Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Handover and Load Balancing Rules for 16m**	
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Re:	IEEE 802.16m-08/052 Call for Comments and Contributions on Project 802.16m System Description Document (SDD) for Session 59.	
Abstract	Provides SDD text to describe handover rules to be defined in neighbor advertisement message.	
Purpose	Discussion and approval of the proposal into the IEEE 802.16m System Description Document.	
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Handover Rules and Load Balancing for 16m

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1 Problem statement

In current HO framework, cell association/selection has mainly been done based on the maximum received signal to interference and noise ratio (SINR), which is optimal when the cell loads are symmetric. However, the cell loads in real networks are not symmetric, and load balancing is required; load balancing is important to increase the cell throughput and reduce user-experienced delay in file transfers.

In rev.2, a cell load is defined but however there is not specification on how his parameter should be used. Such ambiguity may cause problem since cell association has two perspectives: the user's (or MS's) point of view, and the network's (or BS's) point of view. In current HO frame, there may be cases that MS has to pick its own target BS, either there is a list of candidate TBS or it is uncontrolled HO. It is important for the network to define prioritization rules (in an efficient yet effective way), which is known to the MS as well, so that when MS has the cell selection flexibility, the MS could likely make the correct decision to avoid HO failure or poor load balancing.

2 Intuitive interpretation of load balancing

Different load balancing criteria can be summarized by a simple parameterized function:

Pick BS i that maximize $(1-\rho_i)^{\alpha} SINR_i$

- ρ_i is loading factor of BS i
- α is a network defined parameter

Different load balancing criteria is determined by α (which can be shown analytically)

- α=0, it is purely channel quality based, no load balancing in consideration
- α=1, it optimize this particular user's expected service level
- α=2, it optimize the average service level among all users in the network
- α=∞, it is purely load based, no channel quality in consideration

3 An example of effect on handover and load balancing rules

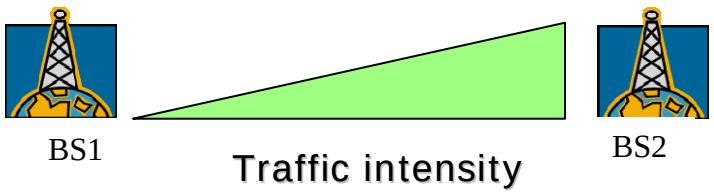

Figure 1 An simple network with uneven loads

As shown in Figure 1, we consider a simple network. We assume the traffic comes in with uneven rate, for which near BS2, the traffic activity is more intense than that near BS1. We simulate how different cell selections rules (parameterized by different α value) leads to different average network performance.

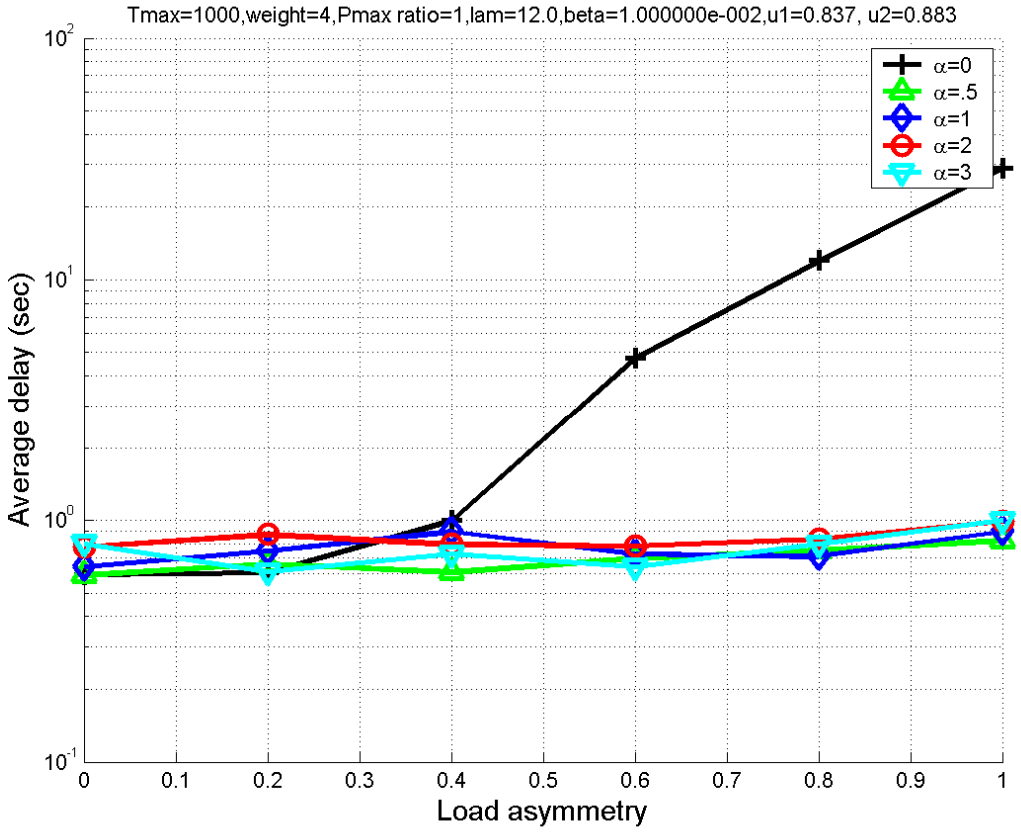

Figure 2 Performance comparison of different rules – moderate load

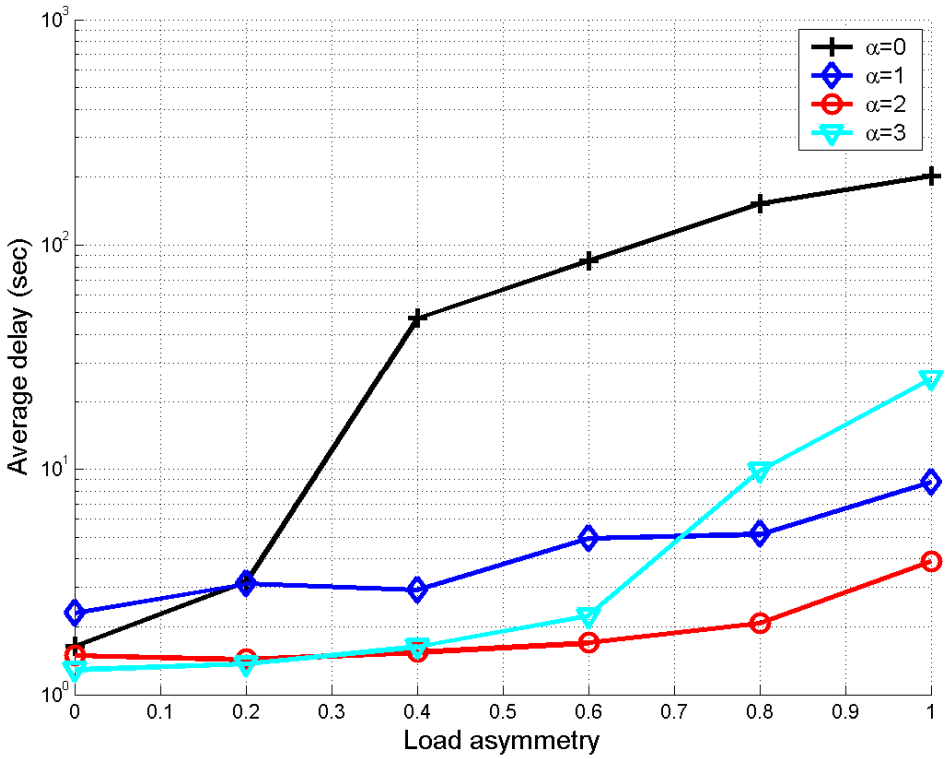

Figure 3 Performance comparison of different rules – high load

When the network is moderately loaded, as shown in Figure 2, any rule that takes load into consideration (all rules except α=0) achieves similar performance. The channel quality only rule with α=0 performs very poorly when the network load gets more uneven, incurring delay that is almost an order of magnitude larger.

When the network is highly loaded, as shown in Figure 3, different choice of α starts showing performance difference even if load is considered. As mentioned early, α=2 optimize the average network performance in this case.

4 Conclusion

- Load balancing consideration is important for cell selection
- The network shall define proper prioritization rules for cell selection for handover (and network entry etc)
- Prioritization rules can be defined with a few simple parameters and could be dynamic based on the real-time network condition

5 Text proposal

Insert the following text to the end of Section 18.3.1.1 of SDD as follows:

---------- Text Start ----------

10.3.1.1 Network topology acquisition

The Neighbor Advertisement message may also define prioritization rules for MS cell selection during handover. Examples of parameters used by such prioritization rules may include cell load, cell types and MS scanning measurement.

---------- Text End ----------