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Enhanced Mobility Aware Channel Assignment for Nodes in the Multihop Cellular Networks

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Abstract: It is more important to deploy Multihop Cellular Networks (MCNs) with increased cell capacity and widening the network coverage at reduced cost. It results of avoiding several problems faced by present cellular networks. However, these networks suffers with lot of problems among which mobility problem is very serious issue needs to be considered to offer better quality of service and increased cell throughput to the users. A enhanced mobility aware Channel assignment Algorithm EMACA is proposed in TDD (time division duplex) WCDMA (Wideband Code Division Multiple Access) MCNs and it is compared with Mobility Aware Channel Assignment algorithm (MACA). The simulated outcome proves that the proposed scheme EMACA is a better option with considerably offers good quality of service and higher throughput than MACA in MCNs.

Key words: Multihop, cellular network, mobility, enhanced channel assignment, quality of service, throughput

INTRODUCTION

With rapid advancement of communication technology, the number of mobile users continues to grow up which demands further cellular facility to fulfill the anticipated high excellence voice and high speed multimedia data transfer services. However, the frequency spectrum is always limited. This has resulted in consumption of radio resources. The use of radio resources increases cellular capacity by dividing a large cell into many smaller cells and then each cell utilizes the channel spectrum. However, this needs that more number of Base Stations (BSs) is to be deployed. Deploying more BSs involves higher cost in terms of infrastructure and administration process. These networks also suffer with dead spots having tough shadowing barriers. To offer services in these kinds of areas, additional BSs or relaying or intermediary unit may be required. In addition, at some point of time, if the communication usage demand is less or the quantity of mobile users is fewer then installing additional BSs or relay stations will remain redundant at least for some duration at some point of the time. On the other hand in 3.5G or 4G Systems, a variety of categories of services through a broad volume of data transmit are granted.

Traffic models in such kinds of networks may possibly be very much vibrant and huge congested over certain areas such as hot spots. This further discourages to install more BSs since it involves more cost expenditures.

Multihop relaying concept has sufficiently demonstrated to be valuable in growing the channel capacity and exposure area. It also reduces the call jamming prospect and decreases the per node broadcast energy (Lin and Hsu, 2000; Radwan and Hassanein, 2006; Kumar *et al*., 2005; Wu *et al*., 2001). Kashwan and Balakrishnan (2012) have proposed a new algorithm, Mobility Aware Channel Assignment (MACA) for a TDD W-CDMA MCNs. The simulated results show that the proposed scheme is a better option with considerably good quality of service and higher throughput. In the conventional system, a user may have to change the location to achieve better channel connection with BS. On the other hand in multihop relaying system, mobiles nodes may relay their calls or data through their neighbor mobile nodes. MCNs are considered into such a manner that a mobile node can relay signals through other mobile nodes for its voice or data services. ODMA (Opportunity Driven Multiple Access), from where, the 3G UMTS (Universal Mobile Telecommunications System) has evolved relies on this perception (3GPP, 1999). Within ODMA, the longer distance transmission has been separated into several small distance communications which are transmitted during neighbor relaying nodes to

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decrease the interfering or delay and it enhances the channel facility. Dead spot or signal shadowing and hot spot or high traffic troubles can be condensed by conveying data from shadowing region to BS and also from highly congested spot to adjacent non-congested cells. Further, no extra BSs are essential. An analysis on the cost effective for deploying MCN (Li and Chong, 2008) has obviously indicated an advantage over other options.

Many researchers have proposed different channel assignment schemes for mobile cellular communication and mobile ad hoc communication networks. To the mobile cellular communication networks, the FCA (Fixed Channel Assignment) in addition to DCA (Dynamic Channel Assignment) schemes has been normally used (Katzela and Naghshineh, 1996; Chong and Leung, 2001). For MANET (Mobile Ad Hoc Network), two channel assignment methods, static and dynamic has been proposed (Grace *et al.*, 2000). A novel design of iCAR (integrated Cellular and Ad Hoc Relaying) organism has been projected (Wu *et al.*, 2001). The logic of the system is distracting the communication process in its highly crammed cells to another a smaller amount crammed cells by via the permanent relaying terminals and by relaying the traffic by further frequencies.

In yet another research for a TDD CDMA, two new schemes of forceful multihop time slot allotment of DSPM along with MIF are proposed (Yang and Chong, 2007). MIF assigns time-slots primarily based totally on the ratio of Energy bit to Noise level (Eb/N0). However, DSPM allots time-slots for all mobile devices within foremost comes then serve foremost base. Outcome proves to facilitate DSPM enhances the speed of data transfer time to a single mobile node client but MIF enhances an entire scheme data transfer rate (Yang and Chong, 2007). To the W-CDMA network an new A-Cell (ad hoc cellular) relay design has been proposed (Safwat, 2003). A-Cell, for propagation directional antennae utilized to enlarge bandwidth utilization. It reduces nosiness and power utilization. The GPS (Global Positioning System) may be utilized to assist routing protocols (Toh, 2001).

A new thought referred to as cMCN (clustered MCN) through a relentless channel assignment has conjointly been planned (Li and Chong, 2010). In cMCN, usually a macro-cell is divided as seven microcells in which one middle microcell and six other microcells are created. The six other microcells considered as virtual microcells and it is neighbored with middle microcell.

Every microcell is allotted a certain channel chunks. Every implicit microcell incorporates a wireless DIP towards allocate bandwidth, choose conveying way and to convey centre for wireless mobile devices. Conversely certain bandwidth allocations never manage among sequential transformation inside its Traffic Model, so researchers planned an MDCA (Li and Chong, 2010). Supported the obstruction condition, MDCA allocate channels to nodes in a cell with esteem to the different intrusive cells. The arrangement is create the foremost of the channel accessibility of the system. Experiment shows that MDCA carry out improved than the certain channel allocation in stipulations of method capability. There are few more methods for channel assignment available for A-Cell. These include ACA (A-Cell Channel Assignment) (Safwat, 2004), DSSA&RSA (Al-Riyami *et al.*, 2005). Make the best channel utilize into A-Cell, the ACA is developed as a linear optimization problem. Though, it doesn't take into account the packet interruption problem. DSSA is a channel assignment method planed supported ACA to require packet delay inside the issues. It is applicable only to omni directional antennae atmosphere and unsuitable to directional based antennas atmosphere. RSA also alike a DSSA, apart from that time-slots as well as channels are being allocated arbitrarily. Clearly, RSA never promises smallest delay. In fact, the experimental output shows that RSA includes a lesser presentation than that of DSSAs packet relaying delay and throughput (Al-Riyami *et al.*, 2005).

In recent past an OCA (Optimal Channel Assignment) Method for MANET TDD W-CDMA MCNs has been proposed to minimize packet delay (Tam *et al.*, 2007). The foremost purpose of a channel allocation concept is avoid signal crash, channel clash and time-slot conflict. Further efforts are made to minimize the total packet relaying interruption. The channel assignment process for all nodes on the path requires information of all presented possible relay paths for the calculation. This makes an OCA computationally expensive and thus is undesirable. Very recently a new channel assignment system MSWF (Minimum Slot Waiting First) has been proposed for TDD W-CDMA MCN (Tam *et al.*, 2010). This scheme assigns a channel for the given relaying path to decrease the packet relaying delay or in other words the time-slot waiting time. It also considerably reduces signal conflict, co-channel conflict and co-time-slot conflict. MSWF is based on greedy algorithm and gives locally optimal solution. Here, the main focus is on diminishing delay for the packets while in transmission path. The MSWF concept is based on two principles. First it eliminates conflicting channels and then select channels with less relaying interruption.

There has been number of proposals for channel assignment schemes to increase capacity, coverage area, to decrease node transmission power and to reduce packet delay in the MCNs. However, the quality of service and cell throughput is remains poor in the MCNs environment. In this study, researchers have taken the node mobility into consideration while designing the channel assignment models for MCNs. The result is that of the improved quality of service and cell throughput. The new model is named as Enhanced Mobility Aware Channel Assignment Algorithm (EMACA) scheme for TDD W-CDMA MCNs.

MATERIALS AND METHODS

Mobility issues during channel assignment in MCNs: The channel assignment is symbolized by a pair of variables, time-slot and code and these variable are named t and c. The channel conflict may occur while allocating or proposing the channel to establish a connection with a mobile device. Node mobility may be one of the causes of channel conflicts among the others. The mobility oriented conflict issue is the main focus of this proposed research.

Figure 1 shows that all mobile nodes have been assigned channels with available time slots t and codes c. The maximum time slot for a single transmission frame is 5 and each time slot has five codes for Base Station (BS) uplink transmission. Initially, it is assumed that all nodes are static and channels are well assigned without any co-channel conflicts and co-timeslot conflicts. The nodes may move towards any direction after establishing connections. However, there is a chance of occurring co-channel conflicts due to node mobility while transmission starts. The scenario in Fig. 1 shows that the mobile nodes M6 and M8 are assigned with same time-slot and code (4, 1) to their call or data transfer requests, respectively. However, the mobility of M6 towards transmission zone of M8 or vice-versa may result in channel collision of M6 or M8 or both. In this case, the quality of service offered to users will be deteriorated as the collision will adversely affect transmission efficiency.

Channel allocation scheme: This part, it demonstrates the Mobility Aware Channel Assignment algorithm, namely MACA and a new method, namely Enhanced Mobility Aware Channel Assignment algorithm (EMACA) for a TDD W-CDMA MCNs. The algorithm placed and also executed in RNC (Radio Network Controller) in the 3GPP 3G UMTS (Holma and Toskala, 2004). Each RNC attached with several amount of base stations and researchers presume, RNC is an entity which has the complete details of the channel assignment, spot, node power capability, route, relaying node load and data rate of the entire mobile nodes concerned in voice are data transfer communications.

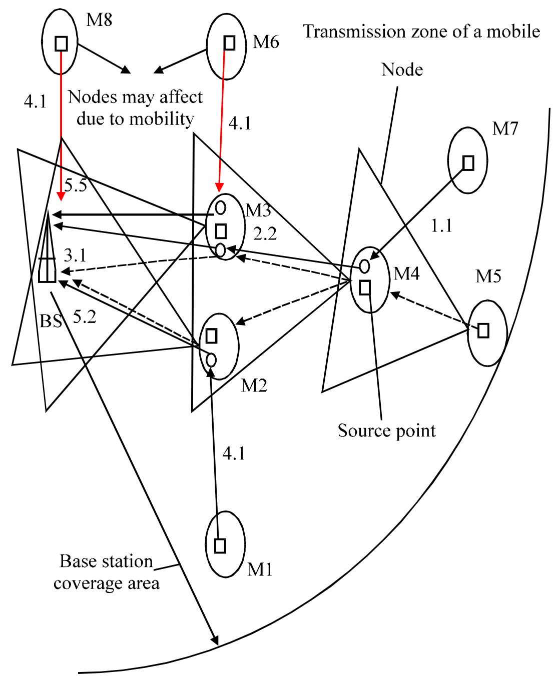

Fig. 1: MCN topology

Mobility aware channel assignment: The MACA algorithm is build on the basis of two underlying functional principles:

- Find and eliminate the channels which could possibly cause conflicts due to node mobility within currently setup path and its neighboring existing setup paths
- Find the channels which will avoid conflicts and also have shortest relaying delay in the current path setup

MACA algorithm: Figure 2 shows various steps of the MACA algorithm in the sequence in which it is executed. proposed channels are allocated originates from the Last-Hop Node (LHN) of the route and this goes in the reverse order up to the source node. It may be noted that an LHN is the node near to the BS on a route. The MACA algorithm consists of four major tasks.

The first task is to get input or in other words gather all information of the current setup path and neighboring existing setup path to the current node call request. Let us assume that RNC has global information about the entire network which includes each mobile node location, transmission zone, possible mobility area, power, data rate and channel information. It uses the routing protocol to find all available paths to the current channel assignment and set a path with shortest route for the transmission.

Second task is to find transmission zones of all mobile nodes of currently setup path and also its

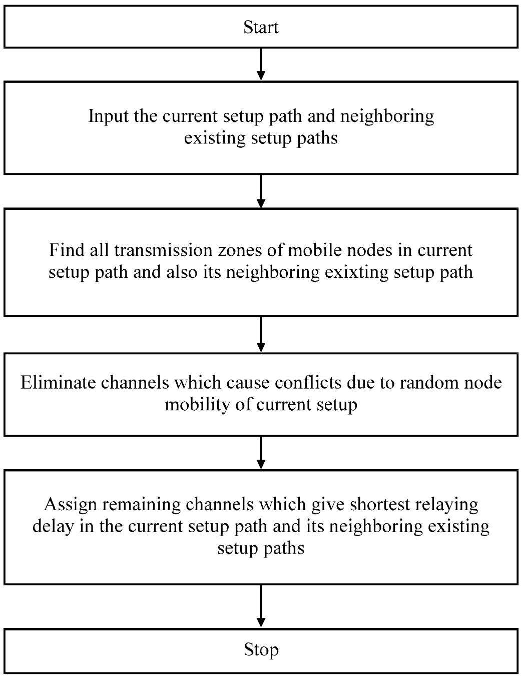

Fig. 2: Sequence flow of MACA algorithm

neighboring existing setup path. The third task is eliminates the channels which could perhaps create channel conflicts due to random node mobility within current path setup and also its neighboring existing path setup. This task is critical for a mobile node with call request and to be resolved before assigning a channel to the same node for subsequent transmission. Let us assume all the mobile nodes shown in Fig. 1 have set up paths and assigned channels without any co-channel conflicts and co-timeslot conflicts. Assume that node M6 has to establish connection to BS through relaying node M3 with channel assignments (4, 1) and (5, 5), respectively. It can be seen that relaying node M3 may collide with an ongoing transmission of node M8 assigned with channel (4, 1). This can happen due to mobility of either node M6 or M8. It therefore, becomes very important to find the possible dynamic zones (ever changing due to mobility) of each mobile node in the current channel assignment before eliminating conflict causing channels.

The fourth main task of MACA algorithm is to choose channels from remained ones after eliminating conflicting channels due to mobility. Here, the channel selection simultaneously require relaying delay criterion. The least relaying delay in the current set up path is selected.

Enhanced mobility aware channel assignment: The EMACA algorithm is build on the basis of three underlying functional principles:

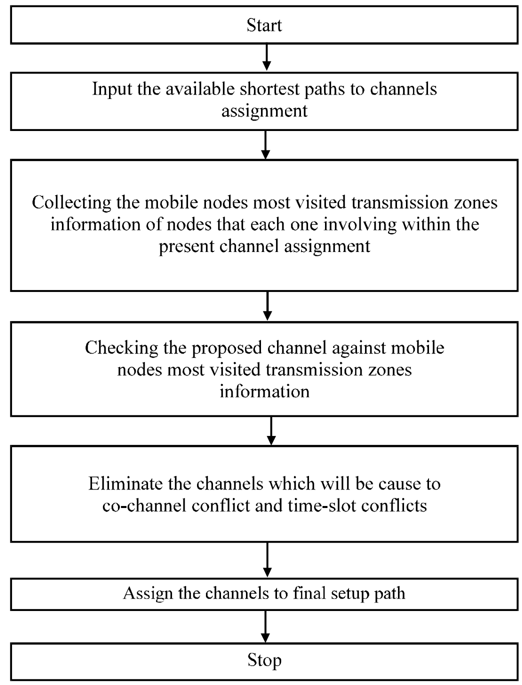

Fig. 3: Sequence flow of EMACA algorithm

- Input the available shortest paths to channel assignment
- Collecting the mobile nodes most visited transmission zones information which are all involving in the present channel assignment
- Checking the proposed channel against mobile nodes most visited transmission zones information
- Eliminate the channels which will be causes to co-channel conflicts and time-slot conflicts
- Assign the channels to the finest path

Figure 3 illustrates various steps of the EMACA algorithm in the sequence in which it is executed. Proposed channels are allocated originates from the Last-Hop Node (LHN) of the route and this goes in the reverse order up to the source node. It may be noted that an LHN is the node near to the BS on a route. The EMACA algorithm consists of five major tasks.

The first task is to gather available shortest paths for the current channel assignment. Let us assume that RNC has global information about the entire network or cells which includes each mobile node transmission zone, location, possible mobility area, data rate, power and channel information. It uses the routing protocol to find all available paths to the current channel assignment and gives the paths with shortest route for the transmission.

Second task is to collect the mobile nodes most visited transmission zones details of nodes that each one involving within the present channel assignment. This stage makes easier the job to next task to identify the nodes that could be most possible to create co-channel conflicts based on the gathered nodes most visited transmission details. The third task is checking the proposed channel against mobile nodes most visited transmission zones information and find the possible channels which could affect any ongoing transmission. The fourth main task of EMACA algorithm is eliminate the channels which will be causes to be causes of co-channel channel conflicts due to nodes mobility. Also, this task avoids timeslot conflicts. The final and fifth task is assigning the channels to final setup path.

Simulations setup and parameters chosen: The simulation model for cell setting is shown in Fig. 4. The intermediary nodes count differs from 0-120 in additions of 30. Mobile nodes have been distributed evenly in the circular region by radius includes 250 m centered at the BS. This setup is used to study the performance of MACA and EMACA. Parameters chosen for the simulation is given in Table 1. This setup, the coverage of the nodes and BS is 250 m and through the network cell zone capability of 1,035 kB sec^{-1}. All data connection the frame size is 3.33 m sec lengthy and data connection can be 5 timeslots. It is also affordable with the standard of WCDMA (Holma and Toskala, 2004).

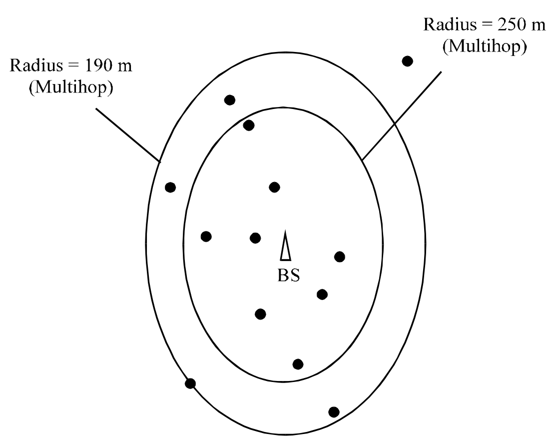

Fig. 4: Cell Model

Table 1: The simulator parameter chosen

Parameteres	MACA	EMACA
No. of codes/Time-slot	5	5
No. of time slots/Frame	5	5
No. of time slot for uplink	5	5
Mobile node transmission range	250 m	250 m
Mobile capacity	1035 kbp	1035 kbp
Hope count	4	4
Data rate/Code	44.4 kbp	44.4 kbp
No. of source nodes	30	30
Duration of the simulation	10 min	10 min

These timeslots has been allocated for the uplink data transmission of the BS. Each timeslot may have been allocated highest of 5 codes. So, 25 channels are possible (pairs of code and timeslot).

Each code associates to the data speed rate of the 44.4 kbp, It also affordable with the WCDMA standard (Holma and Toskala, 2004). The extreme hops count has been set to 4 in order to be away from unnecessary interruption. The total amount of the spirited nodes is 50. It is superior to the concrete amount of obtainable channels. It is notices that a reasonably big number of spirited nodes have been used than the concrete available channels, so a little hop count (multihop) has been used.

Simulation performance metrics: Quite a lot of metrics can be used for evaluate MCNs performance such as cell throughput, packet delay, perhop packet delay, coefficient of variance of packet delay, etc. The proposed research carries packet delay and cell throughput to evaluate the performance of EMACA with respect to MACA in MCNs.

Packet delay: It is a time which is essential to a packet sent as of the data originate mobile device to enter at the destination (BS).

Cell throughput: It is a total quantity of information/ packets a base station obtained in every second. The higher throughput of a cell shows huge number of mobile nodes has been served.

RESULTS AND DISCUSSION

Simulations results of setup for packet delay shown in Fig. 5. Nodes are increased in the variance of 30. Simulation is conducted with the duration of 10 min for the given setup. The average packets delay of the MACA is quietly increased between 5.5-7.5 msec, because of unexpected channel conflicts between the transmission zones in the current data transmission. However in case of EMACA the packet delay is increased very quietly between 3.6-4.5 msec. It shows that the average packet delay of the MACA is significantly increased because of packets drop due to unexpected channel conflicts between the transmission zones and in case of EMACA it is well in terms of very small range of packet delay.

The average cell throughput of MACA is not better than the case of an EMACA. A simulations result of setup for cell throughput is shown in Fig. 6. Simulation conducted with the duration of 10 min for the data transmission. Here, it is found that overall cell throughput of the MACA is quietly decreased and falls in the range

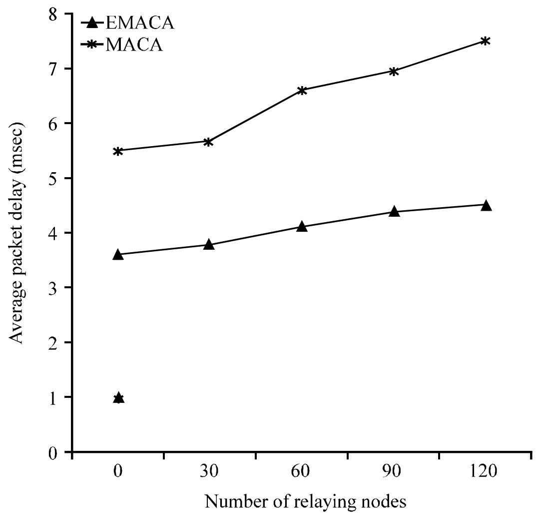

Fig. 5: Packet delay

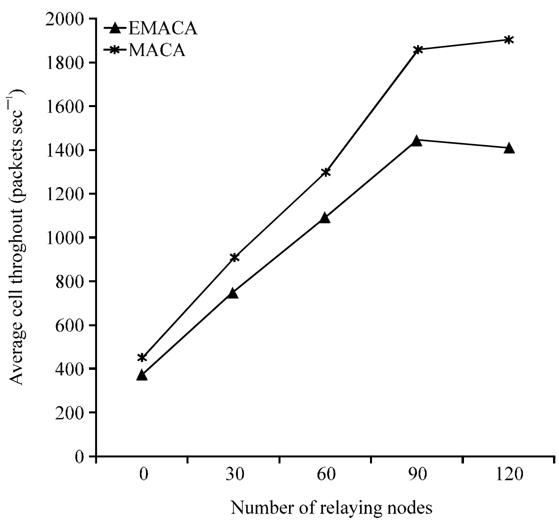

Fig. 6: Cell throughput

of 380-1440 packets sec^{-1}. The reason being is packets drop due to unexpected channel conflicts between the transmission zones. However in case of non EMACA, gives the greater performance in terms of increasing the overall cell throughput and throughput range increased from 450-1900 packets sec^{-1}. It shows that the average cell throughput of the MACA is significantly decreased, because of unexpected channel conflicts between the transmission zones and in case of EMACA, it is not alike.

CONCLUSION

A new channel assignment algorithm called EMACA is proposed against MACA for TDD WCDMA MCNs for taking into consideration of mobility issues while assigning channel. The proposed algorithm EMACA is suitable for mobility aware channel assignment, removing time-slot clashes and co-channel clashes inside MCNs. The simulation results show that the average packet delay of MACA is quietly increased in the range of 5.5-7.5 msec. It shows that the average packet delay of the MACA is significantly increased, because of packets drop due to unexpected channel conflicts between the transmission zones and in case of EMACA it is well in terms of very small range of packet delay between 3.6-4.5 msec. The proposed algorithm EMACA also proves that increased cell throughput in the range of 450-1900 packets sec^{-1} in contrast to significantly decreased cell throughput of MACA which falls in the range of 380-1440 packets sec^{-1}. The proposed algorithm EMACA proved better than MACA to offer higher throughput and lower packets delay in the MCNs.

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