DISTRIBUTED DYNAMIC CHANNEL ALLOCATION ALGORITHM FOR CELLULAR MOBILE NETWORK

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ABSTRACT

A channel allocation algorithm includes a channel acquisition and a channel selection scheme. Most of the previous work concentrates on the channel selection algorithm since early channel acquisition algorithms are centralized and rely on a MSS to accomplish channel acquisition. The centralized schemes are neither scalable nor reliable. Recently, distributed dynamic channel allocation algorithms have received considerable attention due to their high reliability and scalability. The most of the distributed algorithm is based on non-resource planning model in which a borrower needs to consult with every interference neighbors in order to borrow a channel. The proposed distributed dynamic channel allocation algorithm is based on resource-planning model, a borrower need not to receive replies from every interfering neighbors, it can borrow a channel from that neighbor whose all group members replies with common free channels within the predefined time period. The proposed algorithm makes efficient reuse of channels and evaluates the performance in terms of message complexity, blocking rate.

1.0 INTRODUCTION:

As the technology advances mobile computing has gained lot of importance in recent years. Mobile Computing uses cellular/wireless communication network [1]. The whole geographical area is divided into regions called cells. Each cell has a cell site or base station referred as mobile service station (MSS) and numbers of mobile hosts (MH) are present in the cell. Mobile service stations are connected to each other via fixed wire network and communication between MSS and MH is through wireless network. The bandwidth is the limited resource in cellular mobile system. The proper utilization of limited bandwidth is key factor to improve the performance of cellular system. The total bandwidth is divided into a set of carriers is further divided into a number of channels for communication. In cellular communication mainly two types of channels are available between MH and MSS: *communication channel* and *control channel*. Establishing a communication session between MSS and MS in a cell, communication channel is used while control channel is the set-up channel used to send messages that are generated by the channel allocation algorithm.

In cellular/ wireless system two cells can use the same channel if the distance between these cells have the minimum reuse distance D_{min} [2], otherwise cannot use the same channel due to interference. Such interference is known as co-channel interference. A cell C_x is said to be an interference neighbors of another cell, C_y, if geographical distance between them is less than minimum reuse distance D_{min}.

Many channel allocation schemes are proposed in the literature, the purpose of these schemes is to assign channels in such a way so that channel utilization is maximized at the same time maintaining the voice quality. When mobile host needs a channel to support a call it sends request message to MSS in its cell, the MSS tries to assign a channel to the mobile host (MH) using channel allocation scheme. The channel allocation schemes can be classified in three categories, Fixed channel allocation (FCA), Dynamic channel allocation (DCA) and Hybrid channel allocation (HCA).

In ***fixed channel allocation*** **[3][9]**, a set of channel is permanently allocated to each cell of the system. When user requests a channel for communication, it search the free channel in its own cell, if the free channel is available assigned to the user otherwise the request will be blocked. In **d*ynamic channel allocation*** **[4][9]** implies that channels are allocated dynamically as new calls arrive in the system and is achieved by keeping all free channels in a central pool. This means when a call is completed, the channel currently being used is returned to the central pool. In ***hybrid channel allocation*** **[3][9],** few channels are permanently allocated to each cell and the remaining channels are allocated dynamically. The performance of the hybrid channel allocation schemes are intermediate between fixed and dynamic channel allocation schemes.

The dynamic channel allocation schemes are divided into two types centralized and distributed. In Centralized dynamic channel allocation (CDCA) schemes [9][10], a channel is selected for a new call from a central pool of free channels, and a specific characterizing function is used to select one among available free channels. The simplest scheme is to select the first available free channel that can satisfy the reuse distance. Also that free channel can be picked which can minimize the further blocking probability in the neighborhood of the cell that needs an additional channel. Centralized schemes can theoretically provide near optimal performance, but the amount of computation and communication among the BSs (base stations) lead to excessive system latencies and make them impractical. Therefore, distributed dynamic channel allocation (DDCA) schemes [9][10] have been proposed that involve scattering of channels across a network. A channel is selected for a new call from its cell or interfering neighboring cells.

A channel allocation algorithm consists of two phases: a ***channel acquisition*** phase and ***channel selection*** phase. The task of channel acquisition phase is to collect the information of free available channels from the interference cells and insure that two cells within the minimum reuse distance do not share the same channel. The channel selection phase is concern for choosing a channel from the number of available free channels in order to get better channel utilization in terms of channel reuse. In general, the acquisition phase of the distributed dynamic channel algorithm consist of two approaches namely search and update. In search approach [5], when a cell requires a channel, it searches in its all interference neighbors to find the currently free available channel set and this set is used to select one channel-by-channel selection schemes. In the update approach [5], a cell maintains information about free available channels. When a cell requires a channel, the channel selection scheme is used to pickup one available channel and confirms with its all interference neighboring cells whether it can use the selected channel or not. After that, when a cell acquires or releases a channel at any time, inform its interference neighbors so that, every cell in the system model always knows the available channels of its interference neighboring cells.

Distributed dynamic channel allocation scheme proposed by Gouhong Cao et. al. [6] has used a resource-planning model, uses cluster size 9 in which the set of cells in the system model is partitioned into 9 disjoint subsets. Every cell in a disjoint subset is in the minimum reuse distance. The numbers of channel are also divided into 9 disjoint sets of channels. The each partitioned group assigned a channel group. DDCA proposed by Gouhong Cao et. al. [6] uses the cluster size 9, which contains 30 interfering neighbors. When a channel needs by the cell has to send the request message to all its interference neighbors, thus the message complexity of the algorithm is high. This high message complexity of algorithm needs to develop new system model, which reduces message complexity to some extent. The proposed system model of size 6*6 with cluster size 3 is considered, means the set of cells are partitioned into 3 disjoint sets and number of channel sets is also divided into 3 channel disjoint subsets. In the proposed system model when a channel needs to be borrowed by a cell, it has to send request message to its 6 interfering neighbors in spite of 30 interfering neighbors as proposed in [6][7]. The blocking probability and message complexity of the proposed algorithm is reduced; hence the performance of cellular system increases.
The performance of the proposed DDCA algorithm is simulated taking the same metrics and parameters as in [6], for the sake of clear comparison.

2 SYSTEM MODEL:

The proposed system model shown in figure 1, the geographical area is divided into 6*6 hexagonal cells, each cell has a radius of R. Each cell contains a mobile service station, the mobile service stations are connected by wired network and mobile hosts are connected via wireless network to the mobile service station. The distribution of channels among the cells in the system, based on resource planning model with cluster size-3 is assumed. The cluster size-3 means all channels in the spectrum are assigned in three adjacent three cells, if a channel is being used in any cell, then none of the remaining two adjacent neighboring cells can use this channel. The considered minimum reuse distance (D_{min}) is 3R, therefore number of cells in interference neighbors is 6. If channel r is being used in cell then none of its interference neighboring cells can use r. When MH wants to setup a call it sends request message to its MSS, if there exist some free available channels in the requesting cell, then the MSS will pick one in such a way that there will be no co-channel interference and channel utilization is maximized.

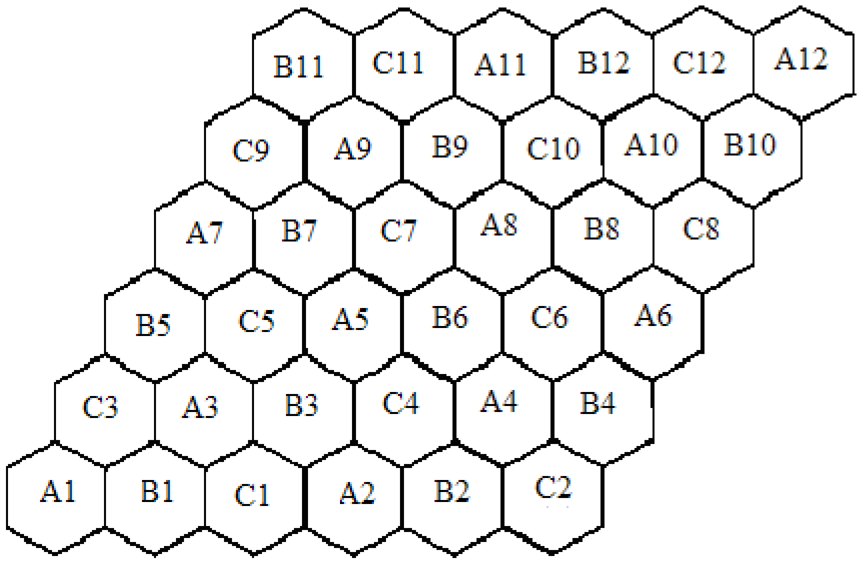

*Figure 1. 6 * 6 cellular system model.*

If a wireless channel allocated for supporting the communication session between the MH and MSS, the two cells can use the same channel only when the physical distance is not less than the threshold distance D_{min}; otherwise their communication session interfere with each other that is called co-channel interference.

Let a cell C_x, the set of interference neighboring cells of C_x is represented by N_x, is

$N_x = \{C_y | \text{distance}(C_x,C_y) < D_{min}\}$. Where cell C_y is the member of N_x.

Some of the channel selection schemes uses resource planning model to get better channel reuse for which the prior knowledge of channel status is required. The rules for using resource planning model in [8] as follows:

(a) The set of cells divided into number of disjoint subsets, F_0, F_1, ……, F_{k-1}, such that any two cells in the same subset are physically separated with at least a minimum reuse distance. Similarly the set of channels are also divided into k disjoint subsets PR_1, PR_2,….., PR_{k-1}.

(b) The channels in PR_x (x= 0, 1, …, k-1) are primary channels of cells in C_x, as secondary channels of cells in C_y ($y \neq x$).

(c) When all the primary channels are exhausted then a cell requests the secondary channel.

Let a cell $C_x \notin F_k$ and a channel $r \in PR_k$, the interference primary cells of r relative to C_x, denoted by $NP_x(r)$, are the cells which are primary cells of r and interference neighbors of C_x; i.e., $NP_x(r) = F_k \cap N_x$. $NP_x(r)$ is also referred to as an interference partition subset of C_x relative to r.

3 PROPOSED ALGORITHM:

Data structure

N_x, NP_x (r) is the interference neighbors and interference partition subset of C_x relative to channel r, respectively.

B_x: A set of channels that C_x can barrow.

S_x: a set of channels that C_x attaches with its reply.

Pc: The set of primary channels assigned to C_x.

Uc: The set of used channels of C_x. Initially Uc is empty.

$I_x(r)$: the set of cells to which C_x has sent an agree(r) message. If $I_x(r) \neq \phi$, r is an interference channel of C_x then C_x cannot use r, but it can lend it to other cells. Initially $I_x(r)$ is empty.

Ci_x (x, y): A set of cells, which saves the state $I_x(r)$, when C_x receives C_y's request message.

Phase 1:

1.When a cell needs a channel to support a call request, let $temp_x = P_x - U_x - \{r / r \in P_x \wedge I_x(r) \neq \phi\}$ is calculated, if $temp_x$ is empty, C_x sets a timer and sends a request message to every cell $C_y \in N_x$; otherwise, it picks a channel $r \in temp_x$ and adds r to U_x. When the call is completed, it deletes r from U_x.

2.When a cell C_x receives a request from C_y, it sends reply $(P_x - U_x - \{r | r \in P_x, N_x(r) \wedge N_y \neq \phi\}$ to C_y, for any $r \in P_x$, $C_x(r,y) \subset I_x(r)$.

3.When a cell C_x receives all reply (S_y) messages or timeout, it sets a new time and does following.

3.1. For each r in the system, $B_x = B_x \cup r$ if C_x is not using r For any $C_k \in NP_x(r)$, C_x has received a reply (S_k) from C_k, and For any $C_y \in NP_x(r)$, $r \in S$

3.2. If B_x is not empty; C_x selects a channel $r \in B_x$ using underlying channel selection strategy and sends confirm(r) message to cells in $NP_x(r)$; otherwise call will be dropped.

Phase 2:

4. In the entire replies find the common number of free channel/channels available in each disjoint subset of cells, determines which disjoint subset of cells has maximum number of common-free channels. Randomly select a channel from a disjoint subset of cells, which has maximum number of common-free channels.

5. If two disjoint subset of cells having same number of common-free channels replied, then that disjoint subset of cells is selected which reply earliest to the requesting cell and it acts as a lender.

4 EXPLANATION OF ALGORITHM:

Proposed algorithm consist of two phases, the first phase is channel acquisition phase and second, is channel selection phase. *In first phase:* A cell C_x needs a channel to support a call request, it first check free primary channels, if available it picks one of the channel r and marks it as used channel and support that call immediately; otherwise C_x changes to search mode and sends request to all its interfering neighbors (N_x). When C_x send a request message to its interfering neighbor C_y and C_y is not in search mode, then it send a reply to C_x, if C_y is also in search mode and its timestamp is higher than C_x, it send a reply to C_x, otherwise not. After the borrower has received reply message from cell in N_x or timer timeouts, the borrower computes the free available channels, the channel selection algorithm is used to select a channel from free available channels. The borrower takes confirmation of selected channel to the lenders; the lender may assign the same channel to other borrower in the mean time when it sends out the reply message, the borrower can use the selected channel when the time-stamp of it is less than requesting borrowers for the same channel; otherwise it picks another channel and confirm again from the lender. After the channel has been borrowed, the lender marks the channel as an interference channel; the channel cannot be used until it returns by all borrowers. The call is blocked if no free available channel is left.

In second phase: It is channel selection phase; the first phase is concerned with the determination of set of all free available channels (primary or secondary) for the requesting calls. The requesting call picks randomly a primary channel from set of available primary channels. If no primary channels are available then it selects a channel from set of free available secondary channels. In case of no free primary channels is available, the requesting cell (C_x) sends request to every interfering cells (both groups) and waits for reply. If at least one of the neighboring disjoint subset of cells replied with one or more common-free channels then the channel selection strategy is mandatory. Let cell C_x request for channel from cell C_y, if C_y has free channels, it sends agree message along with S_y to C_x, similarly all the other neighbors of C_x sends message. After that number of common-free available channels is computed from every disjoint subset of cells, the channel selection scheme select a channel randomly from a particular disjoint subset of cells, that has maximum number of common-free channels. If two or more disjoint subset of cells having same number of common-free channels then the disjoint subset of cells, which sends, agree message first, acts as lender. If two neighboring cells of different disjoint subset of cells request for the same channel then the cell having smaller time-stamp will be served; Otherwise call will be dropped.

5 SIMULATION PARAMETERS AND RESULTS:

The simulated cellular network consists 36 cells divided into 3 disjoint subset (i.e A,B,C). Each cell has six neighbors. In total there are 396 channels available each cell is having 132 primary channels. Assume that the average one-way communication delay between two cells is 4 millisecond, which covers both the transmission delay and the propagation delay. The mean call arrival rate in a cell λ and mean service time is 3 minutes. All the comparisons between our algorithm and the algorithm in [6] are made under uniform traffic. The message complexity of the proposed algorithm is significantly reduces due to reduction in cluster size, to acquire a channel it has to get the reply messages from at most 6 interference neighbors in spite of 30 neighbors as in [6], shown in figure 2.

The blocking rate of proposed algorithm is compared with the algorithm in [6]. Our algorithm significantly reduces the call blocking rate, due to the reducing the cluster size in resource planning model as compared in [6] as shown in the figure 3.

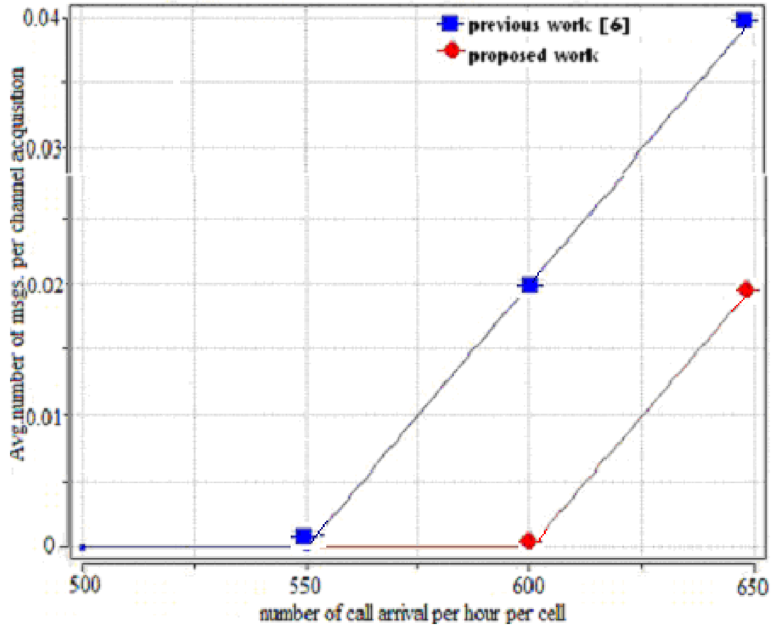

Figure 2. Message Complexity vs Call arrival

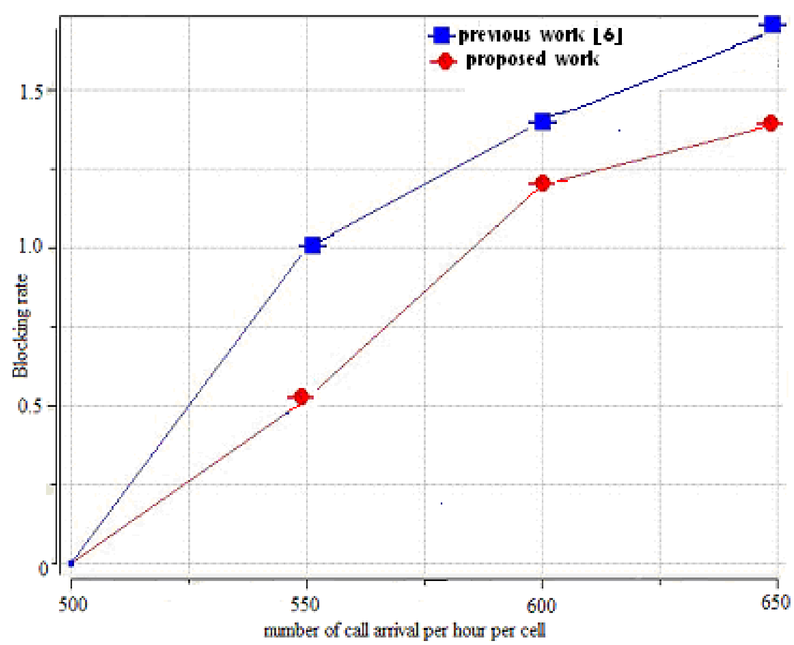

Figure 3. Blocking Rate vs call arrival.

6. CONCLUSION:

Distributed dynamic channel algorithms have received more attention because of high reliability and scalability. Most of the algorithms did not make full use of the available channels. The proposed channel allocation algorithm makes efficient reuse of channels using resource-planning model with reducing the cluster size. The simulation results shows that the message complexity and blocking rate of the proposed algorithm are significantly less than algorithm in [6].

7. REFERENCES:

[1] Theodore S. Rappaport. Wireless communications principles and practice, Second edition 2003.

[2] Jiangping Jiang et.al. On distributed dynamic channel allocation in mobile cellular networks. IEEE transactions on parallel and distributed system, 13(10): 1024-1037, 2002.

[3] Scott Jorden. Resourse allocation in wireless networks. Journal of high speed networks, 5(1): 23-34, 1996.

[4] Justin C.I. et.al. Performances issues and algorithms for dynamic channel assignment. IEEE journal on selected areas in communications 11(6): 955-963, 1993.

[5] Guhong Cao et.al. An adaptive distributed channel allocation strategy for mobile cellular networks. Journal of parallel and distributed computing, 60: 451-473, 2000.

[6] Guhong Cao et.al. Distributed fault-tolerant channel allocation for cellular networks. IEEE journal on selected areas in communications, 18(7): 1326-1337, 2000.

[7] Guhong Cao. Integrating distributed channel allocation and adaptive handoff management for QoS sensitive cellular networks, (9): 131-142, 2003

[8] Jianchang Yang et.al. An efficient fault-tolerant distributed channel allocation algorithm for cellular networks, 4(6): 578-587, 2005.

[9] I.Katzela et.al. Channel assignment schemes for cellular mobile telecommunications systems. IEEE personal communication 10-31, 1996.

[10] Jianchang Yang et.al. A fault-tolerant channel allocation algorithm for cellular network with mobile base stations. IEEE transactions on vehicular technology 56(1): 349-361, 2007.