Resource partitioning in OFDMA Femto-cells

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Abstract -- Due to the rapid demand for high data rates for mobile users; network operators need to increase their capacity with minimum deployment costs. There has been an increasing need for network operators to provide better coverage for indoor users who suffer from wall penetration loses. One possible way to solve this is using Femto-cells (HeNB), which are installed indoors and suffer negligible signal losses. However, due to the fact that HeNB use the same resources as Marco-cells; there is Co-Channel Interference (CCI) between users served by Marco-cell base stations and Femto-cell users. This paper proposes that the Macro-Base Station (M-BS) to monitor the network resources Blocks (RBs) and inform both Marco-Mobile Station (M-MS) and Femto-Base Station (F-BS) about the available RBs. When CCI occurs the F-BS will be informed to use other resources or RBs used by other F-BSs.

Index Terms — Co-channel interfere, Femto-cells, Resource partitioning, CSG, HeNB, HII

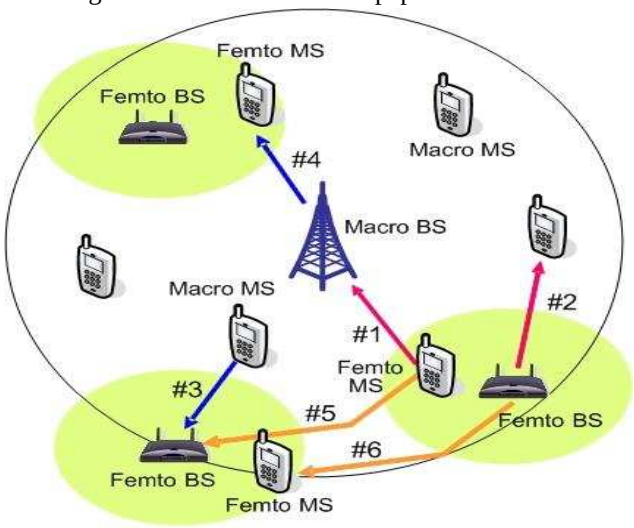
INTRODUCTION

The demand for high data rate mobile services poses great challenges for network operators, especially when considering indoor environments. Given that 70% of mobile usage occurs indoors, there is need for cellular coverage to reach indoor users. Cellular signals suffers from wall penetration loses leading to poor reception [1]. Hence network operators can deploy more base stations (BSs) to increase capacity for indoor users'. However both alternatives are resource inefficient and very expensive to implement. The network operator can increase data rates for indoors users by shrinking the coverage cell and using higher order modulation techniques [5].

There has been growing momentum in academia and industry about Femto-Cells (HeNBs), which help solve the problems mentioned above. HeNB cover a very small area, which in turn increases the Signal-to-Noise Ratio (SNR) between the HeNB the mobile user. Moreover, there is better reuse of the operator's frequency resources [2]. When used indoors it results in improved signal quality for indoor users and optimized utilization of the scarce frequency Resources Blocks (RBs) in the network [2]. HeNB relies on the fixed internet connection (DSL or Ethernet) for its backhaul [2].

HeNB can also improve signal quality for cell-edge users [6]. However, HeNB suffer from Co-Channel Interference (CCI). This happens when a Marco-cell mobile station (Marco-MS) receives the same RB as the Femto-cell user (Femto-MS) [4]. Signal interference will occur (see Figure 1) since the coverage of HeNB and the macro-cell may overlap. HeNBs have three access control strategies: open access, closed access and hybrid access [2]. In open access any Mobile Station (MS) can use the RB of the HeNB, thus its open to any public user. However, in closed access only certain users can use the RB's of HeNB; the user group is called Closed Subscriber Group (CSG) [2]. And any MS that does not belong to this group is denied access to the HeNB's resources. And lastly the Hybrid access allows both CSG members and non-CSG members. The CCI affects the Femto-cell network enormously when the HeNB only accepts CSG members and a non-CSG member is in close proximity [3].

In this paper we present a resource management scheme that reduces the CCI and ensures resource fairness among all mobile users. The scheme will guarantee higher data rates to both indoor and outdoor users and improved signal strength for cell-edge users. The rest of the paper is organized as follows: section II reviews related work; section III describes the proposed scheme, section IV states our research goals and we conclude the paper in section V.



	Interference		UL-DL
	From	To	
#1	Femto MS	Macro BS	UL
#2	Femto BS	Macro MS	DL
#3	Macro MS	Femto BS	UL
#4	Macro BS	Femto MS	DL
#5	Femto MS	Other Femto BS	UL
#6	Femto BS	Other Femto MS	DL

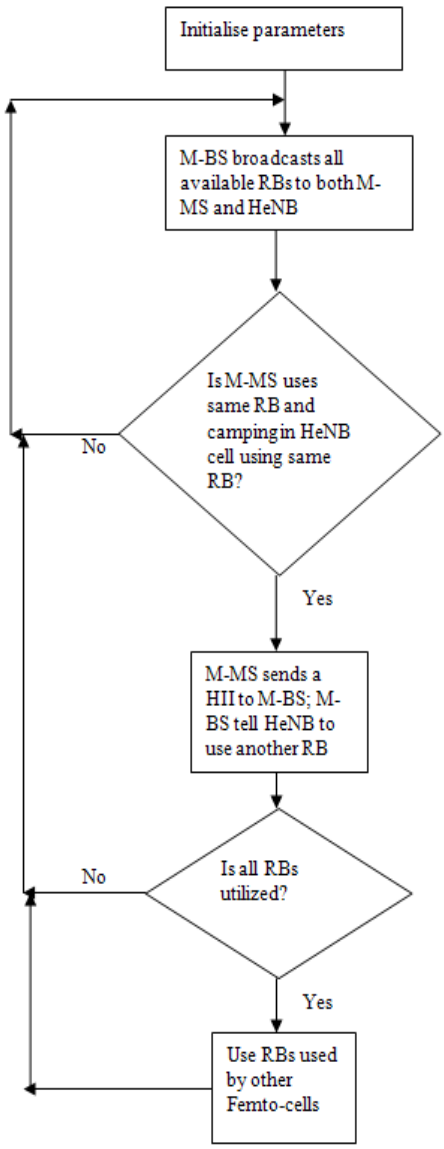
Figure 1: Diagram showing the CO-Channel interference and inter-cell interference [4]

RELATED WORK

3GPP standards prior to release 8 did not cater for Femto-cells. In release 9 a lot of work is done to include HeNB [2]. Bharucha et el. [3] propose a resource portioning scheme for Femto-cells, which reduces the CCI by informing the HeNB to stop using a RB's used by a nearby non-CSG MS. However this scheme will deprive the CSG UE of resources if more than one M-UE camps in the HeNB coverage cell.

Eddanapudi et el. [1] propose a resource brokering method for ensuring authorized UEs are using the available resources. This scheme fails to solve the CCI problem. Haas et el. [5] solves CCI problem by using a Hybrid Division Duplex (HDD) mechanism, which uses the UL (Uplink) of the Frequency Division Duplex (FDD) band as a Time Division Duplex (TDD) channel as an overlay. This is because it is assumed that data traffic is asymmetric, hence the justification to use the unused UL band of the FDD for intra-cluster communication. The scheme relies heavily on a gateway mobile (GM), which is a MS that acts like a relay for the other CSG members. The disadvantage of the scheme is that if the GM fails CSG members will be offline.

PROPOSED ARCHITECTURE



The following assumptions are made for the proposed scheme:

- The indoor user has a DSL or Ethernet connection port; so that the HeNB can communicate with network M-MS and other mobile stations.
- The core network broadcasts information of the RBs used by Macro-UEs to the Femto-cells; information on available RBs is also provided.
- The HeNB's transmission power is small enough not to cause interference with neighboring Femto-cells.

CONCLUSION

Future mobile stations will require high data rates in the range of 1Gbps for non-mobile users. This means indoor users will require high data rates. This is currently a challenge for network operators; because indoor users suffer from poor signal coverage caused by wall penetration loses in office buildings and residential dwellings. Femto-cells provide an easy way to boost indoor coverage and data rates for indoor users. However Femto-cells suffer from co-channel interference (CCI). We proposed a resource partitioning scheme that will reduce the CCI and ensure the network's resources are efficiently utilized. Moreover, the proposed scheme will ensure fairness in resource usage among M-MSs and F-MSs.

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