Project	**IEEE 802.16 Broadband Wireless Access Working Group**	
Title	**Co-existence Scenarios for P-MP and MP-MP Networks**	
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Re:	Call for Contributions (posted 24 September 1999) for Coexistence Task Group, item on Interference Scenarios.	
Abstract	This document considers scenarios in which P-MP and MP-MP networks may be required to co-exist. It concludes that the dominant interfering mechanisms are generally less severe than between two P-MP networks, so that guidelines used for P-MP networks will be conservative and closer spacings are possible in some circumstances.	
Purpose	This document is provided for consideration as part of the Interference Scenarios section of the Coexistence Practice document.	
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Coexistence Scenarios for P-MP and MP-MP networks

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Background

BWA systems in operation today are mostly of P-MP (Point to Multipoint) architecture, using one or more base station sites. They may also use repeater stations and overlapping coverage of base sites, in order to achieve a satisfactory level of coverage (customer reach). The interference created in these situations is more complex than when only single or non – overlapping base site coverage is used.

The P-MP concept can be developed further, by effectively devolving and distributing the base station functionality across the network. This produces MP-MP topology (multipoint to multipoint), in which all radio paths use narrow beam antennas and all system nodes can communicate in several discrete directions. The total system takes on the appearance of a “mesh” of links, the arrangement of which varies as the subscriber base grows.

The advantages of MP-MP networks include low initial costs (costs grow as nearly as possibly in linear relationship to the number of subscribers), very high spectrum utilization and excellent customer reach, which can easily exceed 90%, even with low levels of customer penetration. Even at the very high frequencies being considered in 802.16.2, these advantages are readily achieved.

In this paper, consideration is given to the interference created by MP-MP systems and their susceptibility to interference from others. Scenarios in which one system is P-MP and the other is MP-MP are considered as well as the case where both systems are MP-MP.

ETSI TM4 is preparing equipment and antenna specifications for a range of systems under the general heading of MWS (Multimedia Wireless Systems). These may have P-MP or MP-MP architectures and deliver a range of telecommunications and entertainment services. The initial work is concentrating on the 40GHz band (40.5-43.5GHz).

Scenario with two MP-MP systems

From an interference point of view, an MP-MP system comprises a number of point-to-point links. Narrow antenna beams and short radio paths with low power (and power control) are used, in order to minimize interference and to re-use frequencies to the maximum extent. Low antenna heights are deliberately chosen to give maximum possible frequency re-use and practical systems can be built with as little as one radio channel. The directions of links and the choice of frequencies (assuming multiple channels are available) can be considered quasi - random.

MP-MP systems can operate in FDD or TDD mode but TDD is the most likely choice. From an interference point of view, the difference is not important, so TDD will be assumed in this paper.

As all stations (nodes) are subscriber stations, there being no base stations (hubs) as such, the interference analysis reduces to only two situations.

- The case where two networks are able to reduce mutual interference by means of some form of frequency sharing etiquette.

- The case where two networks are entirely independent and where no attempt is made to interact or adapt to interference from one to the other.

In the latter case, the calculation is similar to that between subscribers in P-MP networks. The level of interference will be relatively low, due to low antenna heights and local clutter, so that co-channel systems can be spaced significantly closer than for two co-channel P-MP systems, for which the dominant interference mechanisms lead to hub spacing of the order of 60km, dependent on assumptions (as noted in paper IEEE 802.16cc-99/05). The horizon distance is greatly reduced when compared with a typical P-MP hub and the effect of multiple interferers on the same channel is very low.

In the case of systems which can co-ordinate, the situation is close to that which prevails inside a MP-MP system. In this case, a frequency can be reused even more closely, with distances of the same order as link path length.

Scenario with a P-MP and a MP-MP system

Subscriber - subscriber

The subscriber to subscriber interference case is similar to that between two P-MP systems, except that the MP-MP system is likely to use lower radiated power on a path (since both ends of the link can have relatively high gain antennas).

MP-MP subscriber to P-MP base (hub)

The MP-MP subscriber to P-MP base scenario can be considered in the same way as P-MP to P-MP. Upstream power control is assumed (on MP-MP links, this applies to both directions of the link). In a rain fade, the interference path to the base (hub) and the path to the far end subscriber will either be simultaneously affected, or the fade will simply reduce the interference to the hub. Power turn – down can thus be assumed in the interference calculation. There are two additional factors:

- The effects of multiple subscribers should be considered. This can only be effectively determined by modelling (the same effect needs to be taken into account when reviewing P-MP subscribers interfering with P-MP base (hub)).
- The effects of real terrain. Since MP-MP systems make use of low antennas and deliberately make use of terrain clutter to reduce interference, the effects of multiple interferers will be reduced.

Initial modelling suggests that the effect in real systems is likely to be no worse than the effect of a single subscriber. The same modelling needs to be applied to P-MP systems, to take account of multiple interferers on the same channel.

P-MP hub to MP-MP subscriber

The base (hub) will not normally deploy power control. The antenna has a wide beam width and may be on a high site. Multiple interferers do not need to be considered. Thus, the situation is virtually identical to the P-MP to P-MP case. MP-MP systems makes use of low level antennas and ground clutter, so there may well be some reduction in the interference experienced. The exact value has to be determined from terrain modeling

Base to base (hub to hub)

This situation does not apply, as there are no base stations (hubs) in an MP-MP system. This scenario is often the worst case of interference.

Conclusions

It is proposed to consider the addition of interference scenarios to the Coexistence Practice Document covering MP-MP as well as P-MP systems. The interference scenarios involving MP-MP systems are in many cases similar to those involving P-MP systems alone but are generally less critical. Geographical re-use of frequencies can be the same as or better than when only P-MP systems are deployed. Interference between two MP-MP systems is inherently low and can be managed by use of frequency sharing etiquettes to reduce geographical spacing considerably.

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