Cambium Canopy PMP 450 GIGATOWER™ Frequency Planning Guide

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Cambium Networks

Introduction

This white paper provides information to guide the user in proper frequency planning for the deployment of a Canopy PMP 450 GIGATOWER. The GIGATOWER is a deployment configuration that provides up to 1,080 Mbps of aggregate throughput on a single tower. A GIGATOWER deployment consists of twelve Access Points and dual-polarized sector antennas configured to operate in 20 MHz bandwidth channels.

This white paper first presents some basic frequency planning guidelines in order to provide the necessary context for describing various GIGATOWER deployment scenarios. This is followed by some example GIGATOWER deployment scenarios that help to illustrate proper frequency planning based on this set of guidelines. This document concludes by describing some additional planning considerations for GIGATOWER deployments whose channel configurations are split between two frequency bands.

The GIGATOWER deployment scenarios described in this white paper include solutions utilizing either 60 degree or 90 degree sector antennas. GIGATOWER deployments using 60 degree sector antennas require two rings, where each ring consists of six Access Points and six sector antennas. GIGATOWER deployments using 90 degree sector antennas require three rings, where each ring consists of four Access Points and four sector antennas. All the GIGATOWER deployments described in this white paper use six 20 MHz channels, where each channel is used twice.

GIGATOWER Frequency Planning Guidelines

In deployments like the Canopy PMP 450 GIGATOWER where there are two or more rings of sector antennas, there are some key frequency planning guidelines that should be followed in order to minimize performance degradation due to either adjacent channel interference or co-channel interference.

1. Sectors re-using the same channel frequency must be oriented 180 degrees apart for both 60 degree and 90 degree sector antenna deployments. Any sector orientation other than 180 degrees will result in unacceptable co-channel interference. This rule applies whether the co-channel sectors are located on a single ring or multiple rings.

2. Sectors that are on different rings and facing the same direction should avoid being assigned to adjacent channel frequencies. The sector antenna is better able to reject adjacent channel interference coming from an adjacent sector facing a different direction than it can reject adjacent channel interference coming from an adjacent sector facing the same direction.

3. Sectors that are adjacent to each other but facing different directions have enough adjacent channel interference rejection that they can be assigned to adjacent channel frequencies. Even so, it is best practice to minimize the number of adjacent channel frequencies assigned to adjacent sectors in order to minimize potential interference.

4. Depending on frequency availability, interference between different rings of sector antennas can be further minimized by assigning the channel frequencies on one ring to be in a different frequency band from the channel frequencies on another ring (e.g. utilize both the 5.4 GHz band and the 5.8 GHz band). This may also be the only practical solution in cases where there aren't six 20 MHz channels in a single frequency band that are available to the user. An example is the 2.4 GHz band, which is not wide enough to support six 20 MHz channels.

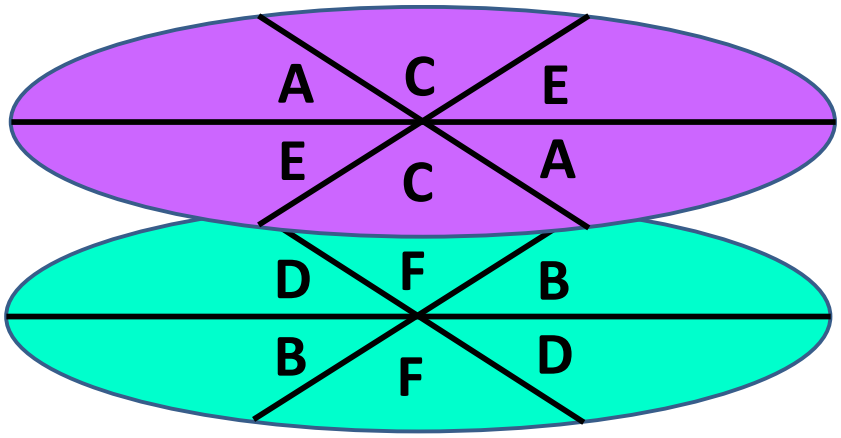
5. The vertical separation between sector antennas on two different rings should ideally be one tower section apart (i.e. a 10 foot center-to-center antenna spacing). Narrower vertical separation distances can still be used, but with a greater risk for unwanted coupling and interference resulting in a reduction in system capacity.

GIGATOWER Deployment Scenarios

A Canopy PMP 450 GIGATOWER deployment consists of twelve 20 MHz bandwidth sectors on a single tower. Each 20 MHz bandwidth sector can support an aggregate throughput of 90 Mbps, where aggregate throughput is defined as the sum of the uplink and downlink throughputs. The aggregate throughput of a GIGATOWER deployment is 12 x 90 Mbps = 1,080 Mbps (1.08 Gbps).

Scenario 1: 60 degree sectors and a single frequency band

Scenario 1 assumes that the Canopy PMP 450 GIGATOWER consists of two rings of six access points using 60 degree sector antennas. Each of the twelve sectors in the GIGATOWER is configured to use one of six 20 MHz bandwidth channels, where each channel is used twice. Scenario 1 also assumes that the six 20 MHz channels are six adjacent channel frequencies utilizing 120 MHz of contiguous spectrum from a single frequency band. An example GIGATOWER deployment that follows the frequency planning guidelines from the previous section is shown below for PMP 450 equipment operating in the 5.8 GHz frequency band.



5.8 GHz Band

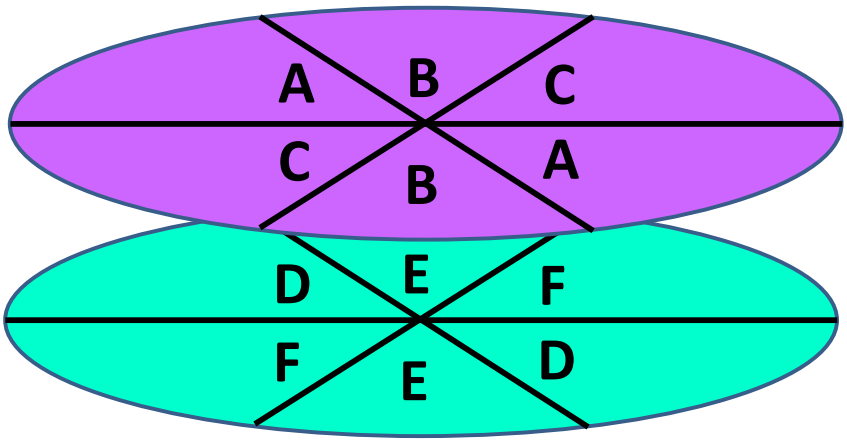
Channel	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz
D	5.800 GHz
E	5.820 GHz
F	5.840 GHz

In this example all sectors re-using the same channel frequency are oriented 180 degrees apart. No sectors that are on different rings but facing the same direction are assigned to adjacent channel frequencies. In this example the sectors from the two rings that face the same direction are all assigned channel frequencies that are three channels apart, providing two channels (i.e. 40 MHz) of guard band protection from adjacent channel interference.

The adjacent channel interference present in a given sector will be due to adjacent sectors located in the other ring. For example, the sectors assigned to Channel C in the upper ring will have sufficient adjacent channel interference rejection from the adjacent sectors assigned to Channels B and D in the lower ring.

Scenario 2: 60 degree sectors and dual frequency bands

Scenario 2 assumes that the Canopy PMP 450 GIGATOWER consists of two rings of six access points using 60 degree sector antennas. Each of the twelve sectors in the GIGATOWER is configured to use one of six 20 MHz bandwidth channels, where each channel is used twice. Scenario 2 also assumes that the six 20 MHz channels are split equally between two frequency bands. This results in one ring being configured using three 20 MHz channels from one frequency band and the second ring being configured using three 20 MHz channels from the second frequency band. An example GIGATOWER deployment that follows the frequency planning guidelines from the previous section is shown below for PMP 450 equipment operating in both the 5.8 GHz and the 5.4 GHz frequency bands.



5.8 GHz Band

Channel	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz

5.4 GHz Band

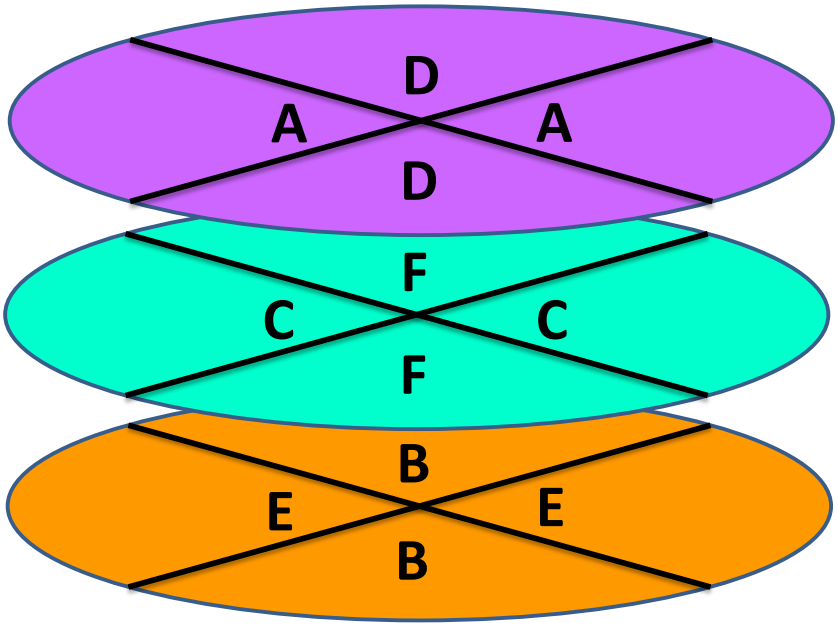
Channel	Frequency
D	5.500 GHz
E	5.520 GHz
F	5.540 GHz

In this example all sectors re-using the same channel frequency are oriented 180 degrees apart. The channel frequencies from the upper ring are assigned to a different frequency band than the channel frequencies from the lower ring. The result is that no sectors that are on different rings and facing the same direction or a different direction are assigned to adjacent channel frequencies, eliminating any possibility of adjacent channel interference between rings.

The adjacent channel interference present in a given sector will be due to the adjacent sectors within its own ring. The sectors in both rings have adjacent sectors which are assigned to adjacent channel frequencies. For example, the sectors assigned to Channel B in the upper ring will have sufficient adjacent channel interference rejection from the adjacent sectors assigned to Channels A and C in the upper ring.

Scenario 3: 90 degree sectors and a single frequency band

Scenario 3 assumes that the Canopy PMP 450 GIGATOWER consists of three rings of four access points using 90 degree sector antennas. Each of the twelve sectors in the GIGATOWER is configured to use one of six 20 MHz bandwidth channels, where each channel is used twice. Scenario 3 also assumes that the six 20 MHz channels are six adjacent channel frequencies utilizing 120 MHz of contiguous spectrum from a single frequency band. An example GIGATOWER deployment that follows the frequency planning guidelines from the previous section is shown below for PMP 450 equipment operating in the 5.8 GHz frequency band.



5.8 GHz Band

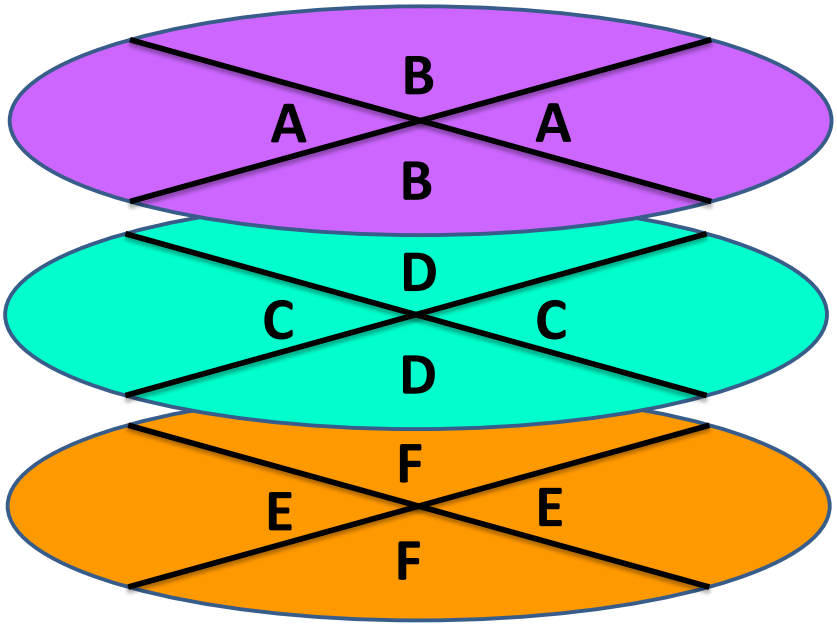
Channel	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz
D	5.800 GHz
E	5.820 GHz
F	5.840 GHz

In this example all sectors re-using the same channel frequency are oriented 180 degrees apart. No sectors that are on different rings but facing the same direction are assigned to adjacent channel frequencies. In this example the sectors from the three rings that face the same direction are all assigned channel frequencies that are two channels apart, providing one channel (i.e. 20 MHz) of guard band protection from adjacent channel interference.

The adjacent channel interference present in a given sector will be due to adjacent sectors located in the other rings. For example, the sectors assigned to Channel C in the middle ring will have sufficient adjacent channel interference rejection from the adjacent sectors assigned to Channel D in the upper ring and Channel B in the lower ring.

Scenario 4: 90 degree sectors and dual frequency bands

Scenario 4 assumes that the Canopy PMP 450 GIGATOWER consists of three rings of four access points using 90 degree sector antennas. Each of the twelve sectors in the GIGATOWER is configured to use one of six 20 MHz bandwidth channels, where each channel is used twice. Scenario 4 also assumes that the six 20 MHz channels are split between two frequency bands. This results in two rings being configured using four 20 MHz channels from one frequency band and the third ring being configured using two 20 MHz channels from the other frequency band. An example GIGATOWER deployment that follows the frequency planning guidelines from the previous section is shown below for PMP 450 equipment operating in both the 5.8 GHz and the 5.4 GHz frequency bands.



5.8 GHz Band

Channel	Frequency
A	5.740 GHz
B	5.760 GHz
E	5.780 GHz
F	5.800 GHz

5.4 GHz Band

Channel	Frequency
C	5.500 GHz
D	5.520 GHz

In this example all sectors re-using the same channel frequency are oriented 180 degrees apart. The channel frequencies from the upper ring and lower ring are assigned to a different frequency band than the channel frequencies from the middle ring. No sectors that are on different rings and facing the same direction are assigned to adjacent channel frequencies. In this example the sectors from the upper and lower rings that face the same direction are all assigned channel frequencies that are two channels apart, providing one channel (i.e. 20 MHz) of guard band protection from adjacent channel interference.

The adjacent channel interference present in a given sector will be due to the adjacent sectors within its own ring and possible that of another ring whose channel frequencies share the same frequency band. The sectors in all three rings have adjacent sectors which are assigned to adjacent channel frequencies. For example, the sectors assigned to Channel B in the upper ring will have sufficient adjacent channel interference rejection from the adjacent sectors assigned to Channel A in the upper ring and Channel E in the lower ring.

Additional considerations for GIGATOWER deployments using dual frequency bands

Canopy PMP 450 GIGATOWER deployments whose channel configurations are split between two frequency bands have some additional planning considerations that need to be taken into account.

One important consideration is the regulatory transmit power limits for each frequency band and its impact on range of coverage. The regulations on the 5.8 GHz and 2.4 GHz bands typically limit the maximum EIRP to 36 dBm in a 20 MHz bandwidth channel, while the regulations on the 5.4 GHz band typically limit the maximum EIRP to 30 dBm in a 20 MHz bandwidth channel. The result is a reduced range of coverage on the order of a factor of two when deploying a GIGATOWER ring in the 5.4 GHz band versus deploying a ring in the 5.8 GHz band.

Another consideration is that the 2.4 GHz band is greater than a factor of two lower than the 5.8 GHz band in terms of its center channel frequency values. Lower frequency values increase free space propagation, resulting in a proportional increase in the range of coverage. The increased range of coverage when deploying a GIGATOWER ring in the 2.4 GHz band versus deploying a ring in the 5.8 GHz band will be greater than a factor of two.

While the increased range of coverage in the 2.4 GHz band is desirable, the 2.4 GHz band is not wide enough to support six 20 MHz channels. More specifically, the 2.4 GHz PMP 450 Access Point can support up to three 20 MHz channels. This means that if the 2.4 GHz band is going to be used in a GIGATOWER deployment, it will require the use of dual frequency band rings similar to those illustrated in Scenario 2 and Scenario 4.

It is also important to note that a 2.4 GHz Subscriber Module can only communicate with a 2.4 GHz Access Point, whereas a 5 GHz Subscriber Module is able to communicate with an Access Point configured to operate in either the 5.4 GHz band or the 5.8 GHz band. This means that a 2.4 GHz Subscriber Module cannot be moved to another frequency band if the channel it is currently on gets too crowded. This flexibility to move a Subscriber Module from one frequency band to another would be possible in a dual frequency band GIGATOWER deployment using the 5.8 GHz and 5.4 GHz bands as long as the Subscriber Module is located within the range of coverage of both frequency bands.