Project	**IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>**
Title	**CR on SDD Section 17: Load Balancing between Femto and Macro BS**
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Re:	Change request to Project 802.16m System Description Document (SDD) (IEEE 802.16m-08/003r7)
Abstract	This contribution provides text addition to SDD to facilitate load balancing between femto, micro and macro BS in the network.
Purpose	For discussion and approval by IEEE 802.16m TG
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Load Balancing between Femto and Macro BS

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Load Balancing

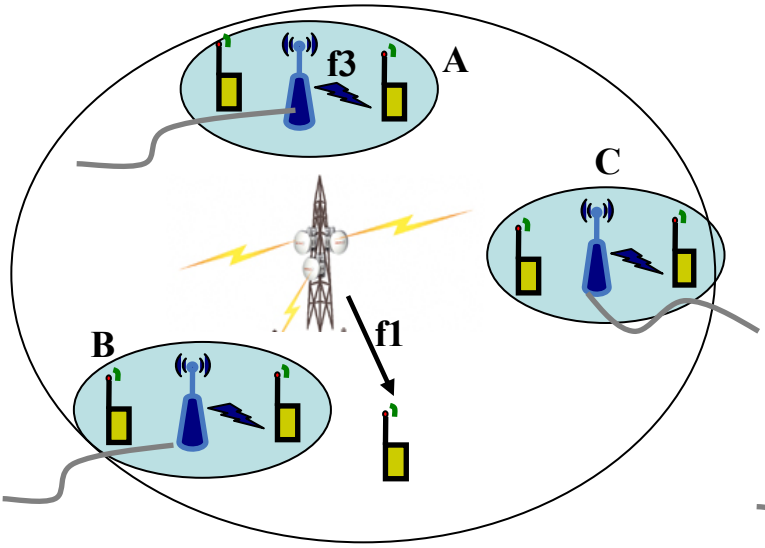

Figure 1a. Traffic concentration in femto cells.

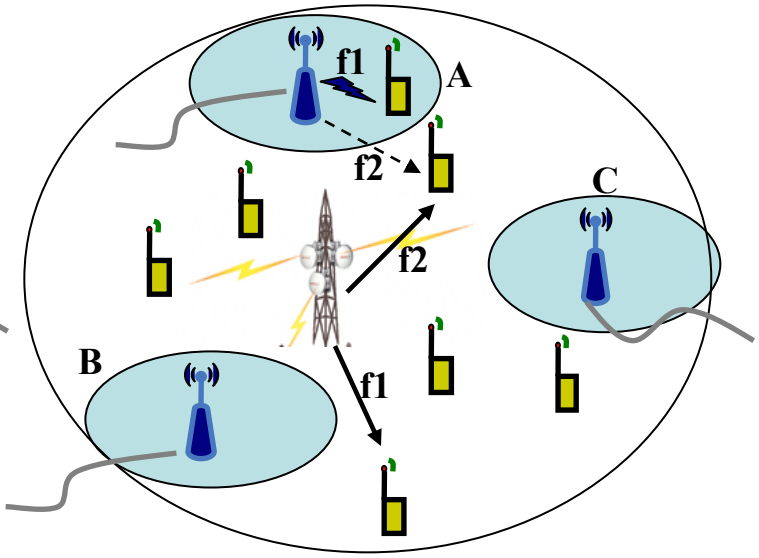

Figure 1b. Traffic concentration in macro cell.

Current SDD text mentions that femto BS can coordinate with the macro BS or autonomously determine the resources to be used for its operation. Irrespective of which method is adopted, it does not currently provide provisions for load balancing between the femto and macro BS. Given the usage scenarios of femto cells in residences, enterprises, complexes, etc. it can be anticipated that the dynamics of traffic in these femto cells can vary significantly depending on the time of the day. For eg, one can expect more traffic from residenctial femto cells during the evenings. Given the large dynamic nature of load in these femto cells, it is very important for the service provider to coordinate the resources between macro and femto cells so that the resources are efficiently utilized contributing to better revenue. For eg. consider the scenario is Fig 1a and 1b. In Fig. 1a, the UE concentration is more in the femto cells compared to the macro, while in 1b it is the macro cell where traffic is concentrated. Using the same allocation of resources for both the scenarios will lead to poor utilization of resources and hence performance. For the scenario is 1a, more resources must be allocated towards the femto cells, while for 1b more resources must be allocated to the macro cell.

To address this load balancing scenario, it is important for some coordinating entity (say macro BS) to

periodically collect some traffic performance metric (load, utility, etc.) from the macro and femto BS to decide on the amount of resources that can be allocated to the macro BS and the femto BS. How the macro and femto BS decide to use these resources is not within the scope of this document. However, being able to periodically collect traffic metrics from them will help efficiently balance the load between them and adapt it to varying network dynamics. The periodicity (semi-static nature) of such information collection could also be implementation dependent.

Reuse of Macro Resource by Femto Cells

The resources used by the macro and femto BS can be mutually exclusive, thereby eliminating interference between macro and femto BS. The split of resources can be coordinated between macro and femto BS and adapted to load dynamics in the network. However, the femto network architecture allows for improved capacity, whereby resources allocated to the macro BS can be reused by some of the femto BS. To see this, consider the example in Figure 1a and 1b, where the femto BS A is situated far from the macro BS. In Fig. 1a, the resources used by macro and femto BS are mutually exclusive, allowing the macro BS to talk to its client on channel f1, while the femto BS A talks to its client on an orthogonal channel f3. On the other hand, in Fig 1b, the macro BS talks to two of its clients on channels f1 and f2, while the femto BS A reuses channel f1 to talk to its client, thereby increasing the capacity. Note that, such reuse of macro resources by femto cells has to be executed carefully. While the location of the femto BS might allow it and its clients to receive weak interference from the macro BS, the femto BS itself could cause interference to macro cell clients who are in proximity, thereby bringing down the macro cell performance. For eg. if the femto BS were to reuse channel f2, then this would cause interference to the maco cell client just outside femto cell A.

Thus, reusing macro resources can lead to improved network capacity. However, to be able to execute it without exacerbating interference to macro cell clients, some geographic information on the macro cell resource allocation (eg. location of region where a macro resource is allocated to a macro MS) could be provided to the femto BS either through direct or indirectly signaling. While femtocell-assisted LBS services are made available, such information could also be leveraged to improve network capacity through efficient resource reuse and load management.

Insert the following text into the "Support for Femtocell" clause (IEEE 802.16m-08/003r7***):***

---------- Proposed text ----------

17.12 Load Management and Balancing

It is important to efficiently balance the load between the macro and femto BS to optimize capacity and QoS. To achieve this, some traffic performance metric (load, utility, etc.) should be periodically collected from the macro and femto BS to decide on the amount of resources that will be used by the macro, micro and the femto BS. How the macro and femto BS decide to use these resources in a distributed manner is not within the scope of this document. However, being able to periodically collect traffic metrics from them will help efficiently adapt and balance the load between them and adapt it to varying network dynamics. The periodicity (semi-static nature) of such information collection could also be implementation dependent.

The femto network architecture allows for improved capacity, whereby resources allocated to macro BS can be

reused by some of the femto BS. To aid in such improved reuse of resources, some geographic information on the macro resource allocation (eg. location of region where a macro resource is allocated to a macro MS) could be provided to the femto BS either through direct or indirect signaling.

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