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CELLULAR NETWORK OPTIMIZATION USING MULTI HOP DYNAMIC CHANNEL ASSIGNMENT WITH DYNAMIC CHANNEL ASSIGNMENT SCHEME

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***Abstract*—Rapid growth in telecom industry searching for new methods provide the better service to their customer here implementing proposes a multihop dynamic channel assignment (MDCA) scheme for time division multiple access (TDMA)-based multihop cellular networks. The proposed MDCA assigns channels are observed in ofdma system to the calls based on interference information in surrounding cells, provided by the Interference Information Table (IIT) in the network. Two different channel searching strategies, Sequential Channel Searching (SCS) and Packing based Channel Searching (PCS), for use in MDCA are proposed and studied. A channel reassignment procedure to further enhance the performance is also investigated. Simulation results show that MDCA significantly improves the system capacity. Furthermore, the MDCA can efficiently alleviate the call blocking in hot-spot cells.**

I. INTRODUCTION

Today major challenge in telecommunication is to con-vey as much information as possible through limited spectral width. By observing the general method and the spectrum allocation more traffic will rapidly increases the channels within limited bandwidth of physical channel. Here the available bandwidth is split into several narrow band channels for simultaneous transmission. Besides cellular communications, ad hoc networking is another type of wireless communication technology [2]. Traditional cellular networks (TCNs) and mobile ad hoc networks (MANETs) both have their respective advantages and drawbacks. TCNs have mature technology support for reliable performance. However, building and expanding their necessary infrastructure is costly. MANETs, on the other hand, are simple to deploy and easily expandable. taking into account the advantages and drawbacks of TCNs and MANETs, notice that a combination of them is the logical solution to the next generation mobile networks. In 1996, Adachi and Nakagawa raised the concept of cellular ad-hoc united communication system [3]. Subsequently, many similar proposals were reported, such as multihop cellular network (MCN) [4]. MCN-type systems are expected to bring considerable amount of benefits. However, with the limited bandwidth for cellular communications, channel assignment becomes even more challenging in MCN-type systems. Wu et al proposed diverting traffic from the congested cells to the non-congested cells [5], [6], which is achieved by relaying traffic through unlicensed frequency band, such as the industrial, science and medical (ISM) band. For iCAR [5], [6], ad hoc relay stations (ARSs), either being fixed [5] or mobile [6], are deployed for balancing traffic. The communication link between a mobile station (MS) and an ARS is established using the ISM band. UCAN is used to increase the system throughput through relaying using the ISM band [7]. an ad hoc GSM (A-GSM) protocol is proposed for using the cellular frequency band for relay stations (RSs) to relay traffic. However, the study did not clearly address how the resources are allocated to the BS and RSs. Recently; clustered MCN (CMCN) has been proposed and studied using a fixed channel assignment (FCA) scheme [9]. It uses cellular frequency band for traffic relaying. Results show that CMCN with FCA can improve the system capacity [9]. However, FCA is not able to cope with temporal changes in the traffic patterns and thus may result in deficiency. Moreover, it is not easy to obtain the optimum channel assignment for uplink and downlink under FCA, which is used to achieve the lowest call blocking probability. Therefore, dynamic channel assignment (DCA) is more desirable.

AIM & OBJECTIVES

This paper proposes a multihop dynamic channel assignment (MDCA) scheme that works by assigning channels based on interference information in surrounding cells [10]. Two channel searching strategies, Sequential Channel Searching (SCS) and Packing-based Channel Searching (PCS), for MDCA are proposed and studied. A channel reassignment procedure to further enhance the performance is also investigated. The channel searching algorithm can be formulated as an optimization problem and it can be proved that the proposed scheme can result in a sub-optimal solution. Using matlab simulation shows that the proposed MDCA significantly improves the system capacity, even with hot-spot traffic.

CLUSTERED MULTIHOP CELLULAR NETWORK

The key idea of CMCN is to achieve the characteristics of the macrocell /microcell hierarchical overlaid system [11] by applying MANET clustering [12] to TCNs. As shown in Fig.1, a BS in TCNs covers the entire macrocell with a radius *rM*. The transmission ranges of traffic and control channels are the same and equal to *rM* for both the BSs and Mrs. in CMCN, a macrocell is divided into seven microcells with a radius of *rm*. Each *virtual* microcell can be divided into two regions: inner half and outer half. The inner half is near the central microcell. The transmission range of the traffic channels in CMCN for both the BSs and MSs is equal to *rm*. The transmission range of the control channels for the BSs and MSs is equal to *rM* so that the BS can communicate with all the MSs within its macrocell area for control information exchange. In this study, the microcells are *virtually* formed by the BSs based on the geographic information using, e.g. global positioning system (GPS).

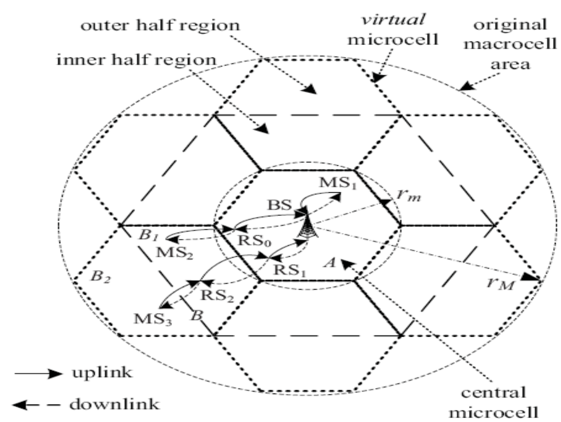


Fig No1: channel assignment in CMCN

PROPOSED MDCA SCHEME in ofdma

A. Channel Assignment

As shows the three most typical channel assignment scenarios, described as follows:

1) *One-hop Calls:* One-hop calls refer to calls originated from MSs in a central microcell, such as MS1 in microcell *A* in Fig. 1. It requires one uplink channel and one downlink channel from the microcell *A*. The call is accepted if microcell *A* has at least one free uplink channel and one free downlink channel. Otherwise, the call is blocked.

2) *Two-hop Calls:* Two-hop calls refer to calls originated from MSs in the inner half region of a *virtual* microcell, such as MS2 in region *B*1 of

microcell *B* in Fig. 1. The BS is able to find another MS, RS0, in the central microcell acting as a RS. For uplink transmission, a two-hop call requires one uplink channel from the microcell *B*, for the transmission from MS2 to RS0, and one uplink channel from the central microcell *A*, for the transmission from RS0 to the BS. For downlink transmission, a two-hop call requires two downlink channels from the central microcell *A*, for the transmission from the BS to RS0, and from RS0 to MS2, respectively. A two-hop call is accepted if all the following conditions are met:

(i) at least one free uplink channel in microcell *B*;
(ii) at least one free uplink channel in the central microcell *A*; and
(iii) at least two free downlink channels in the central microcell *A*. Otherwise, the call is blocked.

2) *Three-hop Calls:* Three-hop calls refer to calls originated from MSs in the outer half region of a *virtual* microcell, such as MS3 in region*B*2 of microcell *B* in Fig. 1responsible for finding two other MSs, RS1 and RS2, to be the RSs for the call; RS1 is in the central microcell *A* and RS2 is in the region *B*1. For uplink transmission, a three-hop call requires two uplink channels from microcell *B* and one uplink channel from the central microcell *A*. The three uplink channels are used for the transmission from MS3 to RS2, from RS2 to RS1 and RS1 to the BS, respectively. For downlink transmission, a three-hop call requires two downlink channels from central microcell *A* and one downlink channel from microcell *B*. It is known however that A three-hop call is agreeable if the set of following conditions are satisfied :

(i) at least one free uplink channel in the central microcell *A*
(ii) at least two free uplink channels in the microcell *B*
(iii) at least two free downlink channels in the central microcell *A*;
(iv) at least one free downlink channel in microcell *B*. Otherwise, it is obstructed.

The channel assignment in CMCN to a call for uplink and downlink is generally unpoised. This is different from that in TCNs, where same numbers of channels are allocated, to a call for uplink and downlink. Also it is known that under the asymmetric FCA (AFCA) for CMCN [9], each *virtual* or central microcell is allocated a fixed number of channels. The uplink and downlink channel combination are (*NU*, *c*, *NU*, *v*) and (*ND*, *c ND*, *v*), respectively, where *NU*, *c*/*ND*, *c* and *NU*, *v*/*ND*, *v* are the number of uplink/downlink channels in the central and *virtual* microcells, respectively. The channel assignment procedure of AFCA is said to be similar MDCA [9].Fig 1 give the channels assignment in CMCN. Table 1 presents Inference Information which is further explained in the section B given below

B. Interference Information Table

	Channel						
Cell	1	2	3	--	--	--	N
0	L	L	2L	--	--	--	L
1		2L	U22				U33
2	L	L	2L				2L
3	L	U11	2L				L
4							
--							
12		U11	U11				L
--							
48	U22	L	U33				

Table I: The table tells how we are creating the optimized cell IIT table

The proposed MDCA scheme works on the information provided by the Interference Information Table (IIT) [10]. Two global IITs are stored in mobile switching center (MSC) for uplink and downlink channels. Every BS is able to access to the global IITs. Denote the set of interfering cells of any microcell *A* as *I* (*A*). The information of *I* (*A*) is stored in the Interference

Constraint Table (ICT). Different reuse factor *Nr* values will have different *I* (*A*) for a given microcell *A* and we can implement MDCA with any *Nr* by changing the interfering cells information in the ICT. For example, with *Nr* = 7 the number of interfering cells in *I* (*A*) is 18, which includes those interfering cells in the first and second tiers. Table I shows the uplink IIT for the CMCN shown in Fig. 2, which includes the shared *N* system uplink channels in each cell. The downlink IIT is similar and hence not illustrated here. The content of an IIT is described as follows.

1) Used Channels: a letter 'U11/22/33' in the (microcell *A*, channel *j*) box signifies that channel *j* is a used channel in microcell *A*. The subscript indicates which hop the channel is used for; 'U11', 'U22', 'U33' refer to the first-hop channel, the second-hop channel and the third-hop channel, respectively.

2) Locked Channels: a letter 'L' in (microcell *A*, channel j) box signifies that microcell *A* is not allowed to use channel *j* due to one cell in *I* (*A*) is using channel *j*. Similarly, 'nL' in (microcell *A*, channel *j*) box indicates n cells in *I* (*A*) are using Channel *j*.

3) *Free Channels:* an empty (microcell *A*, channel *j*) box signifies that channel *j* is a free channel for microcell *A*.

C. Channel Searching Strategies

1) *Sequential Channel Searching (SCS):* When a new call arrives, the SCS strategy is to always search for a channel from the lower to higher-numbered channel for the first-hop uplink transmission in the central microcell. Once a free channel is found, it is assigned to the first-hop link. Otherwise, the call is blocked. The SCS strategy works in the same way to find the uplink channels for second- or third-hop links for this call if it is a multichip call. The channel searching procedure is similar for downlink channel assignment as well.

2) Packing-Based Channel Searching (PCS): The PCS strategy is to assign microcell *A*, *a* free channel *j* which is locked in the largest number of cells in *I* (*A*). The motivation behind PCS is to attempt to minimize the effect on the channel availability in those interfering cells. We use *F* (*A*, *j*) to denote the number of cells in *I* (*A*) which are locked for channel *j* by Cells not in *I* (*A*). Interestingly, *F* (*A*, *j*) is equal to the number of cells in *I* (*A*) with a label 'L' in channel *j*'s column in the IIT. Then the cost for assigning a free channel *j* in microcell A is defined as

$E(A, j) = I(A) - F(A, j)$………… (1)

This cost represents the number of cells in *I* (*A*) which will not be able to use channel *j* as a direct result of channel *j* being assigned in microcell *A*. Mathematically, the PCS strategy can be defined as

Min $J\ E(A, j) = I(A) - F(A, j)$

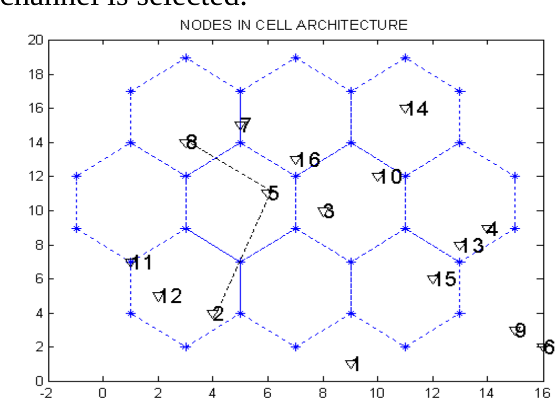
subject to: $1 \leq j \leq N$……………….. (2)

Since *I* (*A*) is a fixed value for a given *Nr*, the optimization problem can be reformulated as

Max $j\ F(A, j) = \_\ X \in I(A)\ \delta(X, j)$

subject to: $1 \leq j \leq N$………………. …(3)

Where $\delta(X, j)$ is an indicator function, which has a value of 1 if channel *j* is locked for microcell *X* and 0 otherwise. Specifically, to find a channel in microcell *A*, the MSC checks through the *N* channels and looks for a free channel in microcell *A* that has the largest *F*(*A*, *j*) value. If there is more than one such channel, the lower-numbered channel is selected.



FigNo:2 IIT table channel optimization

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For example, Table I shows a call in cell 15 requesting a first-hop channel. Channels 1, 2 and 3 are the three free channels in cell 15. Please refer to Fig. 1, I (15) = 2, 7, 8, 14, 16, 20, with Nr = 7. Since most of the cells in I (12) are locked for channel 2, it is suitable to assign channel 2 as the first-hop channel in cell 12 because F (12, 2) = 12 is largest among the F (15, j) values for j = 1, 2 and 3. The best case solution is when E (A, j) = 0. However, it might not be always feasible to find such a solution. The proposed PCS strategy attempts to minimize the cost of assigning a channel to a cell that makes E (A, j) as small as possible. Thus, it results in a sub-optimal solution the worst case algorithm complexity for the PCS strategy with Nr is estimated to be O (12(N − 1) [f (Nr) + 1]) [13],

where f (Nr) is number of cells in I (A) for cell A with a given Nr (e.g. when Nr = 7, f (Nr) = 18).

This worst case algorithm complexity is calculated by estimating the number of steps required to assign channels to a three-hop call when all N channels are free. A three-hop call requires three uplink channels and three downlink channels. First, for a first-hop uplink, it takes N steps to check the channel status of all N channels in microcell A. Then, it takes 2f (Nr) steps to check the entry for each cell in I (A) for a free channel j to calculate F (A, j). Since all N channels are free, the total number of steps to obtain F (A, *) for all N channels is 2f (Nr) N. Finally, it takes N-1 steps to compare the N F (A, *) values and find the largest F (A, *). Similarly, the same approach can be applied for second and third-hop uplink to obtain F (B, *) and the complexity for uplink channel assignment is given by

$O(\{[N + 2f(Nr)\,N + N - 1] + [N - 1 + 2f(Nr)(N - 1) + N - 2] + [N - 2 + 2f(Nr)(N - 2) + N - 3]\})$

$= O(6(N - 1)[f(Nr) + 1])$……………………………………… (4)

Since the computational complexity for downlink is the same as uplink, the total worst case algorithm complexity is simply equal to

$O(12(N - 1)[f(Nr) + 1])$………………………………………..(5)

. *Channel Updating*

i) Channel Assignment:

when the BS assigns the channel j in the microcell A to a call, (i) it will inform the MSC to insert a letter 'U11/22/33' with the corresponding subscript in the (microcell A, channel j) entry box of the IIT; and

(ii) it will also inform the MSC to update the entry boxes for (I (A) channel j) by increasing the number of 'L'.

2) Channel Release:

when the BS releases the channel j in the microcell A,

(i) it will inform the MSC to empty the entry box for (microcell A, channel j); and

(ii) it will also inform the MSC to update the entry boxes for (I (A), channel j) by reducing the number of 'L'.

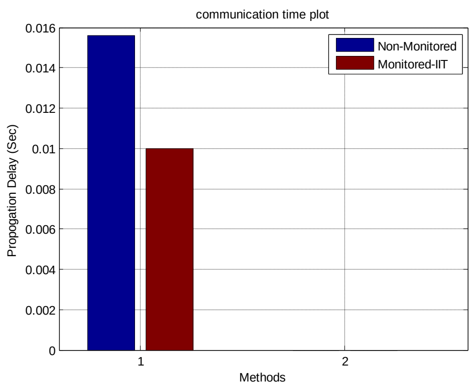
Channel Reassignment (CR) When a call using channel i as a kth-hop channel in microcell A is completed, that channel i is released. The MSC will search for a channel j, which is currently used as the kth-hop channel of an ongoing call in microcell A. If E (A, i) is less than E (A, j), the MSC will reassign channel i to that ongoing call in microcell A and release channel j. CR is only executed for channels of the same type (uplink/downlink) in the same microcell. Thus, CR is expected to improve the channel availability to new calls. Mathematically, the motivation behind CR can be expressed as a reduction in the cost value:

$\Delta E(A, i \rightarrow j) = E(A, i) - E(A, j) = F(A, j) - F(A, i) < 0$……………………...……. (6)

IV. SIMULATION RESULTS

A).Simulation Model

The simulated network is shown in Fig. 2 and the wraparound technique is used to avoid the boundary effect. The number of system channels is N=70 (70 uplink channels and70 downlink channels). We use Nr=7 as illustration, hence a channel used in cell A cannot be reused in the first and the second tier of interfering cells of A, i.e. two-cell buffering. Two traffic models are studied: uniform traffic model generates calls which are uniformly distributed according to a Poisson process with a call arrival rate λ per macrocell area, while hot-spot traffic model only generates higher call arrival rate in particular microcells. Call durations are exponentially distributed with a mean of $1/\mu$. The offered traffic to a macrocell is given by $\rho=\lambda/\mu$. Each simulation runs until 100 million calls are processed. The 95% confidence intervals are within ±10% of the average values shown. For the FCA in TCNs, the results are obtained from Erlang B formula with *N*/7 channels per macrocell



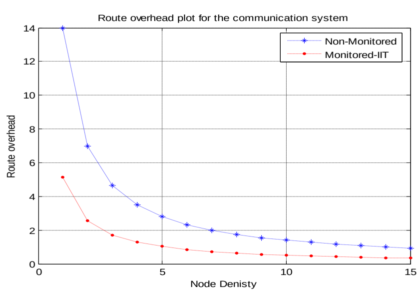


Fig 3 : difference between the TDM, MDCA, the packet distribution in MDCA

B). Simulation Results with Uniform Traffic

Fig. 4 shows both the uplink and downlink call blocking probability, i.e. *Pb,U* and *Pb,D*. Notice that the *Pb,U* is always higher than the *Pb,D* due to the asymmetric nature of multihop transmission in CMCN that downlink transmission takes more channels from the central microcell than uplink transmission. The channels used in the central microcells can be reused in the other central microcells with minimum reuse distance without having to be concerned about the co-channel interference constraint, because two-cell buffering is already in place. The system capacity based on *Pb, U* = 1% for MDCA with SCS and PCS are 15.3 and 16.3 Erlangs, respectively. With PCS-CR (channel reassignment), the capacity of MDCA is increased by 0.4 Erlangs. Fig. 3 shows the average call blocking probabilities for FCA and DCA-WI for TCNs [10], AFCA for CMCN [9], MDCA with SCS, PCS and PCS-CR. DCA-WI, known as DCA with interference information, is a distributed network-based DCA scheme for TCNs. Under DCA-WI, each BS maintains an interference information table and assigns channels according to the information provided by the table. Only the *Pb, U* for MDCA is shown because uplink transmission has lower capacity. At *Pb, U* = 1%, the system capacity for the FCA and DCAWI are 4.5 Erlangs and 7.56 Erlangs, respectively. AFCA with optimum channel combinations, (*NU, c*=22, *NU, v*=8) and (*ND, c*=40, *ND, v*=5), can support 9.3 Erlangs. The MDCA with SCS, PCS, and PCS-CR can support 15.3 Erlangs, 16.3 Erlangs and 16.7 Erlangs, respectively. As compared to DCAWI and AFCA, the improvements of MDCA with PCS-CR are 120.9% and 79.6%, respectively.

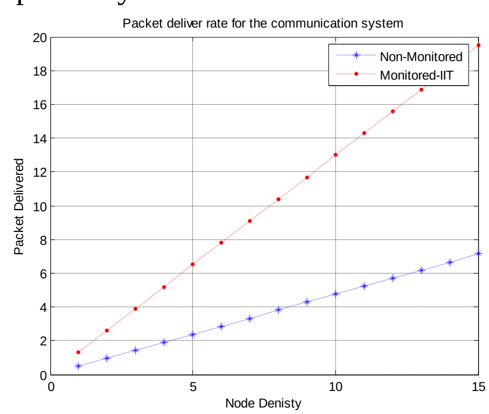


Fig 4 : uplink or downlink using packet distribution

V. CONCLUSION

The feasibility of applying DCA scheme for MCN-type systems is investigated. A multihop DCA (MDCA) scheme with two channel searching strategies is proposed for clustered

MCN (CMCN). A channel reassignment procedure is investigated. Results show that MDCA can improve the system capacity greatly as compared to FCA and DCA-WI for TCNs and AFCA for CMCN. Furthermore, MDCA can efficiently handle the hot-spot traffic.

REFERENCES

[1] Imdadul Islam and Siddique Hossain"Comparison of tra_c performance of QPSK and 16-QAM
modulation techniques for OFDM system"journal of Telecommunaction and information technologies 2005

[2] C. E. Perkins, *Ad Hoc Networking*. Boston MA: Addison-Wesley, 2001.

[3] T. Adachi and M. Nakagawa, "A study on channel usage in cellular adhoc united communication system for operational robots," *IEICE Trans. Commun.*, vol. E81-B, pp. 1500-1507, July 1998.

[4] Y.-D. Lin and Y.-C. Hsu, "Multihop cellular: a new architecture for wireless communications," in *Proc. IEEE INFOCOM'00*, vol. 3, pp.1273-1282, Tel Aviv, Israel, Mar. 2000.

[5] H. Wu, C. Qiao, S. De, and O. Tonguz, "Integrated cellular and ad hoc relaying systems: iCAR," *IEEE J. Select. Areas Commun.*, vol. 19, pp.2105-2115, Oct. 2001.

[6] H. Wu, S. De, C. Qiao, E. Yanmaz, and O. Tonguz, "Managed mobility: a novel concept in integrated wireless systems," in *Proc. IEEE MASS'04*, pp. 537-539, Fort Lauderdale, FL, Oct. 2004.

[7] H. Luo, R. Ramjee, P. Sinha, L. E. Li, and S. Lu, "UCAN: a unified cellular and ad-hoc network architecture," in *Proc. ACM MOBICOM'03*, pp. 353-367, San Diego, CA, Sept. 2003.

[8] G. N. Aggelou and R. Tafazolli, "On the relaying capacity of next generation GSM cellular networks," *IEEE Personal Commun.*, vol. 8, pp. 40-47, Feb. 2001.

[9] X. J. Li and P. H. J. Chong, "A fixed channel assignment scheme for multihop cellular network," in *Proc. IEEE GLOBECOM'06*, vol. WLC 20-6, pp. 1-5, San Francisco, CA, Nov. 2006.

[10] P. H. J. Chong and C. Leung, "A network-based dynamic channel assignment scheme for TDMA cellular systems," *International J. Wireless Inform. Networks*, vol. 8, pp. 155-165, July 2001.

[11] S. S. Rappaport and L.-R. Hu, "Microcellular communication systems with hierarchical macrocell overlays: traffic performance models and analysis," *Proc. IEEE*, vol. 82, pp. 1383-1397, Sept. 1994.

[12] J. Y. Yu and P. H. J. Chong, "A survey of clustering schemes for mobile ad hoc networks," *IEEE Commun. Survey & Tutorials*, vol. 7, pp. 32-48,First Quarter, 2005.

[13] S. W. Herber, *Algorithms and Complexity*. Prentice-Hall, 1986.

[14] C.-L. I and P.-H. Chao, "Local packing: distributed dynamic channel allocation at cellular base station," in *Proc. IEEE GLOBECOM'93*, vol.1, pp. 293-301, Houston, TX, Nov. 1993.