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INCENTIVE COOPERATION IN PEER TO PEER VIDEO STREAMING USING COOPERATIVE GAME

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Resumen: En la actualidad, con la intención de expandir los sistemas de transmisión de vídeo en redes peer to peer y aprovechar los recursos de la asociación, se proporciona una plataforma barata para la computación distribuida, el almacenamiento y el intercambio de datos que es escalable, accesible, tolerante a fallos y robusto. Mientras tanto, la investigación sobre las redes sociales multimedia está emergiendo y se han analizado los comportamientos de los usuarios, así como sus impactos dinámicos en los sistemas multimedia. Dado que la participación en sistemas de igual a igual es voluntaria y también los recursos son muy variables e impredecibles en los sistemas, la mayoría de estos sistemas son simplemente un consumidor. Por lo tanto, estos compañeros o bien tienen muy poca cooperación o no tienen cooperación con los sistemas que son generalmente llamados "jinetes libres".
En este artículo se ha presentado un enfoque propuesto para motivar una cooperación en el streaming de video en redes peer to peer utilizando un modelo cooperativo de juegos en el que se otorga un privilegio basado en el valor de Shapley según el mecanismo de Incentivo Resultante de la cooperación entre los pares mutuos para proporcionar una oportunidad única para una mayor participación entre los pares. Las funciones de beneficios en un juego cooperativo para intercambios de recursos compartidos están de acuerdo con el principio de agregación de juegos cooperativos y proporcionan mayor fama a los jugadores al cooperar en mayores integraciones. Por lo tanto, una mayor eficiencia en el sistema puede lograrse mediante una integración general resultante de la cooperación entre todos los pares.
Palabras clave: redes peer to peer (p2p), video streaming, privilegio, free rider, juegos cooperativos y valor Shapley.

Abstract: Nowadays, looking to expand Video streaming systems on peer to peer networks and benefiting from partnership resources, an inexpensive platform for distributed computing, storing and sharing of data is provided which is scalable, accessible, fault-tolerant and robust. In the meantime, the research on Multimedia social networks is emerging and users' behaviors as well as their dynamic impacts on multimedia systems have been analyzed. Since participation in peer to peer systems is voluntary and also resources are highly variable and unpredictable in systems, most of such systems are merely a consumer. Thus, these peers either have very little cooperation or have no cooperation with the systems which are generally named "free riders".

In this paper a proposed approach has been presented in order to motivate a cooperation in video streaming in peer to peer networks using a cooperative games model in which, free rider operators are granted a privilege based on Shapley value according to Incentive mechanism by just benefit distribution resulting from cooperation between mutual peers to provide a unique opportunity for further participation between the peers. Benefit functions in a cooperative game for resource sharing exchanges are in accordance with principle of aggregation of cooperative games and provide greater fame for players by cooperating in bigger integrations. Thus, greater efficiency in the system can be achieved by a general integration resulting from cooperation among all peers.

Keywords: peer to peer networks (p2p), video streaming, privilege, free rider, cooperative games, and Shapley value.

1. INTRODUCTION

Nowadays, due to User's requirement increase, network technology development and the internet multimedia capability enhancement, it is needed to transfer high quality flexible video data via the heterogeneous and dynamic network environment.

Through using the participation of resources by peers, p2p systems can create a cheap base for distributive calculations or shared data to gain comparison, accessibility, fault tolerance and high robust. Peers change dynamically, but they don't have any commitment for participating in the resources, because peer's participation is voluntary and the system sources can be so variable and changeable. Cooperation of a peer can be stopped for the uploading band with starvation [5]. Lack of cooperation is so important because the short-term participation can harm the system efficiency. In this essay authors' aim in [1], is to plan a motivating strategy for peer's co-operation in social networks, and motivation for this plan is considering peers cheating in their interaction. The game theory framework and interchange based incentive mechanism have been used in this essay. The main idea was creating an unlimited repeated twosome game between the peers in time rounds with equal length, and also the method of evaluation of benefit amount of accurate and fraudulent peers has been compared. In each round, a peer can request for the chunk video and can respond to maximum one request. The server function is to accept or reject a request in each round.

The forwarding chunk cost equals to uploading band width consumed, and the received benefit which has been considered with a figure between 0 and 1. In live video streaming construction, a current bit video is divided into M bit chunks, and all the chunks can also be in the access from the main server. During video watching, a peer, first receives a list of current watching peers as well as present chunk information in other buffers. In each round initiation, a user sends a request to one of the peers or to the main server. Each round equals to the time parameter "T" and, as a whole, N user can exist in a social network, and the upload band width of the main server can afford only N chunks in T seconds (N<< N').

Two peers interact in variable rounds reciprocally and none of them knows exactly when his/her rival will leave the game. For this reason, we define a utility function for each peer. We also create an algorithm for request answering in which a peer will randomly selects one of the several suggested incoming requests in a round. In [3], we have suggested a game based on correlated balance for peers' co-operations in a file sharing system. Peers request are framed in three types of B, P, and I, and we use a bank-set collection for measuring peers co-operation amount. Every peer, for serving requests, selects one of the neighbors based on a weighed round –robin algorithm. According to the results, we found that the proposed solution has improved the average efficiency of all peers.

In [4] & [6], with Shapley value approach, a new generation of content delivery networks has been introduced for video streaming and VOD that decreases the operating cost. On the contrary, with the former uncoordinated peer to peer approaches, the users used to allocate some parts of their resources such as uploading band width and saving spaces for helping to content delivery against peer service reception in less price. Such mechanisms are not only attractive but also simple. Moreover, using statistical behavior of active users proves that Shapley value, can be included in peer systems without any complex calculations. Every user and service provider shares their resources according to the value added though. There are variable reasons for free riding indication such as lack of resources, lack of dynamic peers, and cheating. Shapley value allocates integrated distribution of total profit to all gamers in a cooperative game.

2. PROPOSED APPROACH

The proposed method in this Essay gains the cooperative game benefit function among the peers, and uses Shapley value just for distribution of profits gained by interactive cooperation of peers. This method is different from the former ones given for granting bonus in a system. Since there is no guarantee for peers' cooperation, we ratiocinate peer's behavior in a system. Benefit function in a cooperative game gives an opportunity to peers to make a bigger coalition and further reputation by exchanging their common resources. Via using Shapley value, we can motivate each peer couple to co-operate in a game. Although users are cheating for increasing their profit in a social network.

In this essay, incentive mechanism gives the users enough motivation for resources sharing by using Shapley value. The suggested method of the essay tries to determine the free rider according to a definite algorithm in a sub-coalition, and divides the gained profit among the users as an incentive by using Shapley value based on band width. The most important part of the suggested method execution is to apply it on heterogeneous networks and resources like band width. The result of the new mechanism implementation will be a system which moves toward a general coalition in a definite period of time, and every couple of users will give services to one another. This mechanism causes the system to approach to a balanced state of its cooperation.

We have to mention that the suggested construction is Mesh, and the applied mechanism is Pull. In a Mesh-Pull system, the peers internally follow the chunks accessibility by using their neighbor's buffer map. A buffer map includes the consequent numbers of existing chunks in the map. The peer can set time for fetching to get its neighbors' buffer map, and can send its request for fetching the needed chunks to its neighbor [8].

Since the requested chunk can be loaded only by one neighbor, no extra chunk will be sent, but frequent buffer map exchange and fetch requests will increase the overload signaling and cause likely extra delay in chunk recovery. Based on Mesh method, it will highly preserve the efficiency along with Swarming mechanism usage. In Swarming method, different chunks of a file are distributed among the participating peers and full delivery will be made via outlet band width participation of the peers [11], [13].

Mesh streaming system, like file sharing systems such as Bit Torrent, uses a tracker for preserving the active peers' information in a video meeting. Imagine that there are N networks including N peers. When one peer joins a meeting, first it connects to the tracker and informs its identification such as its IP address and port number, and then sends its needed chunk request to the tracker. Then after, the tracker returns it a random subset of the active peers in the meeting from the group N. This random subset will be considered as a set neighbor of the newly coming peer, and will make a coalition with one another [7].

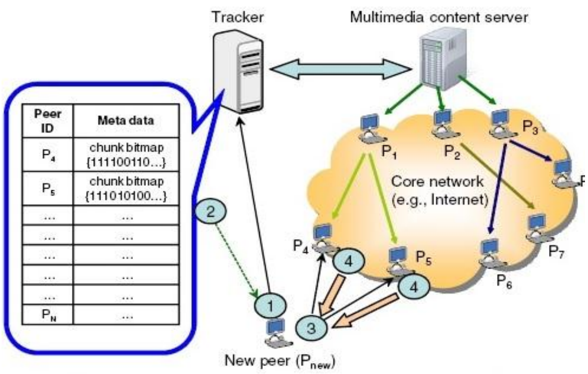

Fig 1. Mechanism of the incorporation of new peer to the system [7]

Then, the peer starts to make contact with other peers in the group. For each peer as a server peer, there are two operational fields corresponds to the peer's inquiry including an accepting and a rejecting field. In this Essay, we suggested an approach focuses on the replies rejected by the server peer which we call them free riders to the inquiries. Therefore, the suggested algorithm consists of two steps; the first step focuses on finding the free rider peer based on the peer's co-operation in a coalition. The second step of the approach goes to motivating the peers based on reputation mechanism using Shapley mean value for inducing the free rider. Improving the cooperation in group N is due to simultaneous co-operation of all peers in sub coalitions. Thus, we believe that sub coalitions and finally the system efficiency will improve the main coalition N.

3. FREE RIDER DETECTION METHOD

Peers participating in the coalition neighborhood contain portions of the video to play on its own buffer. At the beginning of the coalition users can begin to send a request and then get the chunk from the set of their neighborhood. So, in a real situation one can immediately receive some parts of video from the set of neighbors and with updating own buffer map by tracking, it could be used as a server for other peers. Each peer will spend the required amount of time to receive and prepare video chunk. In this paper for the purpose of simplicity in calculations, all the delays associated with sending and receiving chunk are considered negligible. In each round of 1 second, peers inside each coalition will send requests to each other and server peers will respond to them with two operations of accept or reject [11].

In order to properly evaluate the performance of the proposed approach, the number of execution of the algorithm in this paper is considered 10 times. Information about the number of rejected and accepted requests for each peer will be calculated and maintained in information table of each peer. Due to the use of reject field values in acquiring a peer such as free rider in the proposed approach, we use a threshold parameter named a=2 that according to it, each cooperative peer server inside coalition will situate as follows:

Status I) $\alpha \leq$ reject: In this case, after the end of the algorithm, the number of rejected requests in each peer server, will be smaller or maximally equal to the threshold value α (reject ≤ 2) which in this case the status could be negligible because of some errors in the system's normal behavior and it represents an active condition mode or be willingness to cooperate with the system.

Status II) $\alpha \geq$ reject: In this case, after the end of the algorithm, the number of rejected requests in each peer server will be larger or maximally equal to the threshold value α in implementation of the algorithm ($2 <$reject ≤ 10). This condition indicates that the system has little cooperation or no cooperation to analyze the situation and propose solutions to the purpose of this article. Accordingly, in each coalition may one or more peers in a neighborhood are identified as a free rider.

Free rider due to selfish behavior, refuses to service to such applicants or inform the wrong information and attempts to fraud. In any coalition, the random number of peers will be categorized in two positions which are totally placed as cooperative or non-cooperative. For non-cooperative peers, which do not tend to cooperate with the system, based on reject field, a collection consists of one or more free rider is achieved. In addition, the possibility of rejection in free riders can exist in two states in free riding set. First, the number of unequal rejects, second the number of equal rejects which are expressed as follows:

Mode a) unequal rejects number: In this case, naturally start the implementation of peer algorithms with the highest reject.

Mode b) equal rejects number: In this case, the priority is based on the parameters we use in bandwidth, thus the implementation of the algorithm of the free rider with the most bandwidth starts uploading.

In the proposed approach, the presented pseudo-code for creating an incentive in free rider is as below:

```
01. N is a network with n Peers
02.   P_new is a New Peer that want to Contribution with N
03.     P_new Registers own (Peer ID, IP Add) at Tracker && Request to Tracker for get chunk's
04.       Tracker returns Peer ID's that Consist of chunk's that P_new need to them
05.          Peer IDs from step 4 in the Collection S_i named (S_i is a Collection with n_i Peer's)
06.             τ = 1, P_Rej= 0, α = 2; (In each round of the algorithm, one unit is added to τ)
07.               While (τ ≤ 10) each of P_new neighbor's do {
08.                 send (Peer ID's request's to source's at S_i) &&receive (one chunk each other's);
09.                   IF source's not response to requests of each other's, then
10.                      P_Rej(source's)++;
11.                    K++;}
12.             IFP_Rej(source[i]) <αthen
13.          source[i] is a Current Server else
14.       For i = 1 ton_i;
15.     IF (2 <P_Rej(source[i]) ≤10) then
16.   f[i] = source[i];
17. attach f[i] to F_i Collection (Collection of  free rider's that is named F_i)
```

Fig 2. To obtain the algorithm of free rider's peer

Functions v which is called a characteristic function, considers the set of all possible subsets of such peers into the set of real numbers.

Assuming, network N exists with n-peers and it forms the main coalitions in network. According to a declared neighbor set to any applicant peer by tracking is divided to set N to K coalition S_1, S_2, ..., S_k. So, each coalition of S_i includes n_i and is determined by n_1, n_2, ..., n_k respectively. Therefore, any S_i is a subset of the set N. Due to the cooperation model of game theory, it can be considered as a collection with n_i actor in the cast in which the actors are peers forming of this collection and we intend to arrange a game between peers.

If $S_i \subseteq N$ and active random set of n_i are the peers which cooperate with each other, after the implementation of the first part of the algorithm, peer or peers which have the most reject in coalition to other demand peers are considered as free riding which is shown with F_i. Given in any coalition of S_i, $F_i \subseteq S_i$, set includes m peer free rider as f_1, f_2, …, f_m then F_i is a subset of m peer free rider in which each Si belongs to N.

4. Incentive cooperation in the free rider

An important part of implementing the proposed method is creating incentive cooperation in peers' free rider to interact users for streaming. For this purpose, opposed to used models in [2] and [3], using a cooperative model which benefits from Nash equilibrium-based approach could almost help to implement the target. Using a non-cooperative model, in a coalition in which a group of peers have created to provoke each other is not recommended, because in non-cooperative approach, each unique peer considers its own benefit selfishly and it is one-way relation and it is clear that such behavior is not appropriate to work as a group in which its optimal output is the result of resource sharing to cooperate with all peers in the coalition. For this reason, the idea of using a collaborative model informs the user the necessary knowledge to incorporate the resources.

Proposed pseudo-code for creating incentive in free rider is as follows:

$$u_i = (a_i * \frac{p_{ij} * w_i}{2}) - (a_j * \frac{M}{w_i * \tau})$$

```
For i = 1 to m;
    IF f[i] of F collection P_Rej(source[i]) = Max then
        f[i] = u[i];
        source[i] = f[i];
    m--;
next[i];
```

Fig 3. Incentive cooperation Algorithm in the free rider

It should be noted that the cooperative model just creates the possibility of cooperation between peers and it is possible that the statistical analysis of users' behavior in this network doesn’t have the required efficiency in user's and supervisor's point of view. But in general, due to little incentive, for working in small networks in collaborative models, some actions could be taken to prevent users’ selfish behavior to conserve the resources exclusively in the streaming.

For this purpose, by underlying this method in the article, we will somewhat move toward the target. As mentioned previously, Mesh-based method, along with using swarming mechanism, will keep performance at a high level. In swarming method, various chunks of a file will distribute among participating peers and full delivery will be achieved through the participation of bandwidth output of these peers. For using swarming method output in cooperating resources, it is necessary to distribute fairly in system to determine each peer’s benefit in coalition. To use Shapley analysis relation in this article, for fairly distribution of benefits attained by cooperation of n peer in coalition is highly recommended. In other words, using Shapley value for cooperation in a coalition allows in advance the other peer to have the minimum benefit from the cooperation in coalition, even though the mentioned peer doesn’t take any advantages of creating that benefit for the group.

In this section, the aim is to provide an incentive mechanism algorithm which is based on the reputation. According to Shapley relationship, this mechanism in a sub-coalition will be allocated to every simple game which is created as a result of confronting of free rider with the required peer.

The coalition S_i, consists of free rider peers (which belongs to F set), applicant peers and other peers, which are active in S_i set, cooperate for streaming. By examining the membership of the $F \subseteq S_i$, we can place every free rider of this set with the relevant applicant peer in a T_i sub coalition which defines a simple tiny game between two peers in free rider and the relevant applicant.

According to the noted statements, each S_i set, contains q which is T_i subset as $T_1, T_2, \ldots, T_q$, and each T_i has two F_i, P_i members which represents free rider and applicant peer respectively.

So, in short, each N set has K coalition or S_i game and each S_i game consists of F set which contains at least one and at most M free rider peer. Every free rider which belongs to F along with an applicant peer belonging to S_i form a sub coalition or T_i tiny game which is shown as Pi.

Considering Shapley relationship, the profit of cooperation in these two peers under the T_i coalition should be divided fairly among them. In better words, if F_i cooperates P_i, based on reputation mechanism, the gained cooperative benefit will be divided fairly among them. To this end, to formalize this situation the concept of cooperative game issued in equation 1.

If N is a finite set of n actor, the gained characteristic function will be as follow:

Equation 1 $$v: 2^N \rightarrow R \ ; v(\emptyset) = 0$$

2^N consists of all possible coalitions set in cast. Characteristic function describes how much collective interest of a set of players has been achieved by forming a coalition. With a Shapley value cooperative model game, a benefit vector is unique, efficient, symmetrical and increasing and is used as a conceptual solution. By using Shapley value, a unique distribution is allocated to the cooperative game in sub coalition of T_i and it consists of two players as F_i, P_i.

Shapley value is a way to distribute the overall benefit of all participated peers. It is assumed that all peers will cooperate. Therefore, assuming that the free rider cooperates in tiny game T_i and also according to equation 1, benefit of T_i sub coalition will be equal to benefit of all subsets which is known as Power set (T_i). It is sum of total profit of f_i-p_i cooperation. With allocating average profits of T_i to Fi in peer’s tiny game cooperation, F_i reputation will enhance and encourage peers in next cooperation.

In cooperative game theory, to solve the problem of peer’s non- cooperation in the system, it should be implemented a uniform and parallel algorithm on each of T_i sub-coalition with Si coalition which belongs to N original coalition.

In other words, by solving non-communication problem in T_i tiny game in entire system, we can achieve greater efficiency in the system by giving the average value of Shapley to F_i.

5. SIMULATION SETTINGS

At first for the simulation, it is used a network with n=400 users without any cooperation and participation. In this paper 40 percent of peers benefit from the Uplink bandwidth with attribute of 768Kbps and 60 percent of peers benefit from the Uplink with attribute of 300Kbps. Considering the importance of bandwidth parameter in video streaming to calculate profit functions in sub coalitions of T_i, an available upload bandwidth with the capacity of 1 Mbps is used in this article which is shown with W.

Initially, the video is stored in a server with 3 Mbps bandwidth. Each round is considered as 1 second and it is shown with τ. Buffer length for each peer is considered 30 seconds. Sharing video into one second chunks is considered with 150 kbps capacity and it is shown with M. Free rider peer uses a_i parameter with the value of 1 for rejecting the applicant's request and applies a random probability between 0and 1. This probability is shown with P_{ij} and it means that free rider answers to the relevant request with what possibility.
So, the probability of rejecting any request of peer, which is a complementary admission of that request, will be a number between 0 and 1. In the simulation, a neighborhood set or S_i coalition with 50 users is identified randomly by tracking in N set which is shows n_i. In order to ensure the quality of the simulation evaluation, the frequency of implementing the proposed approach has been considered 10 times more.

Payoff Function

Since in simple game with offered algorithm subset of coalition T_i contains a peer free rider, the payoff function by sharing available resources of free rider should encourage it to cooperate in order to obtain received benefit amount in payoff function by using Shapley value. Due to free rider selfish behavior for attempting to fraud and providing false information of own buffer, it doesn't usually use available resources of free rider such as upload bandwidth. Therefore, by making reputation-based incentive, it is attempted to have optimal use of upload band width. Thus in general, the benefit function with existing scenario will be considered in 2 moods: one mood is network behavior without cooperation of free rider in normal condition and second is stimulation of free rider by reputation mechanism based on Shapley value in order to cooperate with system.
It can be proved that the more free rider uses bandwidth for uploading, the more participation will be occurred in system and the benefit function will have greater value. Here, Shapley value is considered in a simple game. So sub-coalition for ({P_i, P_j} *T_i is counted as a simple game.

Given that P_j & P_i requests a chunk. Pi is a free rider peer (because of simplicity in writing about relationship and computing, f_i is used instead of P_i) which denies to send the requested chunk, but in case of giving the reputation and adopting the request of P_j and by using the benefit function, it will send the requested chunk to the upload bandwidth. In this case, the benefit function of peer's free rider will be calculated by following equation (Shown in figure 3).

The purpose of gain is received benefit of peer and the purpose of cost is the cost of sending chunk for a peer of free rider.

Equation 2 *Payoff Function = gain - Cost*

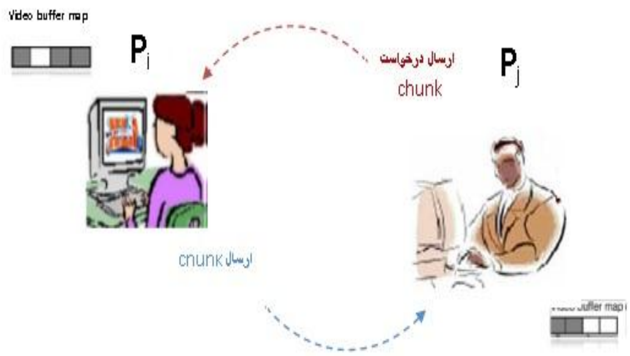

Fig 4. The coalition of T yielded by simple game between two samples as P_j & P_i

Benefits Received by peer

By giving reputation to the peer of server or free rider, if the peer of p_i sends the requested chunk of p_j, and p_j gets the chunk successfully, P_i gains a benefit of g_i. The benefit is obtained through using Shapley value, on two peer participants in a mutual coalition, and it is the result of sharing the benefit of T coalition into two peers of p_i & p_j peers or free rider and applicant peers. So, the benefit g_i, equals to Shapley value formula that is a function of band width parameter. From the perspective of applicant peer, the amount of received benefit could be interpreted as the number of received video pieces.

Sending cost of a chunk

The cost of sending a chunk equals to the consumed uploading band width for sending a chunk for peer "i" which can be obtained via the following equation**:**

Equation 3 $$i's_{\mathbf{cost}} = \frac{M}{\tau.W_i}$$

Where τ, the duration of each round and w_i determines available bandwidth. It is clear that equation the more bandwidth is available, the peer "i" will bear less cost in equation 3. Each chunk equals to M bit. The benefit function is calculated by the following equation:

Equation 4

$$\begin{cases} \pi_1(a_1.a_2) = (a_2 p_{21}) g_1 - a_1 \frac{M}{\tau.w_1} \\ \pi_2(a_1.a_2) = (a_1 p_{12}) g_2 - a_2 \frac{M}{\tau.w_2} \end{cases}$$

The first part of the profit equation 4, calculates the productivity of user "i" on a scale of operations that it does for its corresponding peer. The second part of the function calculates cost of user i for the operations that it does has done in favor of its corresponding peer. Considering the equation 1 and cooperative game (v, n), the amount that peer "i", gains as a free rider is equal to Shapley value in [9], [10], [12]:

Equation 5

$$\boldsymbol{\varphi_i(v)} = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!\,(n-|s|-1)!}{n!} \left(v(S \cup \{i\}) - v(s)\right)$$

which shows the total extension on all subsets of "S_i" of "N" which does not include peer "i". If S_i, is a coalition of peers, then $v(S_i)$ coalition value is called "S_i" and is the expected total benefits of Si which can be achieved by means of cooperation with peers. Similarly, in sub-coalition of T_i, we can also find the similar results. If $S_i \subseteq N$ and S_i are a non-empty coalition of peers, it means that the sub-coalition of S_i includes at least a simple game of T_i and $v_{S_i}: 2^{S_i} \rightarrow R$ the profit function of Si is defined as follow:

Equation 6 $\boldsymbol{v_{S_i}(T) = v(T)\ ;\ \forall i j \in T\ ; T \subseteq S_i}$

Where $v(T_i)$ is the coalition value of T_i. In other words, our proposed algorithm focuses on, on sub-coalition inside Si which includes an applicant and a free rider. S_i is a set of twosome coalitions or simple games that include free rider and applicant peer and by cooperative model of game theory form a simple game that we call it tiny game. Tiny games are useful because the concepts of defined solution in famous and original coalition are exactly implemented on smaller coalitions. T coalition consists of P_i and P_j peers that are free rider and applicant respectively. In other words, the aim of the different possible permutations is the role of each peer against the rest of the peers in the coalition, which represents the various states of peers in a set that is known as power set (T_i). So, Shapley value is as follow:

Equation 7: $\boldsymbol{\varphi_i(v) = \frac{1}{|2|!} \sum_{T_i} \left[v\left(P_i^2 \cup \{i\}\right) - v(P_i^2) \right]}$

Where the sum of intervals on T_i categorizes two peers and $\boldsymbol{P_i^2}$ is the set of P_i peers in T_i. In the proposed approach, the equation 8:

Equation 8

$$u_i = (a_i\, p_{ij}) \frac{1}{|N|!} \sum_{n_i} \left[v_T\left(P_i^{n_i} \cup \{i\}\right) - v_T(P_i^{n_i}) \right] - a_j \frac{M}{\tau.w_i}$$

could be used for any coalition S_i that contains n_i peer. i should always be smaller than $n_i (i<n_i)$ and this is proved because in each round there is at least one peer that cooperates with others. By placement of $\varphi_i(v)$ or Shapley value, instead of profit function of g_i we will have in equation 4:

Equation 9

$$u_i = (a_i p_{ij}) \frac{1}{|2|!} \sum_{T_i} \left[v_T(P_i^2 \cup \{i\}) - v_T(P_i^2) \right] - is\ a_j \frac{M}{\tau.w_i}$$

That a_i server action is for answering to the request of applicant peer and in p_{ij} it is possible to transfer from the server to the supplicant. It is clear from the above equation that if peer i or free rider rejects the peer j request, a_i is equal to zero and finally the benefit gaining from the applicant request equals to zero. Also when the possibility of transferring from free rider to peer j is zero, p_{ij} will be zero. Here, the server deals with applicant's demand with the lowest possibility and respond to it. As a result, the first part of relation which is gain value function is zero and the payoff function will alter to the cost function:

Equation 10 $$\mathbf{a_j \frac{M}{\tau.w_1}}$$

It means that the simple game has no benefit. In proposed approach for avoiding from any deception of free riders, we can use the Ms. W. Sabrina Lin method. So that the rejected requests set (that based on value table is calculated for each available peer) will not be more than total transferred requests to the free rider peer.

The solutions of Game Theory can be used for optimum analysis and deceitful cooperation strategies. The more the band width is available, less cost is considered for i. Accordingly, with improvement of sharing more sources on behalf of i, more benefits will be gained by i. The first part of equation 7 is equivalent to the benefit gained by cooperation in twosome coalition that because of complicated calculations, we can calculate the equivalent payoff function like following methods:

Method 1: Replace the amount of benefit with P permutation and calculate it.

Method 2: Design a twosome game and for each subsection of game create a value based on bandwidth parameter and we have:

Equation 11 $$v(T_i) = \sum_{i=1}^{2} p_i \, (e^{T_i}) \mathrm{w}_i$$

p_i is the possibility of transferring from free rider, $e^{T_i}$is the power set average and $w_i$is upload of bandwidth of I peer. Since the coalition is based on a simple 2 twosome game, therefore:

Equation 12 $$v(T) = \sum_{i=1.\{i,j\}\epsilon T}^{2} p_{ij} \, (e^{T_i}) \mathrm{w}_i$$

Equation 13 $$v(T) = \mathrm{a}_i p_{ij} e^{T_i} \sum_{i=1}^{2} \mathrm{w}_i$$

Using [10] and defining first values of uploading the bandwidth of each P_i and P_j, we have:

$$W_i = w_i \, Mbps \, , W_j = w_j \, Mbps \, , v(i) = \frac{1}{2}\sum \mathrm{w}_i = \frac{a}{2}, v(j) = \frac{1}{2}\sum \mathrm{w}_j = \frac{b}{2}$$

So the replacement will be as follows:

$$U_i = \frac{1}{2!}\sum_{T_i}[v(T(2,i)) - v(T(2,i)\backslash i)]$$

$$= \frac{1}{2}\Big(v(\{i\}) + \big(v(\{i,i\}) - v(\{i\})\big)\Big) \to \{i\} = \{1,2\}\backslash\{i\} = \frac{1}{2}(\frac{a}{2} + \frac{b}{2} - \frac{b}{2}) \to$$

Equation 14 $$u_i = \mathrm{a}_i \frac{p_{ij}}{2} w_i - \mathrm{a}_j \frac{M}{w_i \tau}$$

Based on the above equation we can see that the bandwidth parameter which is shown by w_i, has a direct relationship with productivity function and on the other hand, a reverse relationship with the cost function and determines the free rider's shared amount of bandwidth. The higher the bandwidth of upload by the free rider, the more improvement is in productivity function and also decreases servicing cost.

In order to evaluate the results of the suggested approach, the method based on the simulation settings in [1] and [4] have been studied. For simulating, we applied a network with 400 non-cooperative users (n=400) that 40 percent of peers using Uplink Bandwidth with attribute of 768 Kbps and 60 percent benefit from the Uplink Bandwidth with attribute of 300 Kbps. In this paper, due to the importance of Bandwidth parameter in the video streaming, for calculating the payoff function in sub-coalition T_i, an available Upload Bandwidth, with 1 Kbps capacity is used that is shown by “W”. At first, the video file has been saved in a main server with 3 Mbps Bandwidth. Each round has been considered as 1 second and it is shown by τ. Buffer length for each peer is 30 seconds. Video file is divided into 1 second chunks with 150 Kbps capacity which is shown by “M”. Free rider peer for rejecting the request of an applicant uses the a_i “action” parameter with 1 value and a random probability of “P_{ij}” between zero and one. So, the probability for rejecting the request of each peer, which is an acceptance supplement of the request of that peer, will be a number between zero and one. In a simulation process, the neighbor set or “S_i” coalition with 50 users is randomly identified by the tracker and is shown by “n_i”. In order to evaluate the quality of the simulation assessment, the number of implementations in suggested approach is considered 10 times more.

6. SIMULATION RESULTS

Since in this research the main part of the suggested payoff function method is based on Shapley value, firstly we should achieve to an acceptable assurance about the accuracy and quality of the implementation of this method. Then, we could claim that in video streaming the suggested approach with cooperative model is comparable with the non-cooperative models and it operates better than that. So, in this section simulation results, after obtaining the average value of Shapley within simple intervals, have been compared with each other in two modes: one mode is non-cooperative and in natural condition and the other mode is based on the cooperation of free rider peer.

In the implemented simulation the horizontal axis represents the quantity of chunks which is directly related to the cost function. Limitation of productivity function results from bandwidth limitation in free rider, and in general, is due to the limitation of u_i benefit function in the network. Whatever the rate of application of free rider peer enhances, the use of network resources will also increase.

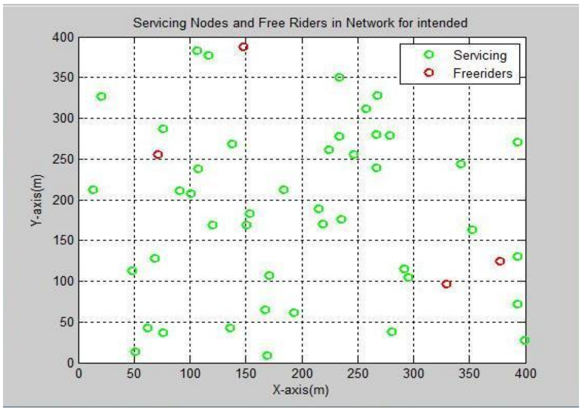

Figure 5. The graphical distribution of serviceable peers and free riders on the network

Also, the resources usage will be optimized, and non-acceptance of requests will reduce. For evaluation of simulating function of benefit and cost function, we observe that the cost function changes have converged to zero by increasing the bandwidth and this effect is reverse in benefit function. (Fig 6 and fig 7)

Yet, by growth of coalitions and increased rate of request, the possibility of non-existence of free rider peer's increases and it is due to the cooperation of giving incentive to Shapley value in each simple game of T_i. (Fig 8 and fig 9)

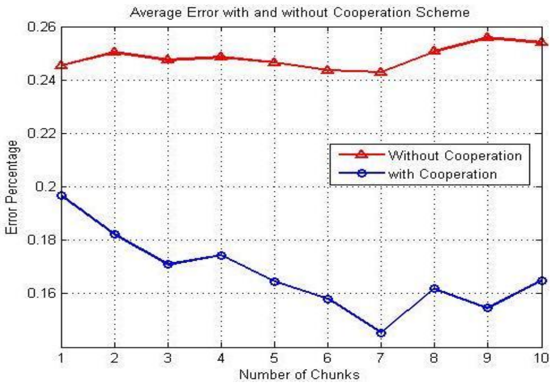

Figure 9. shows the average percentage of errors in accessibility to chunks, before and after the cooperation approach

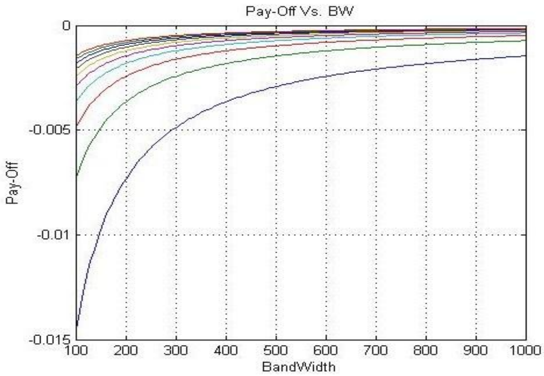

Figure 7. benefit function changes according to the amount of bandwidth changes

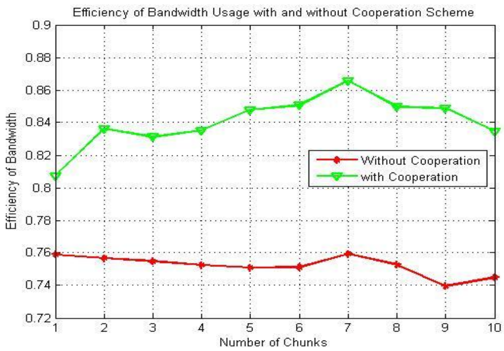

Figure 8. calculates the effect of chunks optimal usage of bandwidth before and after the cooperation approach

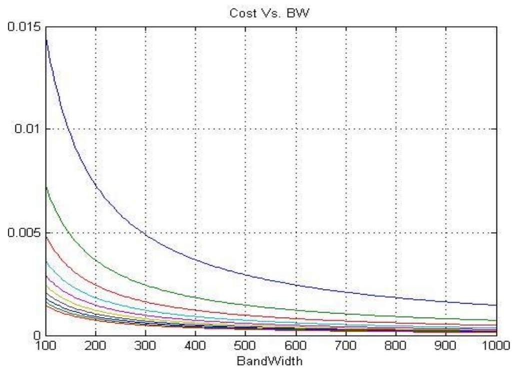

Figure 6. shows the changes in cost function versus bandwidth changes

This function actually, shows the average changes in the number of chunks which is done by incrementing the number of coalition members in a network and also shows the proportion of increment in the average number of available chunks, due to all coalition users which have entered into the system. This rate will increase by incremental number of users into the system and by development of neighbor set for each peer. (Fig 10 and 11)

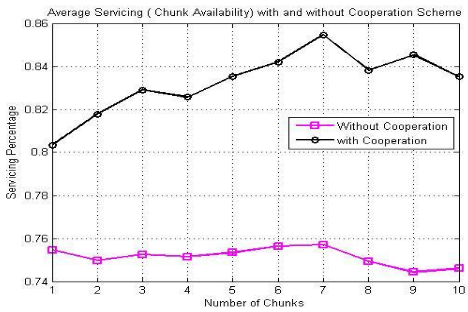

Figure 10. the average percentage of service by available chunks, before and after the cooperation approach

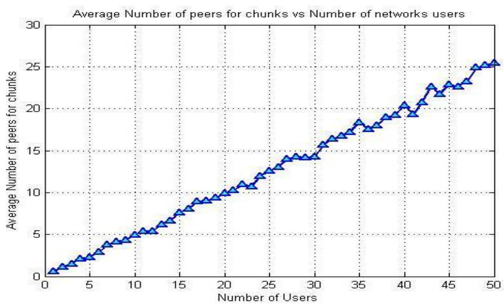

Figure 11. shows an increase in the number of chunks of each peer due to the increase of the number of network users

7. CONCLUSION

Investigations shows that user's behavior has significant dynamism, thus lack of a cooperation between peers leads to a reduction in the efficiency of the system, and also because of deception, the effects of failure in sharing the resources reduces streaming in the system. In this article, a hybrid algorithm is presented in order to find peers which do not have participation in streaming or has very little cooperation with system, so that to keep cooperation and improve performance of the system and eventually system gets closer to the ideal state. While the system has an acceptable scalability, it attempts to use the capabilities of the shared resources among peers in the best way. Swarming structure along with Mesh-based method causes better management and controll over the network and it's performance will be at the maximum level. Using the proposed structure leads to the fair distribution of profits and improves the value of gain function. The proposed approach, in addition to have equality in the distribution of information, causes more participation of resources. The results of the proposed algorithm simulation show that after cooperation of the free-riders in the system, distribution of resources has been uniform and the number of chunks available to the applicants has increased; so proportionally, optimal use of bandwidth has incremented up to one tenth percent and the error rate in accessing to chunks has decreaed to four hundredth percent. Also, by developing the heterogeneous upload of bandwidth and as well as arrival rate of customers, the service has improved in the system. As a result, the consistency of presentation has increased by the availability of more quartile in the system and totally, the scalability of the system will increase.

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