An Intelligent Method for Resource Management in Wireless Networks

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Abstract—**In wireless cellular network, resource constraint has become a critical and important issue. Users always and everywhere expect telecommunication systems with the best quality. They also need visual and multimedia communication. So, an intelligent wireless network that has the ability to adapt to environment in different network traffics is needed. The intelligent network has the capability to decide and modify itself. One of these intelligent methods is the use of multi-agent system. The main criteria considered in resource management of cellular networks are rate of dropped calls and blocked calls. Blocked calls include new calls and dropped calls include calls which are made by transition a mobile from a cell to another cell. In this project, we take a look at former techniques and then we will propose solutions to reduce the two mentioned criteria based on intelligent agents. The main purposes of this article are: reducing dropped calls, reducing blocked calls and decreasing traffic load variance between several cells and balancing among them. The results show that implementing multi-agnet system concerning intelligence and using agnets in proposed method has noticeable improvement than other methods in decreasing blocked calls and dropped calls.**

Keywords: Cellular Wireless Network, Multi-Agent System, Call Allocation, Mobility Management, Handover

I. INTRODUCTION

Nowadays, a wide variety of communications is allocated to wireless communication. Cellular network is capable to transmit data and imitate general roaming in addition to creating voice and video telecommunication.

Optimum use of resources always is an important bottleneck for wireless networks and wide varioty of users is utilizing wireless services despite resource limitation. It is needed a most efficient resource management system for resolving high bandwith and appropriate data rate requirements of users. Several techniques for channel allocation, optimum communication between cells and etc is creating in order to advance resource management solutions. Intelligent agents with attention to their internal reaction have certified impovement of resources usage.

In this article, we proposed an optimum solution for resource management in cellular network by using intelligent agents. Section II belongs to agents and their specifications. Section III is talked about availabe chalenge in wireless cellular network. Section IV is specified to survey different techniques of cellular networks resource management. Afterwards in section V the arthicture of distinct parts of proposed model, main explanation of implimentated model and its related algorithms are explained. Later in section VII results are illustrated and compared with other methods. Finally, conclusion is discussed in section VIII.

II. AGENT AND MULTI-AGENT SYSTEM

Agent is autonomous software that can migrate and transport its code and status from one host to another in a network. We can say that agents are smart programs that learn and predict user needs and act based on it and they can collaborate with each other. [1]

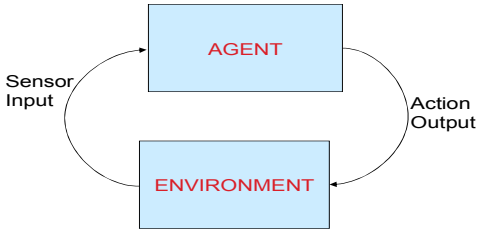

Figure 1. Architecture of an agent

Agents have four prime properties: [2]

Autonomy: the ability of making decisions without direct action of a human. Reactivity: refers to the fact that agents need to know the environment around them. This environment can be the physical world, or a user via GUI or a group of other agents. Social ability: the ability of connection and wise collaboration between other users, agents and environment for collecting data and informing progresses. Proactivity: agents must have proactivity ability and absorb precise and suitable ideas for creating the qualification to decide. For implementing multi agent systems, all the properties are required.

III. CHALLENGES IN WIRELESS CELLULAR NETWORK

Today, wireless communication is more than voice communication and includes multimedia communication. Therefore it is needed to increase bandwith for communication. Video confrencing supporting with high data rate means we need more bandwith in wireless link and it possiblly will change wireless model completely [3].

User mobility is the other problem. Rising of users requires more attention for managing their mobility. Several elements affect upto a call doesn't drop and have had good quality, while a user migrates from a cell to another cell [4].

Security has been a vital issue due to increasing usage of wireless cellular network. It is necessary to prevent from troublous outsiders that maybe have intensive harm for client and server [4].

Power consumption is also one of the main challenges for those nodes which are motivating in networks [5]. So nowadays resource management has became an important goal in wireless networks.

IV. SURVEY OF RESOURCE MANAGEMENT TECHNIQUES

In past in order to establish a communication, some channels were allocated for every cell, but today by regarding use of same frequency in neighbor cells the problem of allocating channel has been changed to allocating bandwith. We can consider channel allocation in explained methods equal to bandwith allocation.

A. Unintelligent techniques

These techniques are old, but have usage now.

1) Channel allocation techniques

In FCA[1] model, all of under coverage area is devided into several cells and based on some usual pattern, number of channels are allocated to each cell. There are several models for managing resource according to FCA but none of them are successful to reach an optimum method. It's Because of when network traffic and users distribution in different parts change, requirement for channels changes too. In DCA[2] method all channels have been standed in a pool and have been allocated according to their trafic pattern. However this method will be inefficient under high impact of traffic and usually combination of these two methods are used as a combination method [6,7].

2) Channel reservation techniques

In FCR[3], fixed number of channels have been reserved for handover calls as a preservation channel.But this method will have useless reserved channels at low traffic time and will have shortage of channels at high trafic time.VCR[4] method despite of FCR has considered to users motivation manner and has allocated channel for handover based on traffic history, present and future. This method in comparison with FCR has better result but it has no idea about users motivation in traffic load in each cell [8].

B. Intelligent resource management procedures

These methods are based on artificial intelligence techniques.

1) Users history measurment

Bandwidth of each cell can be predicted with measurment of users history.There are two way for calculating users history.In first method, profile of each cell has surveyed and in second method profile of each user has surveyed seperatedly. Both of these ways have some problems and some profits. Veiw point based on user seems more accurate, but implementation and spread of this method is precious and sophisticated.On the other hand in point of view based on cell, users personal habit hasn't identified.It seems that cellular view is profitable for steady communications and user based view is usefull for roaming situations and rapid load changes [9].

2) Balancing cells load by intelligent antenna

One way is to use intelligent antenna with capabality of changing vector for balancing the load of cells in wireless network. At the time that traffic load of one cell becomes higher than a specific rate, neighbor cells have negotiated with each other and the best decision has taken and broadcasted. For example, among neighbor cells cell which has lower load and has less distance to this cell has decreased the load with rotating its antenna to that cell and changing its transmitted power [10].

3) None intelligent methods combination with agents

There are other methods that have combined unintelligent methods with agents.It deacreases dropped calls and blocked calls.An example of these methods is DCA method with multi-agent system [11].

4) Socially Intelligent Multi Agent System

Utility function in each cell determines user satisfaction with quality of service. Whenever function coefficient goes up, client satisfaction goes up too. The goal of agent is increasing utility that sometimes it makes increasing global utility of system, but maybe it becomes harmful for some agent and isn't a fair method for subjective nodes.Social intelligent agents is based on increasing utility function of whole system regarding to cells subjective utility.Therefore in

[1] Fixed Channel Allocation
[2] Dynamic Channel Allocation
[3] Fixed Channel Reservation
[4] Virtual Channel reservation

this model agents try to make a decision in order to increasing subjective utility and its positive effect on global utility [12].

V. PROPOSED METHOD

Architecture of proposed method and related algorithm are:

A. 3G Network architecture

Architecture of proposed network is based on UMTS standard. This network includes 3 main parts. Cellphones those are network users. BTS (node B) which are giving service to cellphones and RNC that controls BTS.

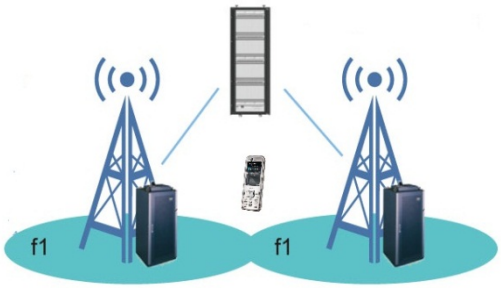

Figure 2. 3G network architechture

B. Network correlation model

Network correlation model which contains 3 parts are like this:

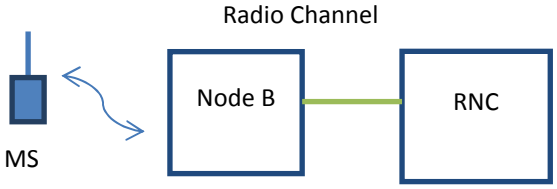

Figure3. Network communication model

C. Cellular structure

Cells are divided into three main regions. This division is based on network traffic, physical point and users speed.

Downtown cell: cell phones speed is low in this region and most of them are stationary. Therefore range of handover calls is lower than other cells.

Urban cell: in these cells there is no balance between motivated cellphones and stationary cellphones. Number of handovers is more than downtown cells and less than highway cells.

Highway cells: movement speed of cellphones and number of motivated cellphones in this cells are more than others. Number of handover is high in this region.

D. Agent structure

Applied structure is OAA[5] that is shown in figure 5. This structure has the ability of parallel cooperation, simple expanding and adding or removing agents simply, in comparison of other structures [13].

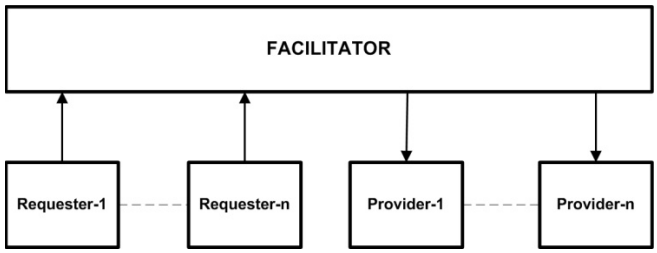

Figure 4. OAA structure

Requester agents request a source or service from provider agent. Facilitator agent is as a controller that takes requests and makes suitable services transmits them by provider.

E. Agents responsibilities and roles

Software agent's assignment of B, RNC and MS nodes comes below:

1) Node B agent

Reserving channel for cells accomplish by this agent according to THD. A list of done works by this node is:

1. Reserving bandwidth for handover based on THD.
2. Call request conduction to neighbor cells.
3. Balancing loads with forcing internal calls which are handover with neighbor cells.
4. On appeal, traffic load pattern preparation for neighbor node B agent.
5. Prediction of entered traffic load from neighbor by user history
6. Requesting user profile and traffic history from RNC

2) RNC agent

Call allocation decision is done in this agent:

1. Creating user profile Databes[6] and traffic history database[7]
2. Determining part of bandwidth for handover calls
3. Network monitoring in order to load balancing in cells
4. Reducing allocating bandwidth to high priority in heavy traffic time
5. Sending requested information about cells and users for B node

[5] Open Agent Architechture
[6] UPD
[7] THD

3) Mobile agent

These agents have less computed load than other agents and are used for:

1. Measuring Signal strenght of B node continuously
2. Initiate negotiotion for call request
3. saving theis last call information and sending them to RNC
4. intiate handover when signal strenght is less than specified value and before call dropping

F. THD

It saves daily traffic data of each cell such as traffic load, blocked rate and dropped rate. This database produces and preserves by RNC instead of node B to decrease signaling and searching expense.

G. UPD

Data like call duration speed and vector of call saves according to users call history. This data is useful for predicting traffic load to cells.

H. Call allocating algorithm and network load balancer

When a new call creates first cellphone requests to its node B that node compares busy load factor with its maximum value for new calls. Also node B requests from RNC to introduce neighbor cell with least busy factor. If cell busy factor was lower than LBF cell, accepts call otherwise devolve it to LBF cell. If all neighbor cells were busy, cell reduces bandwidth calls with low priority to respond created call. Fore handover calls always part of bandwidth is reserved. Therefore a handover call is accepted probably. Because of high calculated load, if cells have full load, call doesn't introduce to cells rather try to reduce bandwidth calls with low priority and respond to handover calls. Quantity of threshold busy factor is calculated with THD and UPD. This quantity identifies with RNC. RNC in each hour based on previous days traffic and number of available mobile calls in neighbor cells, which can inter to cell, make decision about choosing threshold busy factor quantity and reserved bandwidth quantity for handover calls.

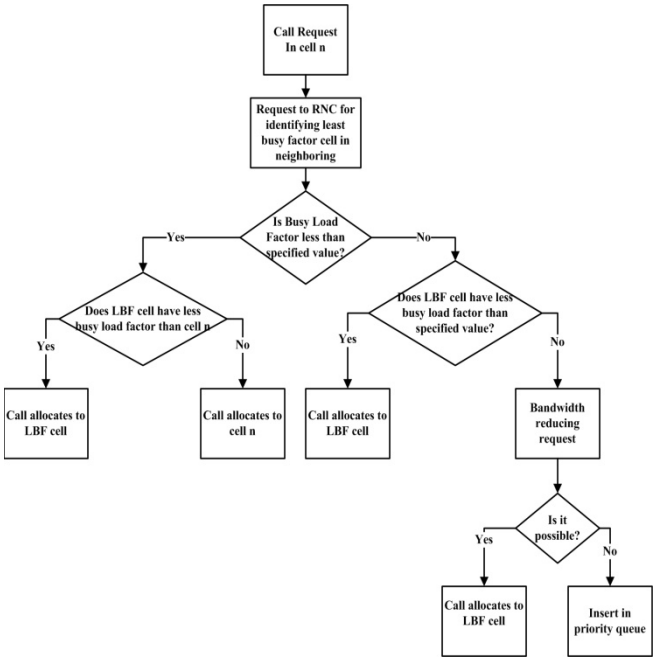

Figure 5. Call allocating algorithm

Mobile agent calculates SIR[8] rate permanently and if its quantity came lower than reserved SIR starts to have conversation with other cells to receive better service. Node B agents with passing calls to neighbors, balance traffic load in different cells. What it seems important is priority for decreasing calls bandwidth. While presenting low quality, mobile agent can request new call to less busy load cell or negotiates with node B agent for receiving more bandwidth. By this way quality of service preserve up to it is possible.

VI. SIMULATION RESULTS

Network traffic calculating criteria is based on two main parameters:

- Blocked calls percent: ratio of blocked new calls to whole calls.
- Dropped calls percent: ratio of all dropped handover calls to whole handover calls.

A. Comparison of proposed model and unintelligent models

Proposed model is compared with two current models FCR and VCR. VCR model has better operation in comparison with FCR because of allocating dynamic bandwidth for reserved calls and new calls. Dropped calls rate of VCR model is lower than FCR obviously but this model in blocked calls has no clear change than FCR. As it is seen in figure (6) and (7) because of reaction between cells for balancing network load distribution and using of intelligent methods, proposed model has an obvious improvement rather than two other methods.

[8] Signal Interference Ratio

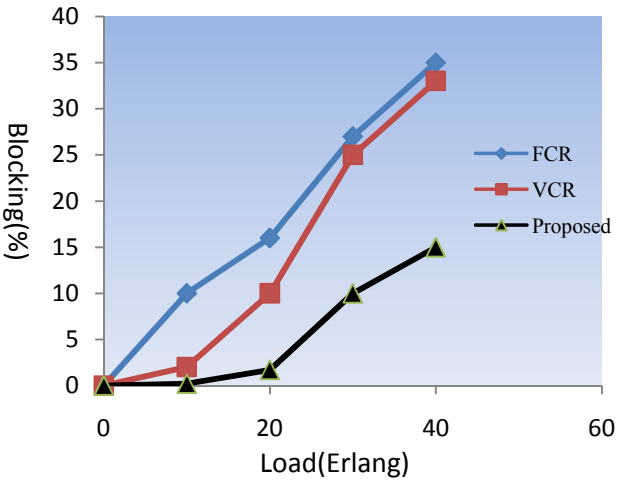

Figure 6. Comparision of proposed model and unintelligent models (Blocking rate)

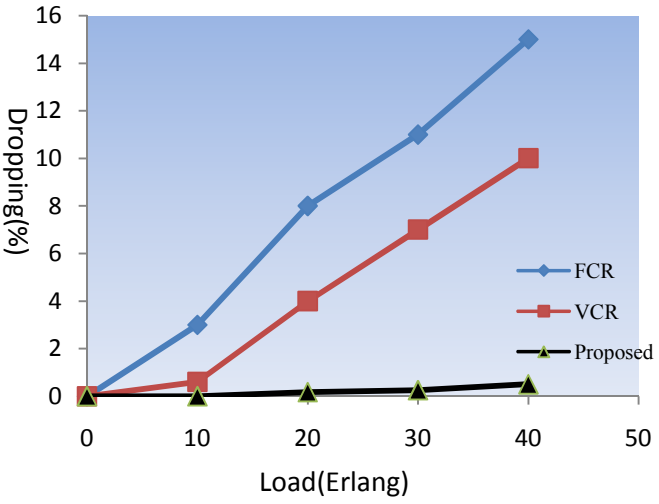

Figure 7. Comparision of proposed model and unintelligent models (Dropping rate)

As is shown in figure (8) and (9), difference between intelligent model and unintelligent method increases with increasing network traffic. With attention to importance of handover calls, difference percent of dropped calls among intelligent model and unintelligent is more than its difference percent of blocked calls.

B. Comparison of proposed method and intelligent methods

Proposed method is compared with three intelligent methods. In two ABRM [13] and CS [14] methods have been used of balancer but lack of active queue and also bandwidth Reducer causes significant difference specifically in dropped calls. ABRM method has better situation than CS in higher traffic because of using cells history.

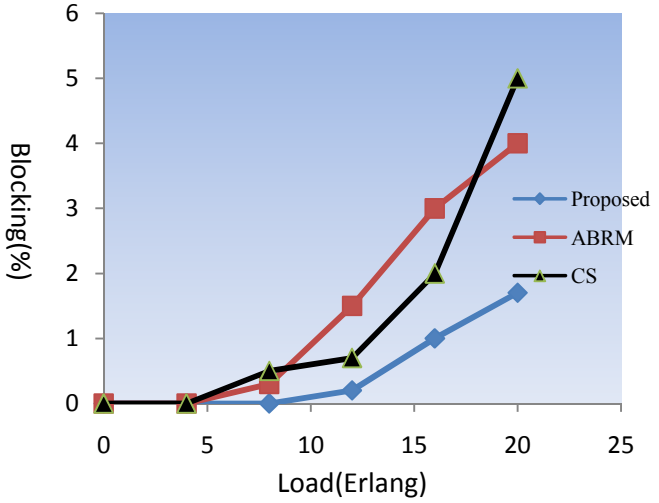

Figure 8. Comparision of proposed model and intelligent models (Blocking rate)

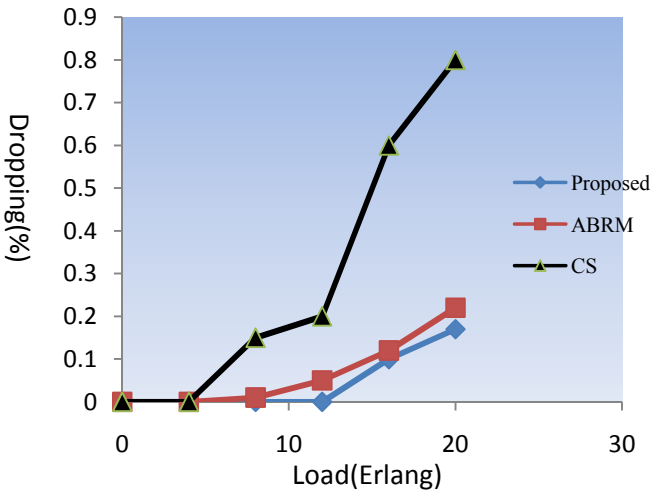

Figure 9. Comparision of proposed model and intelligent models (Dropping rate)

VII. CONCLUSION

Using of intelligent agent in wirelss networks is an appropriate solution that guaranties quality of service. They can approve network management, intelligent resource allocating and increased imformation assistance. Agents have to communicate with their neighbors clearly in an open environment for achieving mentioned objects. In this article we implement intelligent agents in 3G cellular network and used unique agent properties for reducing blocked calls and droped calls in comparision to other methods.

The main strategies are used in this proposed method include: Call transfering to other cells with lower traffic load, reducing bandwidth of availabele calls and allocating base bandwidth to new calls, using user and cell history in order to forcasting necessary bandwidth for new calls and handover calls, using dynamic queue for each new calls and handover calls.

Results show proposed method has noticeable impovement than to other methods. Intelligent Agents can reduce dropped/blocked calls ratio and present suitable quality to

users without any considerable complexity. This article demonstrates practical approach for mobile cellular network resource management.

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