IEEE P802.11
Wireless LANs

Further Considerations When Choosing a PHY

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Abstract

While examining the material presented on each of the PHY candidates, I realized that there several problems that are not addressed by the current evaluation criteria. These problems are discussed here and a recommendation is made.

Introduction

In addition to the PHY level parameters and gross performance criteria discussed to date differentiating one PHY candidate from another, there are subtle interactions between the MAC and PHY that should be examined and weighed when narrowing the field of PHY candidates as the selection process proceeds. These MAC-PHY interactions can have a significant impact on the functionality of the wireless LAN. Because this impact can be severe enough to prevent the operation of some MAC functions, the PHY candidates should be examined very carefully, with these additional considerations in mind. The additional considerations are all due to insufficient channelization. These additional considerations are loss of throughput, loss of PCF functionality, and loss of scanning functionality.

Insufficient Channelization

One of the problems that can cause the IEEE 802.11 MAC no end of grief is insufficient channelization. While this is considered at the PHY level for things such as cell planning, it also has a significant impact on the MAC. It is helpful to have a picture to which to refer, when discussing this problem. See Figure 1.

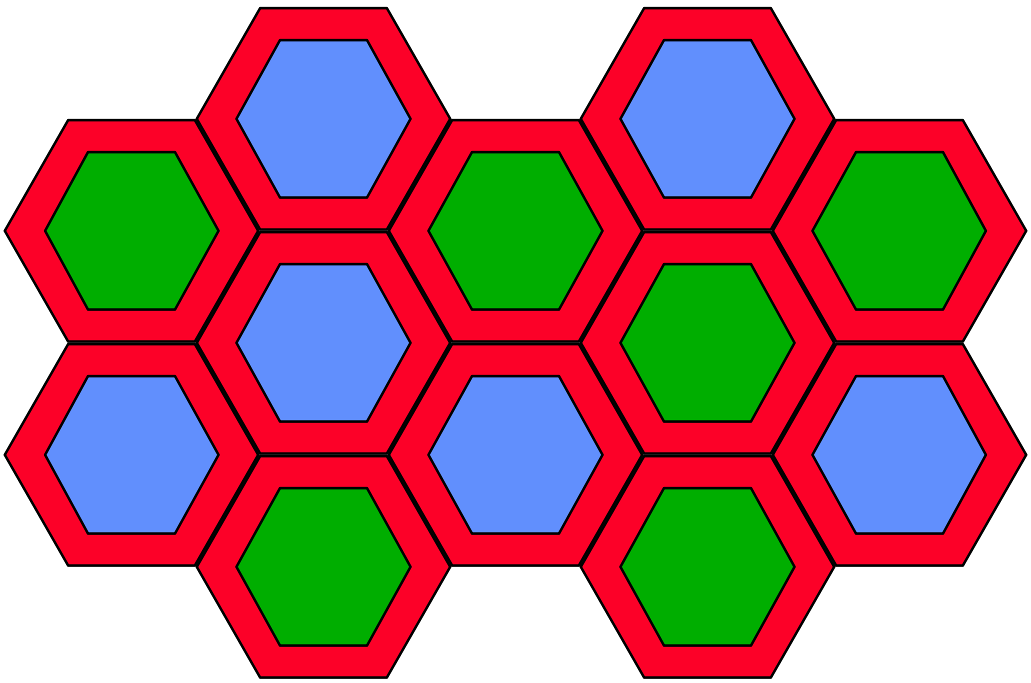

Figure 1, Insufficient Channelization

In Figure 1, Each bicolor hexagon represents a single BSS. The color at the center of each hexagon represents the channel in use by the BSS. As is well known, when fewer than three channels are available, it is not possible to assign channels to the BSSs in a way that does not result in adjacent BSSs using the same channel. Figure 1 illustrates this fact using two channels (blue and green). The case of a single channel is trivial and need not be illustrated. While the figure simplifies the RF propagation situation to a great degree for the purpose of discussion, the problems discussed will only be greater in real-world conditions.

Loss of Throughput

When two adjacent BSSs share the same channel, there is an area between the APs of the BSSs where the power of the signal received at a mobile station is roughly equal from both APs. This is represented by the red annulus around each hexagon. The mobile station will not lose any functionality in this area, so long as a PCF is not being used. However, it will suffer from a significant loss of throughput, because it is now competing for bandwidth with stations in both its own BSS and the adjacent BSS. This loss of throughput gradually increases as the mobile station approaches the annulus region, as it receives signals from an increasing number of stations in the adjacent BSS. When the station begins to receive the signal of the AP in the adjacent BSS, it is now competing with every station in that BSS, as well as those in its own BSS.

Code diversity can reduce the extent of the annuli in a single channel system. However, the area of the annuli will always be greater in a single channel system with code diversity than it will be in a multi-channel system until the coding gain exceeds the channel separation.

Loss of PCF Functionality

The loss of functionality will appear if the PCF is in use. In this case, the mobile station in the annulus region is quite likely to be entirely unable to participate in the contention-free period of its own BSS. The reason for this is that when the mobile station enters the annulus region, it will be receiving traffic from both its own BSS and that of the adjacent BSS. Should the mobile station hear the start of the contention-free period from the adjacent BSS, its NAV will get set to cover that entire CFP. Assuming that the CFPs of each BSS are not coordinated, the only case described in 802.11, the mobile station will likely hear the start of the CFP from its own BSS at some later time, again setting its NAV to cover that entire CFP. Given this fact, the mobile station may never be able to clear its NAV and, thus, never be able to transmit a frame outside of the CFP while it is in the annulus region.

The mobile station in the annulus region is also likely to fail to be able to transmit during the CFP, as well. This is due to the fact that it is receiving signals from both BSSs at roughly the same strength. This will cause much of the information received by the station to be corrupt, preventing the station from successfully decoding any polls directed to it.

Again, code diversity can reduce the extent of the annuli in a single channel system. However, the area of the annuli will always be greater in a single channel system with code diversity than it will be in a multi-channel system until the coding gain exceeds the channel separation.

Loss of Scanning Functionality

This problem occurs due to the fact that only in the annulus region is the power of the signals received from the mobile stations and AP of an adjacent BSS greater than that of the AP of the BSS to which the receiver is associated. The problem that this causes is that a mobile station may be unable to perform any successful scanning operations until it has entered the annulus region. Only in the annulus region does the power of signals received from stations and APs outside the mobile station’s own BSS begin to exceed the power of the “noise” from the transmissions in the mobile station’s BSS. This results in stations being unable to acquire information about their environment in an ongoing manner.

This problem defeats a very effective scanning strategy employed by several manufacturers in current products. In this scanning strategy, a station announces that it is going into power save state and then performs scanning operations. The station thus acquires information about the surrounding environment, while the AP buffers any traffic. The result of this strategy is that a station may make a reassociation decision very quickly when the need arises, since it has a wealth of information available to it. The effect of not being able to acquire this environmental information in an ongoing manner is that a mobile station may not have the information it requires in order to reassociate quickly as it encounters marginal conditions, causing significantly increased delays in reassociation as a station must scan for possible BSSs.

Code diversity affects scanning, as well. Code diversity increases the time required for scanning, since each of the possible codes must now be scanned for the existence of a BSS with which to reassociate. If the number of codes is not restricted to the minimum required for reasonable cell planning, the time required for scanning can increase significantly.

Conclusion and Recommendation

The problems caused by insufficient channelization are obvious and severe, loss of throughput, loss of PCF functionality, and loss of scanning functionality. Because of the severity of these problems, the channelization of the candidate PHYs must be evaluated with these problems in mind.