it selects its first and second best neighboring peers, and calculate its best neighbor paths. The best neighbor paths are the best paths obtained from an average reputation of the neighbors (see Fig. 6), which have a direct connection between each other. Each peer arranges and stores these paths, which are used during the search stage.

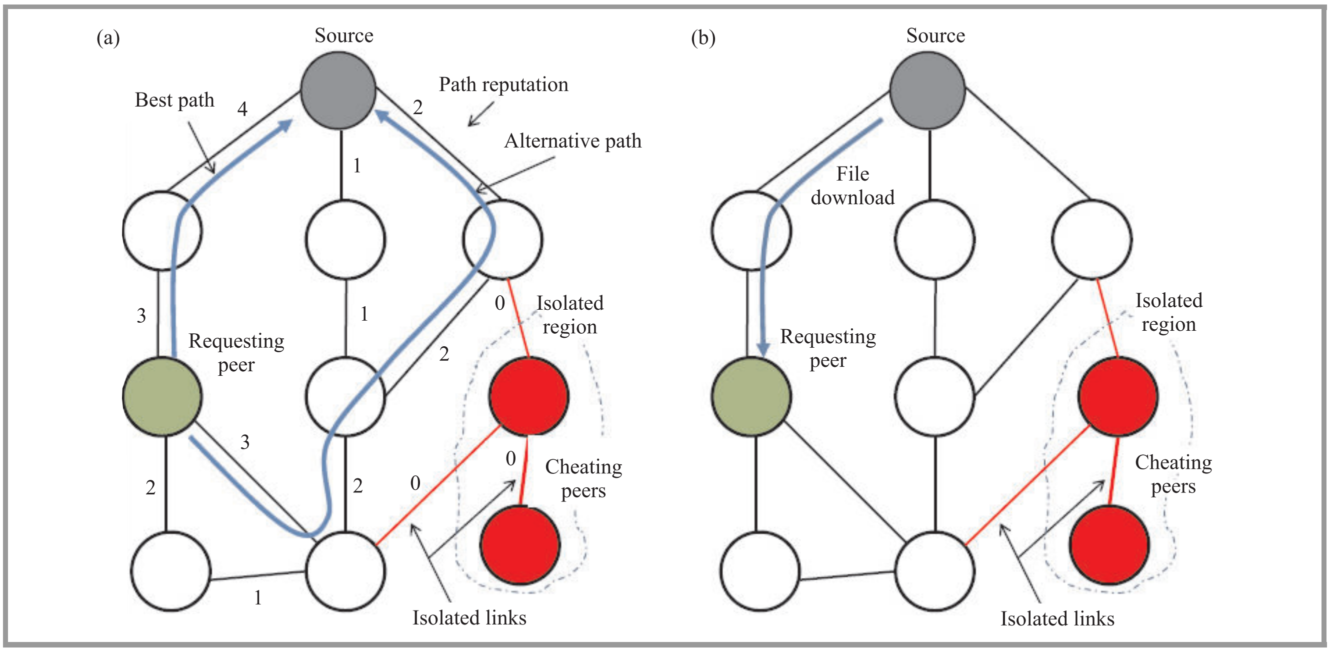

Fig. 6. Example of a content distribution scheme based on the best path strategy: (a) file search, (b) file download.

Content distribution scheme is constituted by two stages: file search and file download. In file search stage, a peer begins a file request by sending a "query" via its best neighbor. This query is forwarded by the neighbors to their best neighbor paths, and the responses are collected. Each peer also forwards to their best neighbor paths the queries realized by its neighbors until the requested file is found. For the file download stage, first, source peer checks all reputation scores of the requesting peer. Second, requesting peers are organized in rings. Following the incentives rules, source peer divides its resources between these requesting peers. If requesting peer is authorized to download a file from the source, then this file is downloaded via the best path. This scenario is shown in Fig. 6. In this case, best path has a reputation score of 3.5, while alternative path has a reputation score of 2.25. When content download is completed, requesting peers are removed from the reputation/generosity ring by the source peer.

5. Evaluation

In this section, the performance of proposed solution is evaluated. To this end, proposed model has been simulated in the Peersim simulator [33]. The author has used this network simulator because it supports dynamism and scalability. Peersim is written in Java language and it can be used to simulate small and large-scale P2P systems. This simulation tool also allows to measure the communication time between nodes. Peersim is composed of two simulation engines: the cycle-based model and a more traditional event-based model. The simulation uses the BitTorrent and Kademlia prototype [34] developed by the Trento University for the Peersim simulator. Communication protocols in both prototypes are developed using Java as programming language. Information about the resources donated by each peer such as CPU, bandwidth, memory and storage capacity is recorded for each peer in its local table. The initial reputation is based on resources only. Initially, there are not any relationship among peers in the system.

A BitTorrent network is formed by several actors and components such as peers, leechers, seeders, trackers and swarm. All users connected to the BitTorrent network are called peers. In this context there are two types of peers: seeders and leechers [35]. Seeders are users who have a file, while leechers are users that only download files. Kademlia is a distributed hash table protocol designed for decentralized P2P networks. Kademlia is deployed as a virtual network on an existing LAN/WAN network or Internet and its topology is based on the XOR metric. This metric is use to calculate distance between points in the key space [17]. Kademlia protocol consists of the following RPCs: Ping, Store, Find Node, and Find Value. These procedures allow to specify the network structure, regulates communication between nodes and exchange of information. The nodes communicate is realized via the UDP protocol. Reputation levels in BitTorent are based on shared pieces, while in Kademlia reputation levels are measured during a direct download from a node.

To simulate presented protocol on Kademlia and BitTorrent 300 nodes (peers) are used and the same file is downloaded from the source node. The author evaluates BitTorrent and Kademlia, without reputation and with reputation levels. The first experiment evaluates both P2P networks without reputation levels in the nodes. In this experiments, 15% of nodes are initialized as seeders nodes while 85% are leechers nodes. The size of the file to be download is

100 MB. Initial reputation is random. If node's reputation rate is 0, then it removed from the system. Results from first experiment are shown in Figs. 7 and 8. The number of leecher nodes that are downloading the same file from Kademlia network such as from BitTorrent is compared in Fig. 7. It shows how BitTorrent maintains a smaller number of leecher nodes compared to Kademlia. Figure 8 shows the number of seeder nodes from which some parts or full file can be download, and how in BitTorrent the number of seeder nodes is increased as time goes. Thus, BitTorrent has more available seeder nodes from which download the test file than Kademlia. This facts allows that BitTorrent presents a best performance to search and download a file compared to Kademlia.

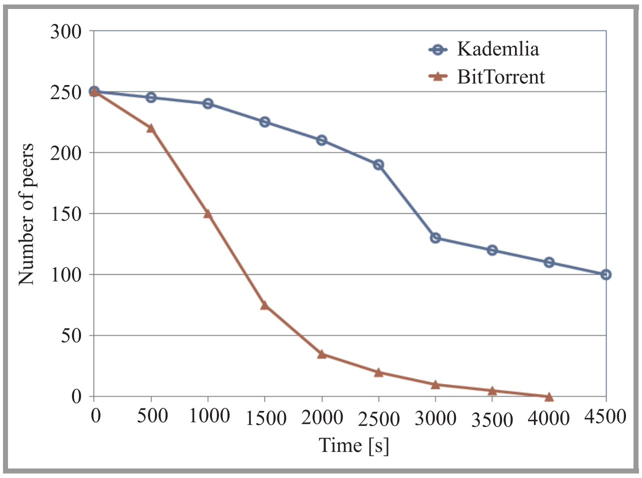

Fig. 7. Comparison of number of leecher nodes in both P2P infrastructures without reputation.

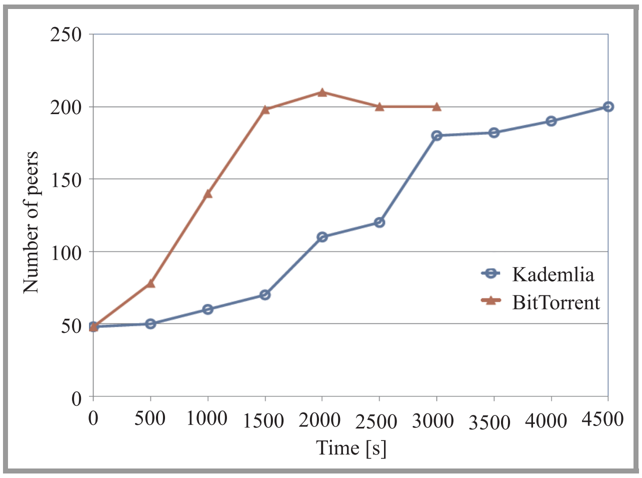

Fig. 8. Comparison of number of seeder nodes in both P2P infrastructures without reputation.

The second experiment evaluates both P2P infrastructures using reputation levels. As in previous experiment, 300 nodes and a file of 100 MB is considered. Initially, also 15% of nodes are seeder nodes and 85% are leercher nodes. Figures 9 and 10 show the results obtained from our second experiment. Figure 9 shows that BitTorrent still maintains a smaller number of leecher nodes than Kademlia. However, leecher nodes are dramatically reduced in the Kademlia network as time goes. Figure 10 compares the number of seeders nodes in both P2P networks with reputation. Initially, BitTorrent has more seeder nodes than Kademlia, but as time goes the number of seeder nodes in both P2P infrastructures is similar. Therefore reputation levels in Kademlia have served to reduce the number of leechers nodes and to increases the number of seeder nodes.

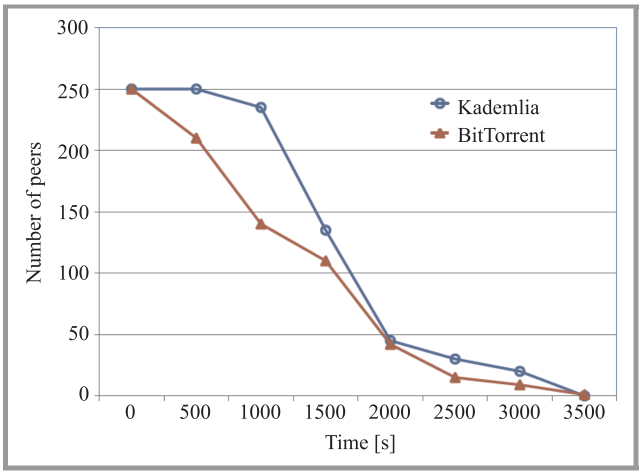

Fig. 9. Comparison of number of leecher nodes in both P2P infrastructures with reputation.

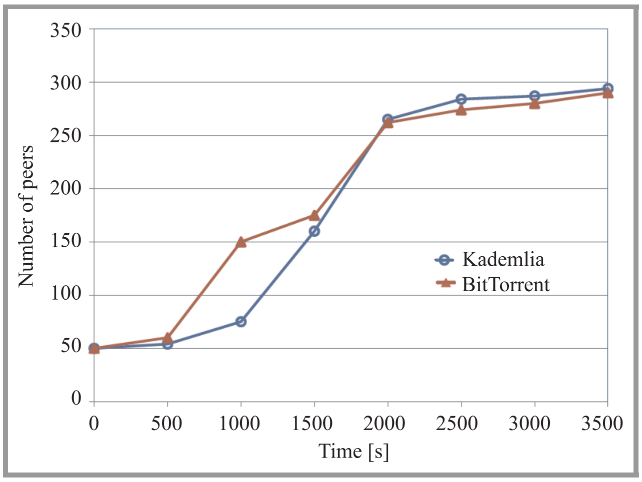

Fig. 10. Comparison of number of seeder nodes in both P2P infrastructures with reputation.

In a reputation system, good peers cannot send queries to the misbehaving peers or receive request from them, because they are isolated. Also, a system without reputation allows download content from the misbehaving peers increasing the probability of having a greater number of corrupted files. Contrary, cooperation between peers and reputation help to reject corrupt files in the systems. However, in the real electronic communities correcting the malicious peer's behavior is a hard task. Instead of correcting each such malicious peer, the author need to minimize its impact in the system performance.

6. Conclusions

In this work, a reputation scheme based on incentives for a P2P system was proposed and evaluated. Most of the reputation systems consider correction of malicious peers by giving incentives for positive feedbacks. However, in our proposed model isolates misbehaving peers from good peers, and incentives are used to motivate most cooperation among peers in the system. The model was evaluated for two different P2P infrastructures which are Superpeer (hybrid) and distributed. BitTorrent is used to simulate the super-peer infrastructure, while the Kademlia protocol is used to simulate the distributed infrastructure. The experiments show how reputation reduces the number of leechers peers and increases the number of seeder peers in both infrastructures. Although, Kademlia is the P2P infrastructure most benefited by incorporating reputation levels at nodes, BitTorrent still presents a little best overall performance, which is reflected by downloading the file most faster than Kademlia. An incentives scheme based on reputation can also reduce free riding, because the non-cooperating peers are isolated from the system. This fact has benefits both in faster downloading of files as non-receipt of corrupt files. Therefore, the reception of corrupted files from the misbehaving peers can be reduced or eliminated. Each peer uses its reputation rings and reputation score in order to distribute its upload capacity among good peers. As future work, the author plans to extend proposed scheme to social networks based on P2P infrastructure. Another possible extension for this work could be addressed to the large P2P streaming systems, and to P2P cloud systems.

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