FAIR AND SCALABLE WIRELESS MULTI-PLAYER GAMING SYSTEM

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ABSTRACT

Multi-player games are engaging because of social interaction and competing with real players. Currently, many digital games are multi-player or have multi-player features. When evaluating the playability of multi-player games, we need to consider fairness of interactions. This paper develops a mobile distributed system for dependable mobile games over WLANs[1], meeting the requirements of fairness, scalability, responsiveness and equilibrium.

Keywords : *Multi-Player Games, Distributed System, Fairness, Wlans, Authority Server, Authority Server Zone, Scrabble Game*

1. INTRODUCTION

Multi-player games are often considered to be more interesting and challenging than single-player games. The reason for this is player-to-player interaction; playing a game against another player instead of artificial intelligence (AI) is typically more unpredictable and enjoyable. In addition, the game sessions can be socially pleasant. In a multi-player game, two or more players play the game in a same game session. The players may play concurrently or the play sessions may be asynchronous [4, 5, 6].

With the development of wireless communication and mobile computing, new ways for people to interact with each other and their surrounding environment are emerging. Mobile devices, such as Personal Digital Assistants (PDAs) with wireless communication interfaces make people able to communicate directly and play with each other via network sessions. Among them WLAN is an immense example of this fact designed to support a network where most decision-making is distributed across the mobile stations [3].

It is needed to be mentioned that the most significant essential point in such large network games is lack of fairness regarding different distances of players from the Authority Server which umpires the game, and limited researches have been proposed in this issue, yet this paper refers to developing an application over networks of this kind [10].

Current game services essentially rely on a centralized authority, but this paper proposes a suitable game system in which categorized players depend on their geographical situation and mobility that helps the system to be scalable and to satisfy a large number of players .The question of finding the fairness of a game is of central importance, and thus, it is the central issue we concentrate on this paper. The system considers variable communication delay of traversing intervals from players to the dynamic main Authority Server and waiting time to obtain fairness. As can be expected, such models tend to ignore the selfish behavior of players.

This paper is structured as follow. In the next section all kinds of Multi-player and Internet games will be discussed. In section 3, the main configuration and structure of WLANs will be reviewed. In section 4, one kind of online game considers. In section 5, we summarize the chief requirements needed to carry out mobile games such as Scrabble game over WLANs. In section 6, the architecture that we propose to support mobile competitive environment, meeting the requirements mentioned, will be described, and communication protocols describes immediately.

[1] Wireless Local Area Networks

Finally, in section 6, we provide some concluding remarks.

2. MULTI-PLAYER GAMES

In a multi-player game, two or more players play the game in a same game session. The players may play concurrently or the play sessions may be asynchronous. In the asynchronous play sessions, the players access the same game world, but not necessarily at the same time.

Multi-player games can be divided into two categories: 1) online games and 2) proximity games [21, 22, 16].

When considering how the game state is maintained from a game session to another, the multi-player games can be also divided into two categories: 1) persistent games and 2) non-persistent games [11, 12].

In the persistent games, the game state is typically maintained on game servers and the players connect to them with a game client. In online games, players are connected to each other via the Internet or other kind of network technology, such as a peer-to-peer network. The players usually do not share the same physical space and they use their own device (a computer, a game console or a handheld device) for playing the game. In these games, the player population can range from a few to hundreds of thousands. For example, a popular Massively Multi-player Online Game (MMOG) World of Warcraft has 8 million registered players and there have been 200,000 players playing the game simultaneously [22].

A single device can also be used for playing a multi-player game. There are three common ways of doing this. First, players can use game controllers to connect to a centralized computer or a game console to remotely control the game. Second, the players can use one game controller and take turns to play the game. This is typically called “hot seating”. Third, the players can use one gaming device and share the keypad or the keyboard while playing the game simultaneously [11, 12].

The objective of this study is to find out issues that affect the responsiveness, scalability and fairness of mobile multi-player games over WLANs, and analyze details of the proposed architecture.

3. WIRELESS LOCAL AREA NETWORKS

The wireless LAN protocol is based on the IEEE 802.11 and 802.11b standards. The standard defines a medium access control (MAC) sub layer and three physical (PHY) layers. The goal of the IEEE 802.11 protocol is to describe a wireless LAN that delivers services commonly found in wired networks, such as throughput, reliable data delivery, and continuous network connections. The architecture of the IEEE 802.11 WLAN is designed to support a network where most decision-making is distributed across the mobile stations.

Some of the basic components of the 802.11 based networks are described below:

• Station: In IEEE 802.11 network a station is the component that connects to the wireless medium. The station may be mobile, portable, or stationary. Every station supports all station services, which include authentication, deauthentication, privacy, and delivery of the data (MAC service data unit).

• Basic Service Set (BSS): The IEEE 802.11 WLAN architecture is built around a BSS. A BSS is a set of stations that communicate with each another. When all of the stations in the BSS can communicate with each other directly and there is no connection to a wired network, the BSS is called an independent BSS (IBSS). An IBSS, which is also know as an adhoc network, is typically a short-lived network with small number of stations that are in direct communication range. When a BSS includes an access point (AP), the BSS is no longer independent and is called an infrastructure BSS, or simply a BSS. In an infrastructure BSS, all mobile stations communicate with the AP. The AP provides the connection to the wired LAN, if there is one, and the local relay function within the BSS.

• Extended Service Set (ESS): An ESS is a set of infrastructure BSSs, where the APs communicate among themselves to forward traffic from one BSS to another. The APs perform this communication via a distribution system (DS). The DS is the backbone of the WLAN and can be composed of wired or wireless networks [6, 21].

4. SCRABBLE GAME

All users of Scrabble shall be called players. We shall refer to a Scrabble player who makes a move in the game as the drawing player. All other players that at this time point play the same game as the player shall be referred to as the competitors. All players that play a game together shall be referred to as the game group or the game players. Scrabble is a game with turns, played usually by 3 or 4 players. Each player has a secret pool of letters that he tries to use to create words on the board. The players are awarded points for the words they put on the board, depending on their location on the board and the type of letters used. The correctness of words on the board is verified using dictionaries. The letters are drawn from a letter sack. At the end of each turn, a player must draw new letters so that he will have a fixed number of letters [23]. We shall not go into further detail of Scrabble rules, referring the reader to the game documentation.

There is no doubt that use of wireless and mobile networks and devices is growing. Advanced and mature wireless and mobile technologies facilitate developing applications conducted from a wired network to a wireless network [6].

In the next section, we will go through the main requisites of a mobile and scalable Scrabble game over the WLANs, and then describe the structure of proposed architecture based on the 802.11 based networks.

5. REQUISITES

The specific requirements implied by the deployment of scalable Scrabble game over internet are included:

5.1. Security

The set of all players in Scrabble is the set of all players currently playing all games. From the point of view of a game group, all other players are called disinterested players. Many problems with the design of Scrabble could be solved if the game players could trust disinterested players.

However, this may not be as simple as it seems. There are two reasons why disinterested players cannot be wholly trusted: first, the players of a game could be in coalition with some disinterested players (in other words, these players may not be disinterested at all). Second, the disinterested players could be malicious: for the sake of spoiling the game for others (and improving their own ranking), a disinterested player could reveal or falsify information related to the players of a game. For this reason, the sharing of information with disinterested players must be limited to a minimum [1, 2, 3,14].

5.2. Fairness

Fairness, which means that all participants should have an equal fair chance for submitting their letters and should be treated equally, is the most important challenge for every type of games or competitions. Because in all networks players who located in farther situation from authority have less opportunity to process their situation, and they will be informed later from the status of the system, unfair condition will be provided [1,14, 9].

5.3. Scalability

Responsiveness and scalability are the essential requirements of large and scalable competitive systems. The responsiveness requirement, i.e. a service must be timely and available under specified load and failure hypothesis, is motivated by the observation that a service that exhibit poor responsiveness is virtually equivalent to an unavailable service. Thus, within the mobile context, an unresponsive service may discourage users from using it. The architecture used for scalable system user should receive a qualified and prompt regardless of the number of users of system [10, 11, 12].

5.4. Integrity

Because of the mobility of users, it is needed that they carry their ranking history themselves via the zones they move [6].

5.5. Speed

The key to a successful scalable game is speed, e.g. the ability to respond without any delay related to the far distance [6].

The problem which addressed in this paper refers to proposing an optimum model for deploying a scalable, fair competitive condition over mobile networks.

6. THE SYSTEM ARCHITECTURE

We assume that the initial steps, included the primary registration for game, performs and the system is in the competitive phase.

In this proposed model, the system is made up of two layers. In one layer, mobile nodes divide in to many zones regarding their geographical position. In each zone, management of competition relies on an immobile or somehow stable node called ASZ[2]. In the underneath layer communications are intra zone and included nodes which the zone possesses. In each zone, users propose their letter one by one to ASZ and will be informed by that

[2] Authority Server Zone

from the competition's status, and rivals' position in a specific round. ASZ acts as an intermediate between nodes inside a zone and the main authority. It conveys only the right letters of winners to the main authority which called AS[3].

The base of this model relies on trust between nodes of a zone and their ASZ. The best positive point for this method refers to being anonymous from the view of the AS and other rivals. As the best strategy might be hard to design, implement, or compute, the equilibrium notion is relaxed, and we also consider approximate equilibrium in which every player achieves a competitive ratio that is within a known factor away from the best competitive ratio attainable by any strategy.

It is also important that AS do not have to communicate with a large number of users participated in the game, it communicates only with the ASZs of all zones instead of their members. This makes the system scalable and increases the power of system responsibility.

We can consider the ASZs as servers which are attached to the access points and the AS as a server attached to the bridge in WLAN networks.

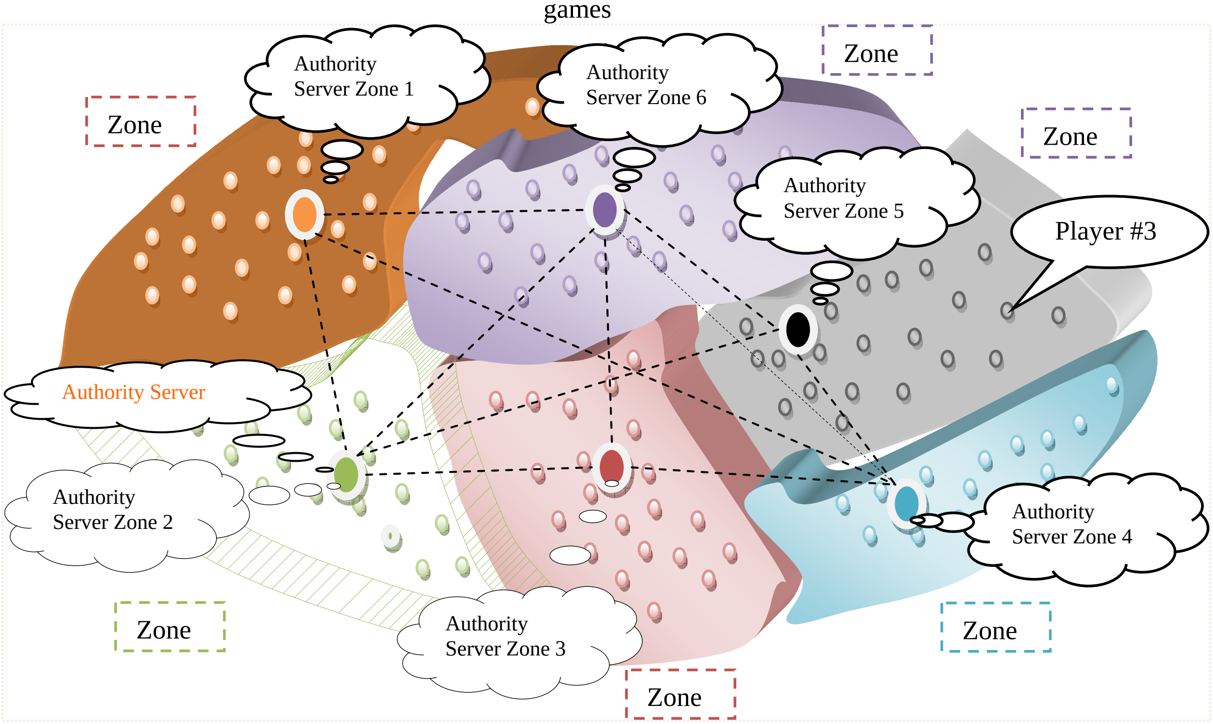
In each zone some players do move from one zone to another zone by passing the time. After moving to another zone, the ASZ of the new zone accepts the node and it can continue the play in the new zone.

Fig 1 gives an example that shows many players arrange in six zones. In this example, ASZ_2 acts as the main authority (AS). Each player proposes his letter to the ASZ related to his zone. If the suggested letter seems to be right in one zone the ASZ has the responsibility for sending that to the AS. In this example if $P_{5.3}$ that is the third node of zone #5 proposes a letter which is the right at the moment, the letter will be sent for ASZ_5 at first and it is ASZ_5 that consider the rank of $P_{5.3}$ solemnly. It waits for all players from users pertained to that zone and then sends the right ones to AS.

The round duration has to be fixed and equal for each competitor such that all participants have enough time and an equally fair chance of submitting a successful letter during the current round. The start point and stop point for each round duration depends on the time that player receives the message and they may be shifted toward rivals. The fairness problem in the WLANs context implies that the farthest player from the AS will always react later than the other players. This results in a lack of fairness with regard to letter submission. Therefore, what is important for resolving the fairness problem relies on the correct estimation of the necessary round duration time allowing the fulfillment of defined fairness condition. The round duration time is calculated on the basis of the worst case, the case allowing the farthest node of AS to receive message and submit letters.

[3] Authority Server

Fig 1: Distributed architecture for mobile games



In each zone, ASZ considers delay time for receiving all available letters from nodes pertain to that zone including the farthest node regarding the number and distance of nodes related to that zone and informs the AS from calculated time. It means AS must wait until all letters of each ASZ were received. The waiting time includes local zone delay plus delay for network communication between ASZs and AS. Therefore, the round duration time is the time that all ASZs submit the letters of winners in game to AS.

Consequently, the optimal calculated delay for assuring fairness is:

$$Delay_{optimal} = (M_{hop} - M_{actual}) * 2 * TD \quad (1)$$

M_{hop} is the maximum number of hops referring to the farthest node from the ASZ. M_{actual} is the number of hops referring to the nearest node or the node whose suggested letter arrives sooner than other players. The factor 2 refers to the RTT condition, and the last parameter TD represents the mediocre time delay for traversing between two nodes (one hop).

This delay time may be changed by changing the number of nodes of one zone. We can assume that in each zone fairness is guaranteed, however it is needed to take in to consideration the communication delays in the second layer between ASZs and AS for assuring fairness throughout the whole system. By dividing the system in to two layers, we can avoid shifting the problem of intra zones to the communication between ASZs and AS. For this purpose ASZs need routing tables which included the address of AS and the optimum path to that and delay for each path. It is needed to consider the different delays related to different distances between ASZs and the AS.

The most positive point about this model refers to the fact that is compatible with the WLAN[4] networks. We can conduct the play in each BSS[5] by attaching servers to access points and a server to the bridge in the ESS[6]. The servers related to access points evaluates the content of packets before the access points forward them. Therefore, most packets are not allowed to send

[4] Wireless LAN
[5] Basic service set
[6] Extended service set

via the connection and decrease the traffic as well as increase the responsibility. In this way the tasks will be distributed among servers and will be done concurrently.

7. COMMUNICATION PROTOCOLS

Since in this model there are two principal transactions, two principal protocols are required in order to implement this model.

7.1. Player-to-ASZ protocol

Mobile nodes are under the control of their ASZ, and receive the information about ranks. If they have a new suggestion, propose it to their local ASZ. The ASZ send the right ones to the AS, otherwise they will be ignored.
By moving one node from one zone to another, the ASZ of the current zone must accept the node and register that in its database, and behave it as the other node pertained to the zone.
Here do we mention the parallel code that must be executed in each player.

Player's pseudo code:

```
cobegin {
        //Do parallel in each Player
        RequestMeessage Msg;
        Msg.setSourceStation (this);
        Msg.setDestination (AszId);
        Msg.send ();
        // send the request message to the ASZ
        GetIncomingMessage (IncomingsMsg);
        // receive response of the request message
        if (getValidate (IncomingsMsg))
        {
        // if user decide to propose a new letter
        Message message = new Message ();
        id.setValue (getNewletter ());
        message.setContent (id);
        message.setSourceStation (this);
        message.setDestination (AszId);
        message.send ();
        /*make a new message and set it's content by the player's letter*/
        }
}coend
```

7.2. ASZ-to-AS protocol

ASZs are usually fixed nodes that act as a proxy for each zone. It has a responsibility to constitute a table which includes Optimum path with delay of path to all ASZs, and informs all of them of other zones.
When ASZs receive letters that come out right from their mobile nodes, inform the AS through the optimum path. They must wait until the time that makes sure no more reaction are existed and letters from the farthest nodes are arrived. This model considers optimum Delay as the fair time. The AS considers differences in distances between ASZs and itself, and waits until the time that makes sure letters from the farthest ASZs are received. This protocol use an atomic transaction to ensure that the letter submission operation performed from the player is executed in a fair manner.
The letter submitting transaction consist 6 stages:

1. An active node, for instance $P_{1.1}$, proposes a letter to the ASZ of its zone (A_1).
2. If the received letter from node N pertained to zone$_i$ is the first letter that is arrived, the ASZ_i must wait $T_{1.i}$ until other assumed letters from father rivals arrive.

$$T_{1.i}=(M_{hop}-M_{actual}) * 2 * TD - T_{(\text{path from N to Ai})} \quad (2)$$

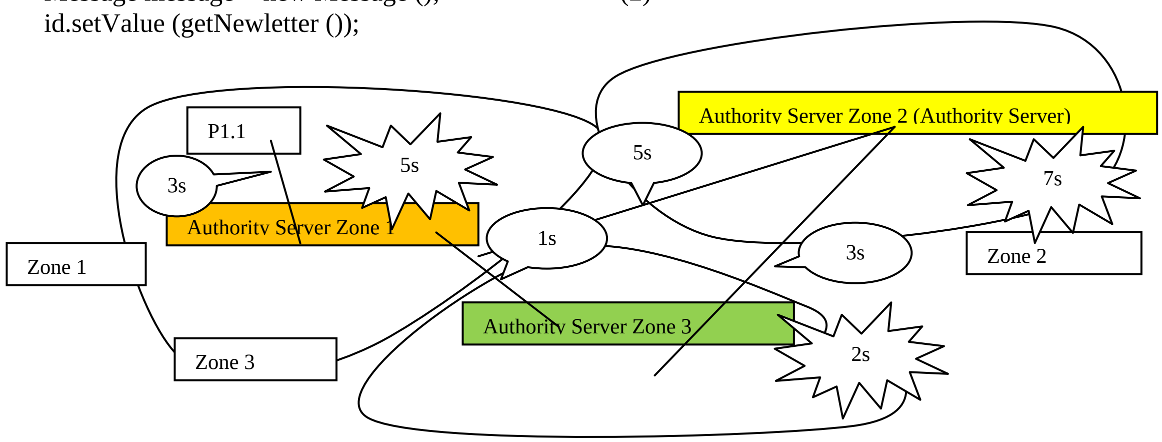


Fig 2: performing fairness by spotting delays and paralleling

After collecting all letters and waiting $T_{1.i}$, ASZ_i (A_i) considers all letters and do nothing if no right suggestion occurs, otherwise forwards the right ones to the AS. For example, in fig 2, ASZ_1 wait two seconds after receiving message of $P_{1.1}$, so that if there are some letters which have not arrived yet, will be received. A_1 surveys all letters locally after that, and forwards the right ones to ASZ_2 (A_2) if it is a letter which comes out true. The codes that must concurrently be executed in each ASZ will be mentioned below.

ASZ's pseudo code:

```
cobegin {
        /* this code is executed parallel!! Until
        the play's end. ASZ receives all
        messages from all clients in the zone */
        for (Message msg:
getIncomingMessages ())
        {
        if (getTime () is valid)
        {// if it is valid, add it to the Incoming
Queue
                IncomingMessageQueue().add
(msg);
                if (Correct (msg))
                {
        LocalWinnerId=msg.getSourceStation;
        Alarmmsg.setDestination
        (localWinerId);
        // send success message for local
        winner!
        /* it will send only if the estimated
        remaining time show that it is possible
        for the client to be winner! */
                if (estimatedTime is valid)
                        Send (Alarmmsg);
                 }
        }
        else
        /* if the round time is over or client
        send another message contained a new
        letter */
                Start new parallel thread;
        }
        if (Correct (Msg in Queue))
        {
        /* if the letter is correct, forward the
        message to AS */
                 Msg.setSourceStation (this);
                 Msg.setDestination (AsId);
                Send (msg);
                }
        Receive (Message Alarmmsg);
        // wait until the response received from
AS
        if (! Alarmmsg.content)
        // send failed message for local winner!
                Msg.setDestination
(localWinerId);
 }coend
```

3. If the proposed letter received from zone k to AS which is the first arrived right letter through the shortest path, AS will waits T_2 until other ASZs reveals their likely right letters.

$$T_2=\max\{T_{j.i}+T_{(\text{best path from Ai to AS})}\}-(T_{1.k}+T_{(\text{path K-A})}) \quad (3)$$

In the expressed example, winner ids and true letters from A_1 are forward to A_2 through the third zone that makes the shortest path. It is because of that if there is no problem in network communication, AS receives messages from the second zone at first, and it must wait 4 second for receiving messages from the first zone which is farther in addition to the high local delay.

In this stage, regarding the arrived ids AS assesses the status and rank of each player in the system, and informs all ASZs through the optimum path if any changes in players' ranks happen. It is needed to take in to consideration delays for sending these messages. Here is the code that must be executed in AS.

AS's pseudo code:

```
cobegin {
        /* this code is executed parallel!! Until
        the end of play. AS receives all
        messages from all ASZs */
        for (Message msg:
getIncomingMessages ())
        {
        if (getTime () is valid)
        // if it is valid, add it to the Incoming
Queue
                IncomingMessageQueue().add
(msg);
        else
        /* if the round time is over or ASZ send
        another message contained a new letter
        that it makes the new round start!! */
                Start new parallel thread;
        }
        if (getIdentifyWinner (Queue)! =
winnerId)
        {
```

```
        // after a round is finished, find the winner
        WinnerId = getIdentifyWinner (Queue);
        Message message = new Message ();
        message.setContent = true;
        message.setSourceStation (this);
        message.setDestinatin (BroadcastId);
        Send (message);
        } // end of if
} // coend
```

4. If play time is over and there is no opportunity to propose new letters, the final winner will be announced and proposing phase will be finished. Otherwise these stages will be repeated from the first one.

8. CONCLUDING REMARKS

Regarding the explained restrictions related to mobile networks such as ad hoc networks it is clear that an especial architecture is required to have a fair, scalable mobile play over networks of this kind.

In the proposed model in this paper, scalability requirement is obviated by categorizing nodes regarding their geographical situation regarding WLANs.

In addition, by considering intra delays for sending and receiving messages and preventing penetration of this kind of different network delays which make the system unfair to the second layer it is tried to construct a fair architecture.

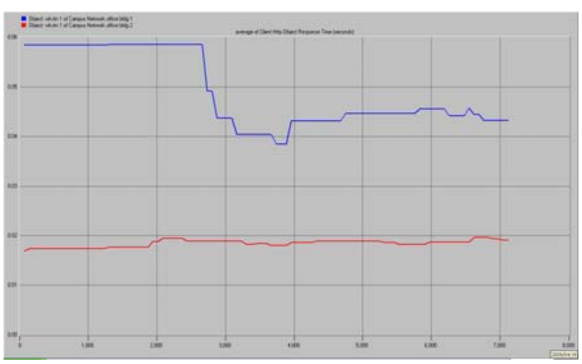


Fig 3: compare response time before apply the proposed idea

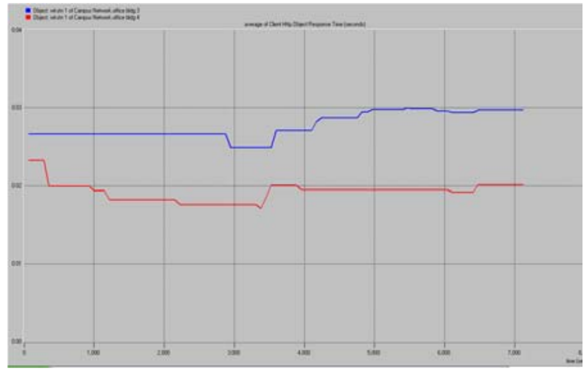


Fig 4: compare response time after apply the proposed idea

We used OPNET.v.10.5 Modeler, An environment that used to study performance changes of networks: organizational scaling, technology changes, and application deployment, to simulate this model and study its performance. As fig 3 and fig 2 shows before applying the proposed architecture, deference between response times of a node far from CS is much than when we consider and imposed the disinterested delay for nodes near to CS. Therefore by making their response time close to each other we make the system fair in competitive environments.

The most positive point about this model refers to the fact that all codes will be executed parallel; therefore the system will be scalable and fair because of the concurrent processing of customers suggested requests.

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