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Optimal Harmonization of Out-Network Traffic Control Regulations in Social Networks

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Abstract

Regulations of use of social networks, as one of the key components in these networks, serve an important role in controlling the flow of traffic. The study of the harmonization of these terms and regulations can be a significant step to avoid congestion and (Users') rejection in the network. Harmonization of traffic control regulations (TCR) among social networks is one of the best solutions to establish consequent traffic flow out of the network. Depending on the conditions, harmonization can be done in different ways. This article examines the direct pass and indirect pass methods. Node phase differences are key elements for harmonization of social networks considered in this review. To calculate the optimal phasing and appropriate phase difference, first the status of a user in the two social network samples has been analyzed

using Gephi software, and then the results have been simulated by charting. In this article, the harmonization of traffic control regulations (TCR) was done based on evaluation of the TCR performance through determining the appropriate phase differences and reference rule and calculating the measurement of Latency (LT) in the main network port. This latency was calculated as the difference of the expected time and real time of connection or login to the network in simulated conditions. The achieved results indicate that in unsaturated conditions using indirect pass method and in saturated conditions, due to rejection of user and inability of network TCR, using indirect pass method is the best choice for harmonization of the TCR among social networks.

Key words: Social networks, Harmonization, Regulation, Traffic, Facebook, LinkedIn, Node, Gephi, Rejection, Latency.

1. Introduction

Nowadays, social networks play an important role in the lives affected by hi-tech and internet. Ratkiewics *et al.* (2010) believe that “Online popularity has enormous impact on opinions, culture, policy, and profits, especially with the advent of the social Web and Web advertising”.

Social network is a network of individuals and groups and the communications among them. These individuals and groups comprise the network nodes and the dependencies among the individuals and groups such as friendship, kinship, commerce, common interests, etc. constituting the edges between nodes.

Boyed and Ellison (2008) defined “social network sites as web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system”. Kietzmann, et al (2011) presented “a framework that defines social media by using seven functional building blocks: identity, conversations, sharing, presence, relationships, reputation, and groups. As different social media activities are defined by the extent to which they focus on some or all of these blocks, they explained the implications that each block can have for how firms should engage with social media”.

As the number of nodes and edges increases, the network becomes more complicated and can, therefore, be investigated through network analysis. Regarding the daily increase of the number of the social networks and their users, we will have traffic interruption and congestion in log-in and using when entering or connecting from one network to another by users. Various studies confirm that use of social networks or websites is higher and, in special conditions, the traffic in these networks increases drastically and considerably. As the study of Wiki network usage by Ratkiewics *et al.* (2010) demonstrated, during the week of the final exams the use of social networks rises significantly. (Figure 1)



Fig. 1. The temporal traffic patterns of one Wikipedia topic, visualized by wikirank.com. ‘Biology’ (top) displays a predictable weekly cycle, as well as peaks in demand around final exam weeks (Ratkiewicz, et al. 2010).

Figure 2 shows the relationship among the hosts and simulation of the links among hosts that have been clicked on by the users. The size of each node is proportional to the entrance traffic of the site. Besides, the thickness of the edges proportional to the number of clicks on links between the two sites is also shown. For example, Indiana University has a large node representing a high traffic of user login to the site. The thick edges between Google and Indiana University website demonstrate high traffic of user login from Google to Indiana University.



Fig. 2. Visualization of the most requested hosts and the most clicked links between them. Node size is proportional to the log of the traffic to each site, and edge thickness is proportional to the log of the number of clicks on links between two sites (Ratkiewicz, et al. 2010).

Although using various tricks can help solve this problem in various ways, they are inefficient when there is not enough space available in the network. Hence, the optimal harmonization of using control regulation in social networks has been proposed as a key solution to solve traffic problems. Limited number of researches has been carried out on social network traffic to look at this problem from different perspectives and aspects. For example, Ratkiewicz, J., Flammini, A. and Menczer, F. (2010) concluded that users tend to move between pages in some correlation with their content similarity, and that high traffic correlation among neighbor pages is often caused by direct traffic between them. Finally, they tried to exploit similarity in content and traffic among topics to predict Wikipedia page categories. Methods based on traffic fail to outperform those based on content, but there is plenty of room for improvement even in content-based methods; in future work they plan to explore ways of combining these methods.

The problem of the current study deals with is the time when users of a social network want to login to another social network, they face to traffic difficulties, a problem which needs appropriate ways to be tackled. Some social networking sites such as Facebook, Youtube, Twitter, LinkedIn and the like have many users and are not comparable with other social networks. Therefore, this study focuses on networks with high traffic, or users.

Also, in-network traffic control will not consider in this research, because there are some research works in this area and the in-network traffic control rules are available to solve it. The problem of control regulations exists between two or more networks. For instance, when a user is in Facebook and wishes to enter another social network by clicking on a link such as Youtube, he/she encounters less no traffic problem.

Based on the previous studies, the current research attempts to suggest appropriate methods for optimal harmonization of out-network TCR among social networks. This study proposes two new solutions, namely, direct and indirect pass which have been proposed based on determination of difference of the appropriate phase, determination of reference rule, and measurement of delay in the main network port. The delay has been measured as the difference of the expected time and real time of connection or the time needed to enter the network in simulated conditions.

2. Design of the Idea

In order to protect the personal data and information privacy of the users, social networks are subject to special laws and regulations. The vast majority of young people who use the Internet worldwide, they use social networking sites such as Twitter, Facebook, YouTube, LinkedIn and similar sites as well. There is significant amount of information shared on these websites. Therefore, most of countries have taken some measures to enact several laws and regulations concerning the how-to-use, protection of personal data and right to privacy in cyber space. It is noteworthy to mention that some of the rules have been enacted by the websites or social networks themselves or they follow the legal system where their head quarter operates. For instance, the head quarter of social networks usually based in USA. On the other hand, usually the countries

impose their domestic laws on the users of social networks in their territory. Furthermore, some of the rules are associated with social networks traffic. Optimal harmonization of TCR helps the improvement and traffic optimization of social networks.

As the user of a social network use various parts and tools of the network with less traffic problem, this study concentrates on the overall out-network traffic control regulations disregarding the type of the network. For example, with a user ID and password a user can employ various tools and facilities of the network without need of various IDs and passwords. A good example for this is Google Network. Having a Gmail user ID and password, one can use the different facilities and services offered by the networks within the Google network. To use Google Analyser, Google Ads, Google Doc and the like, one does not need to register for each separately. On the other hand, to use different social networks, one needs to register in different networks and get license from each to be able to have access to the services.

Although various rules and regulations have provided regarding the use of social networks, little has been done about the inter-network traffic regulations. The researchers believe that TCR applicable to inter-network of social networks, as a key element of these networks, have effective role in controlling the flow of traffic. When traffic and registration rules, login and use of a network or between networks increases, networks need to improve the performance of the using rules. The present paper claims that certain rules can allow a group of nodes to pass by some of the login rules into a network without significant interruptions. For example, if a node is composed of members of a well-known expert's forum, there should be a condition to enable them to pass from one network to another without restriction. Or, in special cases, a user or certain group of users can pass from a lower network to a higher one without requirement of a new user ID or password from the upper network.

Moving a node / user group without observing some of the login rules of the network can called as "direct pass" method. To perform this procedure, there must be a relationship between the TCR of the network using , that is, a timing relationship must be established between the user login rules of a network to another network. In this case, the user, based on the predetermined rules, can leave the traffic behind through the "direct pass" rules. Since the users of a network can be classified into different categories, these rules can be applied to a specific class in groups in direct pass method. In the "direct pass" method, all the TCR are adjusted so that the user who passes the first level will have permission to the next level. This can be similiarized to several doors which open one after another as soon as the user passes through the first one and wants to enter the next one.

Network node phase differences can be key elements of traffic harmonization of entering from a network to another network. When two nodes enter into a network at two different times, the difference in arrival time between the two nodes is called "Network Nodes Phase Difference", which can be automatically created without any stimulant. Sometimes, under certain circumstances, node traffic level is so high that the

ideal phase difference is negative. In such circumstances, unlike direct pass method, the lower network access authorization can be issued before gaining access to the upper network. This way the node become free to provide users with sufficient time allocated for them respectively. Such a method is called "indirect pass" method. Establishment of such time relationship for entering networks without inter-network traffic which can be called "Harmonization of Traffic Control Regulations among Social Networks". In this paper, two methods of direct and indirect pass have been proposed for unsaturated and saturated conditions respectively and their performance has been investigated and compared. Harmonization of TCR of the social networks can be feasible through various mechanisms. One mechanism is "basic time control." In this way, the relationship between the timing of entering from a network to another network can be measured with very precise timers within any social network. Predetermined rules for peak traffic times are set based on direct and indirect pass within a network for a period of 24 hours. When applied to all networks and TCR in different sections, this can lead to achievement of relationship of the phase difference between observing and leaving behind the TCR from its various sections.

Regardless of what kind of mechanism is used for harmonization, system or method should use the basic principles to synchronize the controllers. The first "reference rule" can be observing "cycle length" to ensure the rules or licenses of entering the network need to act with the same cycle duration. The cycle length be set according to the time distance of observing the rules of login for any level from within the network or any inter-network level and based on the speed and accessibility level of the network nodes. Based on this principle, the network designer must look for the rules among the network login control rules which requires the longest cycle for harmonizing the entrance control regulations and consider it as the minimum of the cycle length. Then considering the composition of the network nodes, a suitable cycle length for the synchronized network should be taken into consideration. With revealing the login cycle length, it will be the turn of the design phases order and their duration based on the edges for each rule of the network traffic control. The final and most important parameter that must be carefully specified is the "phase difference" of each control rule and entering the network. Phase difference must be considered as the time difference between the entrance from a network to another network in synchronized movement to the reference rule, that is, the rule according to which the timing of all the other TCR are created.

There have been different studies on the delay model in social networks. Bastani et al (201?) contributed a generic framework for describing the characteristics of content exchange among participating nodes in a network. They incorporated a distributed information popularity measurement and the pair wise interaction of nodes modeled as a bargaining problem. The outcome of this process was the fair split up of transmission opportunity as a network resource and the selection of content objects to exchange in order to maximize the nodes' payoff. Yoneki, et al (2007) presented a socio-aware overlay for publish/subscribe communication in delay tolerant networks. Boguñ'a et al (2004) surveyed on the models of social networks based on social distance attachment.

This article, the delay through the main network port is usually calculated as the difference of the expected time and real time of connection or login to the network in simulated conditions. Therefore, it can be claimed that the overall norm for the optimal harmonization of network TCR, is evaluation of these rules performance according to establishment of a reference rule and determination of suitable phase difference, and calculation of delay in the main network port.

3. Methodology

In this study two methods have been introduced for the optimal harmonization of TCR in unsaturated and saturated conditions. Direct pass techniques for unsaturated conditions and indirect pass techniques for saturated conditions have been proposed and each is discussed below. This methodology concept has been illustrated in the figure below. (Figure 3)

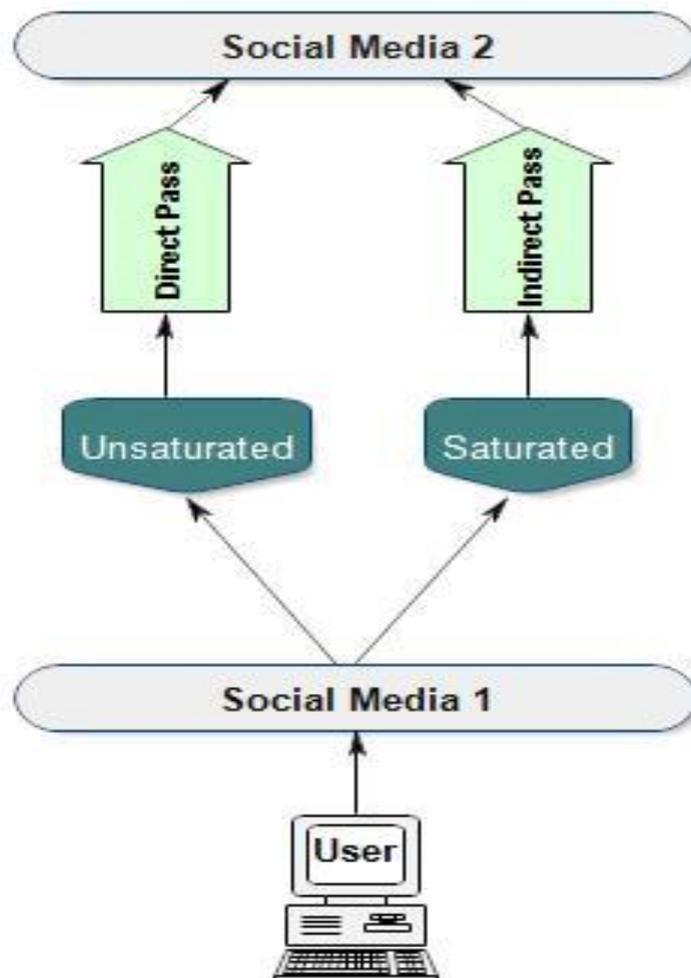


Fig. 3. Conceptual diagram of methodology

3-1 - Unsaturated Conditions

Direct pass method is used in unsaturated conditions. It is assumed that there is no traffic on the way of the lower network node. Considering this assumption, the phase difference (fd) for a direct pass method is defined as following:

$$(1)fd_{n(c)1,2} = \frac{E_2}{v}$$

In this formula, E_2 represents the length of the connecting edge of the lower network node to the upper network node and v is the average access speed of the nodes on this route. In this state of harmonization, for the c cycle the user or node 1 ($n1$) passed through the first access stage should be free at the moment it arrives the next stage in the next network on the way to upper network to be able to continue its task without interruption. The second node ($n2$) also passes the stage and proceeds to the next stage or networks.

3-2 - Saturated Conditions

Due to traffic on the pathway of lower network node, the relationships will change to some extent in the saturated conditions. In this condition we encounter two interrelated norms. One is effective use of free login and the other is preventing unwanted interruptions created by network traffic regulations which are discussed below.

A. Effective Use of Free Login: two interrelated conditions are required for effective and efficient use of the free login. The first condition is optimal use of the free login and the second condition is that the used free login should be able to pass the maximum current of traffic. To achieve the first condition, the phase difference should be adjusted to connect the first node released from the first access stage of the first path, to the end of the second path and node $n2$, while this node progresses within the estimated time. The time $n2$ takes to start its motion, $t(c)2$, can be obtained through concepts of shock wave.

Shock wave in physics means sudden change in pressure and temperature of a layer of air that can be moved to other layers and form a cross-space wavelength. In this paper, the concept of a shock wave is used to calculate the phase difference. For cycle c , when the second access level and crossing Route 2 is free, an accelerated wave in a period of time ($t(c)2$) reaches a second node $n2$. This time is calculated with the following Equation 2:

$$(2) t(c)2 = n(c)2EV/v$$

Where $n(c)2$ is the number of nodes in the path 1, EV represents the effective length of the node and its edge in fixed position status is in terms of ft/nod and the accelerating wave velocity (v) (shock wave) is on ft/sec scale. The time $n1$ needs to connect to $n2$ is $t_{n(c)1,2}$, presupposing that the node moves with a speed equal to the designed basic speed. Thus, the effective use of free transit, the phase difference (fd) is defined by Equation 3:

$$(3) \quad fd_{n(c)1,2} = t_{n(c)1,2} - t_{(c)2}$$

In fact, in this case, the phase difference is defined as the difference of connection time between node 1 and node 2 and the time lower level network node needs to start the movement. Because of existence of traffic in the lower network, the phase difference is negative.

Using the maximum amount of the time of free passage or the indirect pass method means that it is possible to create traffic flow in saturated condition by a combination of the effects of phase difference adjustment, as mentioned above, and dividing this method according to traffic demand. Traffic demand on each route is determined dynamically for each cycle.

In this case, due to saturation conditions and node rejection, the rules of level 1 have negative phase difference in contrast to the rules of level 2. First, the node on the path 2, while crossing the legal limitations of the upper network is not free, is evacuated of the rules of level 2. Then with allowing access to level 1, the waiting nodes on path 1 can enter the Route 2 path. It is obvious, however, to note that if the saturated condition is treated as unsaturated condition and the phase difference is considered positive, we will have node rejection on path 1 and the free passage through the legal limitations will not be able to evacuate it.

B. Prevention of Unwanted Interruptions: unwanted stop occurs when crossing the access level and network TCR is free but due to the node rejection the traffic flow cannot be completed. To deal with this situation, the free passage for upper network path, regarding the free passage time across lower network access level rules, the phase difference between the two levels of access, and the time the fixed status shock wave takes to spread throughout the whole second length E_2 (when the access rule in the lower network path is active) are determined. In this case, we can easily establish the following conditions to avoid unwanted interruptions:

$$[n_{(c)2} = fd_{n(c)1,2} + t_{(s)2}] \geq n_{(c)1}$$

Where $\mu^{n_{(c)1} \rightarrow t_{(s)2} = E_2}$ is the free transit time of the first access level in cycle c and μ is the speed of the shock wave.

3-3 - Investigation of the amount of the delay in two unsaturated (direct method) and saturated (indirect method) states.

Node latency is undoubtedly one of the important parameters for evaluating the performance of social network TCR, which must be taken into consideration by relevant experts. High latency in network, congestion in the network, and increasing number of simultaneous network users are some of the reasons of slow internet.

Importance of this parameter should be taken into consideration in designing network usage and network TCR evaluation. For example, minimizing latency is used in the optimization criteria for network TCR in direct pass method. Nevertheless, the latency parameter cannot be easily defined.

In this part of the article a model for determining the latency time of node and then a final formula to calculate the latency time is explained. To estimate the user login time to the network three different times have been determined. These three are: a) the minimum time used to connect to the network (at), b) the maximum time spent to login to the network (bt), and c) expected login time to the network (ct). It can be used to determine the users' expected time (et) through the following equation:

$$et = \frac{at + 4 ct + bt}{6}$$

When a user enters the network and wants to go from one network to another network, we will have the three estimated times, that is, for entering from node 1 to node 2, there are three estimated times like the time of connection to the first network or node 1. Therefore, in order to determine the waiting time to enter different networks / nodes, these three times should be converted into one time. Since incidence of minimum and maximum times is approximately the same and probability of the possible time is greater than the other estimations, to convert the three times into one, more chance and credit should be considered for the expected time through the following formula:

$$ET = \frac{AT + 4 CT + BT}{6}$$

In this formula, ET is the expected time used by user to log into node 1, node 2 and node x . AT represents the total minimum or least time used to enter node 1, node 2 and node x . BT is the total maximum time used to log into node 1, node 2 and node x . And CT is the total possible login time used to connect to node 1, node 2, and node x .

According to the following formula, in order to obtain the amount of the LT of a user from one network into another, the real time (RT) can be deducted from the expected time (ET) to get the LT.

$$LT = ET - RT$$

3-4 – Network Analysis

Social network analysis software to identify, analyze, visualize and simulate different types of nodes and edges of data input (relational and non-relational), is one of the mathematical models of social networks. Network analysis tools allow researchers to investigate networks of different sizes (small networks such as family and large networks such as the Internet). By providing a variety of tools, these software allows math and statistical proceedings on the network model. These software applications contribute to comprehension and analysis of the results with visual display of the social networks.

“Many users now encounter Internet social network services as well as stores of personal communications like email, instant message and chat logs, and shared files.

Analysis of social media populations and artifacts can create a picture of the aggregate structure of a user's social world" (Smith, et al. 2009).

Mathematical models and social network analysis software can be used for harmonization of the TCR among social networks. There are many software in the field of which *Gephi* has been used in this article. The reason of using this software is its capability in Graph exploration and manipulation software and its support of different formats. Besides, since this is Open Source software and access to it is free, this software was used to analyze and simulate the social network.

Using simulation and analysis of user's status in using the network, it can be shown how sequential access rules and permissions can be used to harmonize in unsaturated conditions. When the user who has entered a lower network passing through consequent rules, she/he can enter a higher network without interruption, waste of time or tolerance of network traffic. In this status, the objective and criteria for optimization is to minimize some perversity such as number of interruptions. While under saturated conditions, objectives and criteria changed to maximize system output performance or minimize network latency.

Using *Gephi* to simulate the traffic flow of social networks in this paper and the plotted time axis, the latency has been calculated as the transit time difference from the expected access levels (when a node experiences in perfect conditions) and the measured transit time in simulated conditions. The transit time is calculated as the average of all the nodes, and then it is converted into bits per second (*bps*).

4. A Case Study

Based on apost of Honeytechblog(2013), Social Networking is the buzz word today with growing number of popularity each day. With more number comes more competition and so is happening with Social Media sites as well. There are many social network sites emerged, yet among them Facebook and YouTube are on top and steadily taking over the social web. According to a data revealed by ComScore and shared by Mashable says that Facebook now has 41% of Social Media Traffic. In addition to showing massive and continued traffic growth throughout 2009 and the beginning of 2010, Facebook and YouTube continued to capture the highest volume of social web traffic. Twitter also garnered a ton of mainstream attention, helping the company increase the number of visitors to its site by fivefold over the course of the year. Figure (4) show that widespread migration from MySpace to Facebook even more clearly. As of March 2010, Facebook traffic made up 41% of all traffic on a list of popular social destinations. MySpace was in second place, capturing around 24% of traffic. Gmail (Gmail) had 15%, and Twitter had 8%. However, during the same period in 2009, MySpace was in the lead with 38% of site visits over Facebook's 33%.The charts posted on Mashable clearly explains the changes in social media traffic between March 2009 and March 2010, and a quick look at them would further offer more details on the difference between the amount of traffic various online destinations enjoyed in the time frame.

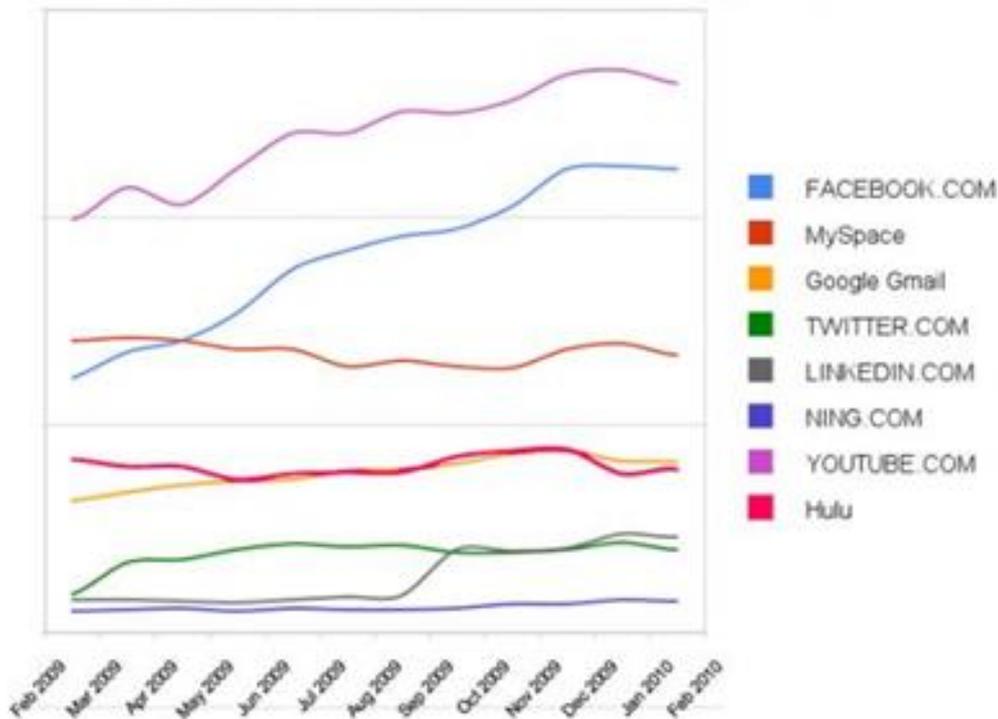


Fig.4. Social Media Traffic Changes (Honeytechblog, 2013)

Social Networks of Facebook and MySpace have millions of members. Facebook was primarily designed for students. According to a study by Dwyer *et.al* (2007), most of the users of Facebook are aged between 18 and 30. They also found that compared to MySpace, another popular social network among users, Facebook has better policy and more reliable environment.

As per the discussed points above, the main reason for choosing Facebook and MySpace as samples for case studies was the popularity of these networks and their rules and policies and the way they interact with their users and vice versa and their traffic level compared to other social networks. For this purpose, the network traffic was initially measured for a period of one week from 9 to 16 of December using NetFlow Analyzer software, a product of Manage Engine.

Manage Engine Net Flow Analyzer is a web-based tool, being used by more than 4000 enterprises, that analyzes NetFlow exports from Cisco routers to provide in-depth information about network traffic including, traffic volume, top talkers, bandwidth consumption, and high usage time. (Manage Engine, 2013)

Figure 5 shows this traffic. As the chart demonstrates, network traffic is different for different times. At times of peak traffic, the OUT category reaches over 70 thousand kilobytes per second. There are also limited times on December 15, when the traffic is zero.

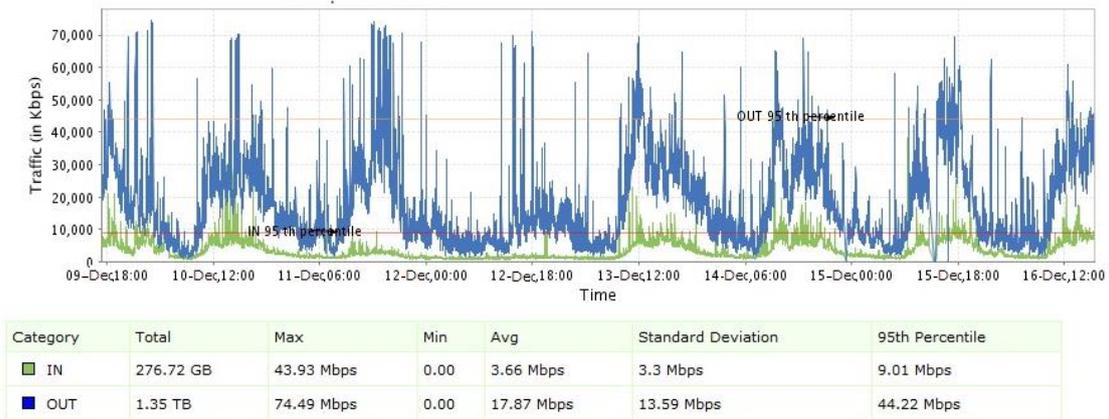


Fig.5. Social Networks of Facebook traffic for a period of one week from 9 to 16 of December 2013

Figure 6 is based on the selected social networks, Facebook and MySpace, using graphics of *Gephi* software output. To determine the phase difference, the second unit was assigned to the horizontal axis and KB to the vertical axis. Hypothetically, the simulated figure shows when a Facebook user connects to MySpace, she/he causes a phase difference resulted from the time difference *between the connection time and difference between network node phases*. This phase difference can be used to control the network traffic using direct and indirect pass methods as elaborated in Design of the Idea section. As mentioned earlier, establishing the time relationship to enter networks without inter-network traffic is known as "harmonization of TCR among social networks".

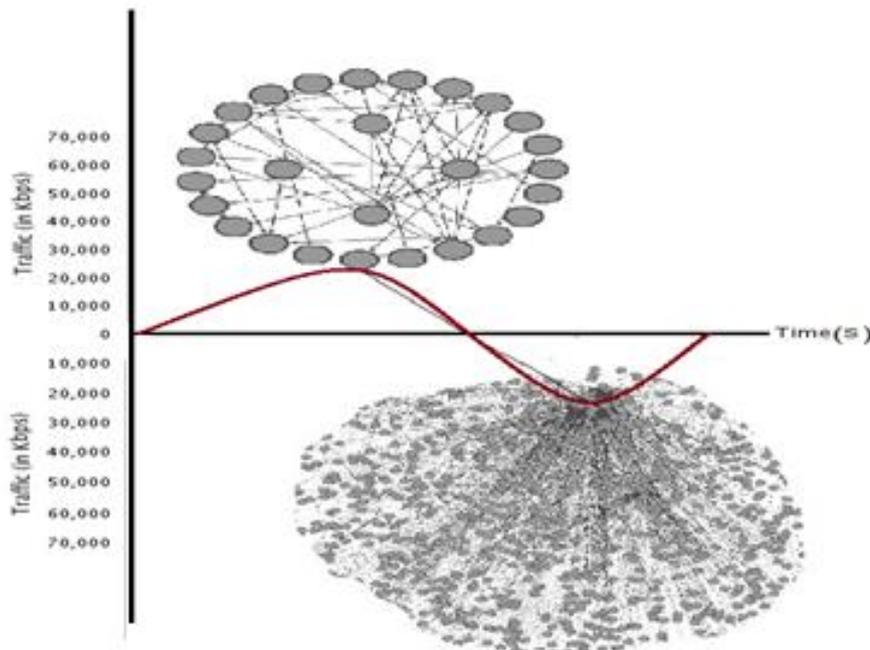


Fig. 6. Display of the phase difference among nodes of two social networks, Facebook and LinkedIn in harmonization of the TCR between social networks

In this study, to do research on direct and indirect pass methods, the social networks of Facebook and MySpace with the access level have been simulated as a member. The traffic in these social networks during peak hours becomes saturated based on geographic location of the user around the world. For this reason, indirect pass method has been used to harmonize the rules of the network traffic control or its access levels. In off-peak hours, however, the network is in unsaturated mode and its harmonization is based on direct pass (positive phase difference). The arterial latency resulted in both unsaturated and saturated modes are listed in Table 1.

Table 1. Arterial latency in unsaturated and saturated statuses

	Latency (centesimal second)	
	Average	Total
Saturated	۴۱۷	۴۲۱
Unsaturated	۲۲۵	۲۲۸

After determining the length of the cycle and phasing in this stage, the phase differences for both unsaturated and saturated conditions was tested using different scenarios. Regarding the latency criterion, the best phase difference was determined for both conditions. The simulation results are given in the following table.

Table 2. Determining the phase differences using the latency criterion in unsaturated and saturated statuses

phase differences (Saturated)	Latency centesimal) (second		phase differences (Unaturated)	Latency (centesimal second)	
	Average	Total		Average	Total
-۱۰	۱۸۹	۱۹۰	۱۰	۱۹۳	۱۹۷
-۱۵	۱۸۵	۱۸۶	۱۵	۱۸۵	۱۸۸
-۲۰	۱۸۴	۱۸۵	۲۰	۱۸۹	۱۹۲

As the result demonstrate, considering the minimum latency criterion, phase -20 difference is selected as the best phase difference for saturated condition. In unsaturated condition, the phase difference of 12 seconds was set as the optimal phase difference.

5. Conclusion

Network traffic is an important issue which is followed by user satisfaction and satisfaction of user is an essential issue which should be taken into consideration in designing social networks. Harmonization of the TCR in social networks is a proper way to more satisfy the network users. However, saturated condition in any network is considered as special and critical condition. Hence, the current research has introduced

new ideas in this regard because research on different harmonization methods and TCR phasing can be a significant step toward removal of the congestion and rejection of nodes in networks. The provided solutions are applicable to direct and **inverse passes**. The results achieved through the present study indicates that in saturated conditions, due to rejection of nodes and inability of the lower network TCR in appropriate evacuation approach, using indirect pass method and in unsaturated conditions using direct pass method, is the best choice for harmonization of the TCR among social networks.

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