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MultiHop Dynamic Channel Assignment to Optimize Cellular Networks Based on Dynamic Frequency Selections

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Abstract: - The day to day demand for mobile communication has been rapidly increasing in recent years. With the limited frequency spectrum, the problem of channel allocation becomes very important, i.e., how do we assign the calls to the available channels so that the interference is minimized while the demand is met? This problem is known to belong to a class of very difficult combinatorial optimization problems. In this situation, we apply the Dynamic frequency selection scheme to channel assignment problems. Interference-free solutions cannot be found for some of these problems; however, the approach is able to minimize the interference significantly. With the limited frequency spectrum, the channel assignment problem (CAP) i.e., to assign the calls to the available channels so that the interference is minimized while the demand is met, has become increasingly important. The Channel Assignment Problem is an NP-complete problem to assign a minimum number of channels under certain constraints to requested calls in a cellular radio system.The dynamic channel assignment (DCA) in mobile communications systems using Dynamic frequency selections among the available free frequencies (DFS) is investigated in this research.

I.INTRODUCTION

One major requirement for any cellular network operator is to ensure that the network is operating to its maximum efficiency. As a result cellular network optimisation is a major feature of many modern cellular networks.

If a cellular network is not performing to its maximum this can directly result in poor performance: dropped calls, insufficient bandwidth causing phones to reduce the audio bandwidth, even barred access, or slow response times for data downloads. As a result, network performance and hence the service quality seen by users is a key differentiator. A good level of perceived quality will help retain users, whereas poor service will lead to high levels of churn for the cellular network operator.

In view of the huge amounts of investment that cellular operators require to set up their systems, it is necessary to ensure that they operate to their greatest efficiency. Optimisation might enable lower levels of infrastructure to be used. This could then reflect in a lower level of investment being required, and the resulting considerable cost savings being made. Additionally cellular network optimization can enable problems to be identified and the network to overcome the results while the problem is being fixed.

As a result, cellular network optimization tools are an essential requirement for any network these days. They enable a faster response to be gained for performance issues, a better service quality across the network, lower operating costs for the cellular network, and a much more efficient use of capital investment. Accordingly a number of network optimisation tools are available on the market, both from network vendors as well as from the independent suppliers.

DFS is a mechanism to allow unlicensed devices to use the 5 GHz frequency bands already allocated to radar systems without causing interference to those radars. The concept of DFS is to have the unlicensed device detect the presence of a radar system on the channel they are using and, if the level of the radar is above a certain threshold, vacate that channel and select an alternate channel.

2.AIM & OBJECTIVES

This paper proposes a multihop dynamic channel assignment (MDCA) scheme that works by assigning channels using Dynamic frequency allocation schemes based on interference information in surrounding cells. Dynamic frequency allocation is based on the identification of available free frequencies and assigning them to the calls . 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.

3. CHANNEL SEARCHING STRATEGIES

There are two channels that are searched by mobile devices.

Table 1 .Types of Channels

Channel	Purpose
Strong Dedicated Channel (DCC)	A channel used for the transmission of digital control information from a base station to the Mobile device or vice versa.
Strong Paging Channel	A channel used by the MSC for seeking the Mobile device when a call made to it.

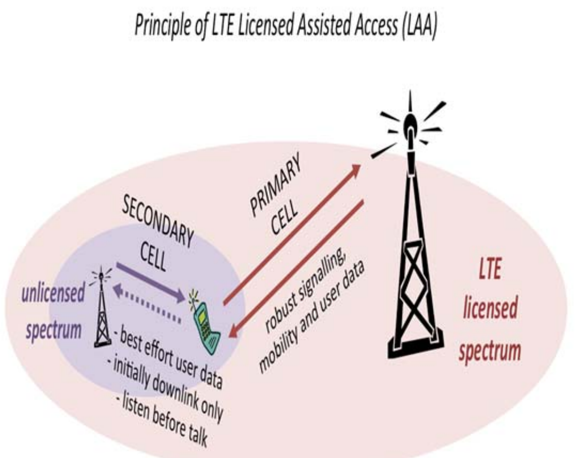
Sequential Channel Searching (SCS): When a new call arrives, the SCS strategy is to always search for a channel from the lower to higher-numbered channel for the first-hop uplink transmission in the central microcell. Once a free channel is found, it is assigned to the first-hop link. Otherwise, the 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.

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 ≤ j ≤ 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∈I (A) δ(X, j) subject to: 1 ≤ j ≤ N……………...... …(3)

Where δ(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.



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: ΔE (A, i → j) = E (A, i) − E (A, j) = F (A, j) – F (A, i) < 0……………………...……. (6)

4. 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/μ. The offered traffic to a macrocell is given by ρ=λ/μ. 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

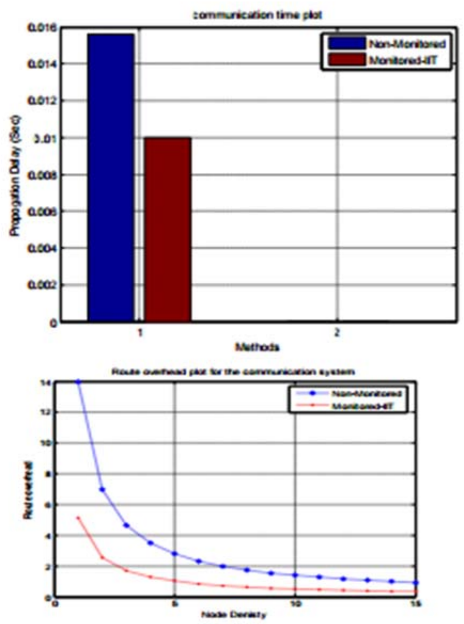


Fig 3 : difference between the TDM, MDCA, the packet distribution in MDCA

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 using Dynamic Frequency allocation(DFS) 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.

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