Cambium Networks™

Co-location of PMP 450 and PMP 100 systems in the 900 MHz band and migration recommendations

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Introduction

This white paper provides information to guide the user in strategies for migrating from a PMP 100 deployment to a PMP 450 deployment in the 900 MHz band. The objective is to be able to provide a strategy for migrating one sector at a time, versus taking a knife switch replacement approach.

Also, co-location of the two systems is discussed, if both are deployed in the same geographical area, either during migration or as a permanent solution.

This paper focuses on two areas.

Synchronization and Timing describes the importance of selecting the correct frame parameters in both the PMP 100 (FSK) system and the PMP 450 (OFDM) system for co-location and migration. It describes each of the parameters that affect the frame structure, how to select them in each system, and it introduces the PMP 450 – PMP 100 co-location tool, which aids in the selection of these parameters.

Migration Strategy presents examples of migration strategies from a PMP 100 system to a PMP 450 system, and also examples of Greenfield deployments.

Synchronization and timing

When co-locating systems, either for migration from an older technology to a newer technology, or for a more permanent mixed deployment, it is important to select the correct system parameters in order to avoid interference.

Both PMP 100 and PMP 450 are TDD systems, which means that the same frequency resources are used both in the downlink (AP to SMs communication) and in the uplink (SMs to AP communication), but multiplexed in time. A TDD cycle, or frame, is the minimum amount of time used to communicate in both directions, and it also includes gaps for hardware turnaround and over the air propagation delays, as shown in Figure 1.

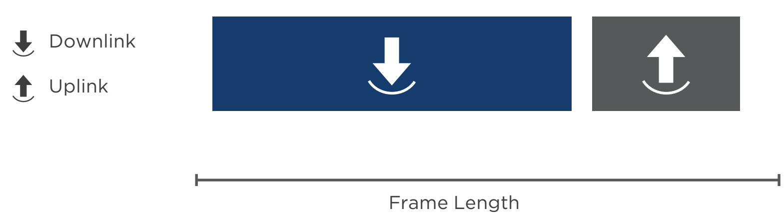


Figure 1 - TDD frame structure

When multiple access points (APs) are deployed in the same geographical area, it is important that they all transmit and receive at the same time. If one AP transmits when another receives, the AP that is receiving might not be able to correctly decode the signal coming from the SMs communicating with it, because of the interfering signal coming from the other AP.

In order to avoid this type of interference, three features are needed:

1- The TDD cycle, or frame, needs to start at the same time for all APs

2- The TDD cycle, or frame, needs to have the same length for all APs

3- The frame parameters need to be selected in each AP so that there is no overlap between one AP transmitting and another receiving. An example of these parameters is the duty cycle, i.e. the ratio of the time dedicated to communication in the downlink direction over the total frame time.

Note that these parameters don't need to be the same in all APs, but they need to be selected to avoid interference.

These features are needed regardless of the technology used by the APs.

Typically, when the APs use the same technology, it is sufficient to select the same configuration parameters to guarantee interference-free co-location.

However, when the APs do not use the same technology, the parameters to select may be specific to the technology used, and care has to be taken during co-location and migration.

FRAME START

GPS synchronization is the way of guaranteeing that the frame start is the same for all APs.

However, the timing between the GPS signal and the start of the TDD frame varies according to the sync source, and it has changed over past releases.

In order to align the frame start of the PMP 100 and PMP 450 systems, the Frame Alignment Legacy Mode has to be selected from the following options: OFF, ON (Mode 1), and ON (Mode 2).

This selection can be found under Configuration → Radio → Advanced, as shown in Figure 2.

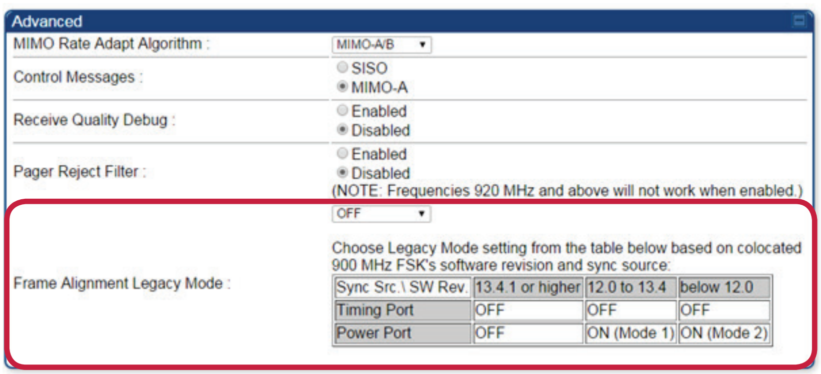


Figure 2 - Selection of Frame Alignment Legacy Mode

A table is provided to aid with the mode selection.

The option ON (Mode 1) has to be selected only if the PMP 100 sync source is the power port AND the PMP 100 system is at a release between 12.0 and 13.4.

The option ON (Mode 2) has to be selected only if the PMP 100 sync source is the power port AND the PMP 100 system is at release below 12.0.

In any other scenario, the Frame Alignment Legacy Mode has to be selected as OFF.

The Alignment Legacy Mode selection assumes that the PMP 100 remains on a fixed sync source.

If autosync is enabled, and the PMP 100 changes sync sources, the PMP 450 AP's Alignment Legacy Mode setting would have to be changed to match. Therefore it is best to ensure only a single sync source is used on the PMP 100 AP.

The PMP 450 AP, however, can use autosync and will remain synchronized to the PMP 100 regardless of its own sync source.

If the PMP 100 system is upgraded to release 13.4.1, and the PMP 450 system is running release 14.1.1 build 5 or higher, they can both be set to autosync, have legacy mode OFF, and will maintain sync regardless of both of their sync sources.

FRAME LENGTH

Once the frame start of all APs has been aligned with GPS synchronization, the next step to avoid interference, is to use the same frame length.

Figure 3 shows why it is not possible to co-locate APs supporting mismatched frame lengths.

Let us assume that AP1 uses a 5 ms frame, while AP2 uses a 2.5 ms frame.

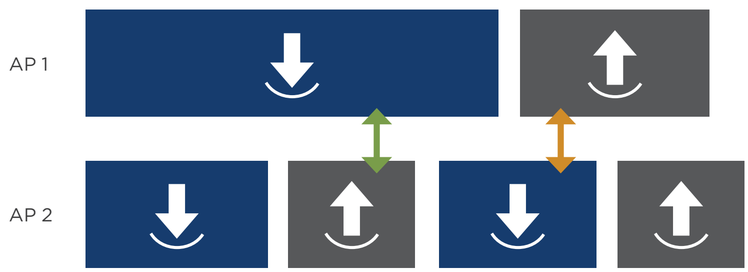


Figure 3 - Mismatched frame sizes

Figure 3 shows that in a 5 ms interval AP1 has one transmit time and one receive time, while AP2 has two transmit times and two receive times.

The interference that mostly affects the system performance is the one at the AP receiver.

For example, in the time indicated with the green arrow in Figure 3, AP1 transmits when AP2 receives. This may completely corrupt the reception of AP2's uplink signal. Also, in the time indicated with the orange arrow in Figure 3, AP2 transmits when AP1 receives. This may completely corrupt the reception of AP1's uplink signal.

Additional interference may be experienced at the SM. In the time indicated with the green arrow in Figure 3, the SM communicating with AP1 receives when the SM communicating with AP2 transmits. Similarly, in the time indicated with the orange arrow in Figure 3, the SM communicating with AP2 receives when the SM communicating with AP1 transmits. This source of interference is generally less critical in the overall system performance because the SMs' antennas have a narrower beam and point to the corresponding AP. Therefore the signal received by other SMs is significantly more attenuated compared to the interfering signal received at the AP.

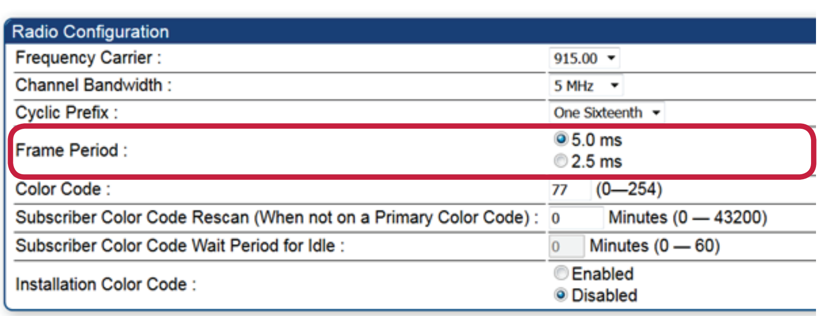
Frame length configuration

PMP 100 in the 900 MHz band only supports a frame length of 5 ms.

PMP 450 supports two frame length options in all bands: 2.5 ms and 5 ms.

In order to avoid interference, the PMP 450 AP needs to be configured with a frame length of 5 ms.

This option can be found under Configuration → Radio → Radio Configuration → Frame Period, as shown in Figure 4.



Radio Configuration	
Frequency Carrier :	915.00
Channel Bandwidth :	5 MHz
Cyclic Prefix :	One Sixteenth
Frame Period :	5.0 ms 2.5 ms
Color Code :	77 (0—254)
Subscriber Color Code Rescan (When not on a Primary Color Code) :	0 Minutes (0 — 43200)
Subscriber Color Code Wait Period for Idle :	0 Minutes (0 — 60)
Installation Color Code :	Enabled Disabled

Figure 4 - PMP 450 Frame Period selection

FRAME PARAMETERS

At this point, all APs are synchronized, and the frame length is the same.

Next, the frame parameters have to be selected in order to avoid any overlap between one AP transmitting and another receiving.

As mentioned above, the parameters do not have to be the same in all APs, but they have to be coordinated in order to avoid interference.

Figures 5 and 6 show one example of frames that do not interfere and one example of frames that do interfere.

In both Figures 5 and 6 the Downlink time and Uplink time of the two APs are not identical.

In Figure 5, there is no overlap between one AP transmitting and another AP receiving, and the two APs can be co-located.

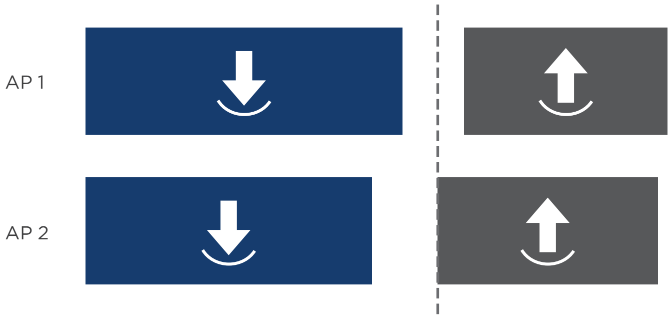


Figure 5 - Example of APs that can be co-located

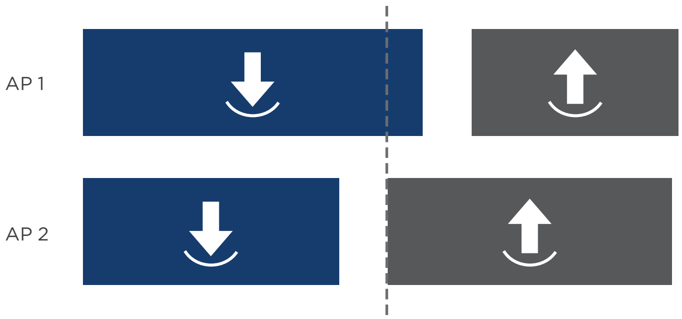


Figure 6 - Example of APs that cannot be co-located

In Figure 6 however, AP1 is still transmitting when AP2 is already receiving. This creates interference at the AP2's receiver and the APs cannot be co-located with these parameters.

PMP 100 frame configuration parameters

The PMP 100 frame structure is determined using three parameters:

- Max Range: distance between the AP and the farthest SM communicating with the AP

  Max Range is selected in miles, between 1 and 120.
- Downlink Data: duty cycle, ratio between the time dedicated to downlink transmission and the total frame time

  Downlink Data is selected as a percentage, between 1% and 99%.

  Note that for Downlink Data selections very small or very large, the software may overwrite the selection in order to guarantee a minimum amount of time for transmission in each direction.
- Contention Slots: time slots reserved in the PMP 100 system for random access, registration and bandwidth request

  Contention Slots is a number between 0 and 15.

All these parameters can be configured under Configuration → Radio → Frame Configuration, as shown in Figure 7.

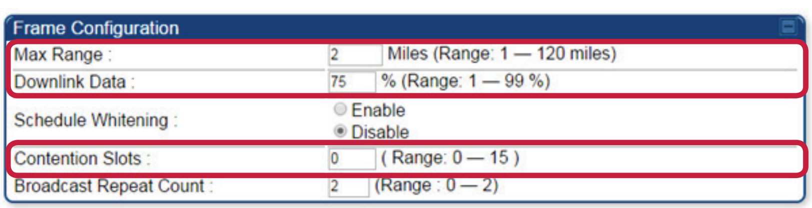


Figure 7 - Configuration of PMP 100 parameters

Once these three parameters are selected, the frame calculator sets
up the downlink and uplink timing for the frame.

PMP 450 frame configuration parameters

The PMP 450 frame structure is determined using four parameters:

- Channel Bandwidth: amount of spectrum allocated for communication in the sector

  Options for the Channel Bandwidth in the 900 MHz band are 5 MHz, 7 MHz, 10 MHz and 20 MHz.
- Max Range: distance between the AP and the farthest SM communicating with the AP

  Max Range is selected in miles, between 1 and 120.
- Downlink Data: duty cycle, ratio between the time dedicated to downlink transmission and the total frame time

  Downlink Data is selected as a percentage, between 15% and 85%.

- Contention Slots: time symbols reserved in the PMP 450 system for random access, registration and bandwidth request

  Contention Slots is a number between 1 and 15.

The Channel Bandwidth can be configured under Configuration → Radio → Radio Configuration, as shown in Figure 8.

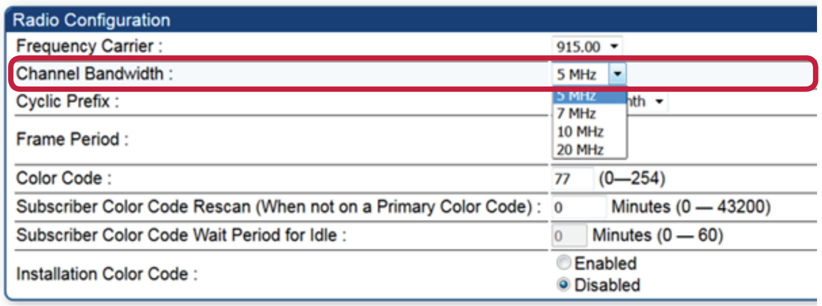


Figure 8 – Configuration of Channel Bandwitdh in the PMP 450 system

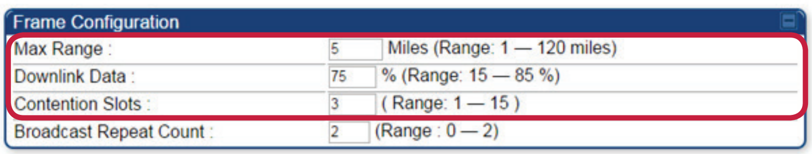


Figure 9 - Configuration of Max Range, Downlink Data and Contention Slots in the PMP 450 system

The Max Range, Downlink Data and Contention Slots can be configured under Configuration → Radio → Frame Configuration, as shown in Figure 9.

Once these four parameters are selected, the frame calculator sets up the downlink and uplink timing for the frame.

PMP 450 – PMP 100 CO-LOCATION TOOL

The configuration parameters that affect the frame structure, need to be selected in both systems in order to avoid any overlap between transmit and receive times. Selecting the same Downlink Data, Max Range and number of Contention Slots does not necessarily guarantee that there will be no overlap. The reason is that the two systems use a different technology, in addition to a different channel bandwidth. One difference, for example, is that the amount of time corresponding to one contention slot is different between PMP 100 and PMP 450, because of the different granularity offered by the two technologies. Also, hardware delays are different between the two platforms.

In order to help with the selection of system parameters, Cambium Networks offers a PMP 450 – PMP 100 co-location tool, available at https://support.cambiumnetworks.com/files/pmp450i/

Examples 1 and 2 show how to use the co-location tool when one or more parameters are different in the two systems.

Example 1

Let us assume that an existing PMP 100 system is deployed with the following parameters:

- Max range: 10 miles
- Downlink data: 75%
- Contention slots: 4

The PMP 100 AP in one sector of the existing deployment is replaced with a PMP 450 AP.

As the PMP 450 AP needs to replace the PMP 100 AP, the same parameters are selected:

- Max range: 10 miles
- Downlink data: 75%
- Contention slots: 4

The bandwitdh however is different, because the PMP 100 system uses an 8 MHz channel bandwidth, which is not offered in the PMP 450 platform. For this example, let us assume a 5 MHz PMP 450 channel bandwidth.

In order to verify that these parameters do not create interference between the two systems, the co-location tool is used, as shown in Figure 10.

900 MHz PMP 450 - PMP 100 CO-LOCATION TOOL

PMP 450		PMP 100	
PMP 450 Inputs		**PMP 100 Inputs**	
Channel Bandwidth	5	Channel Bandwidth	8
Max Range (mi)	10	Max Range (mi)	10
Dowlink Data	75%	Downlink Data	75%
Contention slots	4	Contention Slots	4
PMP 450 Timing (ms)		**PMP 100 Timing (ms)**	
AP Antenna Transmit End	3.083	AP Antenna Transmit End	3.366
AP Antenna Receive Start	3.258	AP Antenna Receive Start	3.477

CHECKS					
PMP 450 DL End	3.083	<	PMP 100 UL Start	3.477	OK
PMP 100 DL End	3.366	<	PMP 450 UL Start	3.258	NOT OK

Figure 10 – PMP 450 – PMP 100 co-location tool Example 1: invalid parameters

The co-location tool shows the parameters that are important for co-location, which are the end of the downlink time (AP Antenna Transmit End, equivalent to DL End) and the beginning of the uplink time (AP Antenna Receive Start, equivalent to UL Start) for both systems.

For successful co-location, the two following conditions need to be met:

PMP 450 DL End < PMP 100 UL Start

PMP 100 DL End < PMP 450 UL Start

These conditions guarantee that each AP has finished transmitting when the other AP starts receiving uplink transmissions from its SMs.

These conditions are checked in the co-location tool:

CHECKS					
PMP 450 DL End	3.083	<	PMP 100 UL Start	3.477	OK
PMP 100 DL End	3.366	<	PMP 450 UL Start	3.258	NOT OK

Figure 11 - Checks in PMP 450 – PMP 100 co-location tool

The tool shows how the first condition is met, meaning the PMP 100 AP starts receiving after the PMP 450 AP has finished transmitting. The second condition, however, is not met: the PMP 450 AP starts receiving before the PMP 100 AP has finished transmitting. During this period of time, any uplink signal received from the PMP 450 SMs will be corrupted by the downlink signal coming from the PMP 100 AP.

For successful co-location, one or more parameters need to be adjusted, until both conditions are met. As both the PMP 450 and the PMP 100 offer a 1% granularity in the downlink data parameter, it is recommended to attempt to change this parameter first.

Since the PMP 100 system is already deployed, no changes should be made, if possible, to the existing PMP 100 configuration. The newly deployed PMP 450 configuration should be adjusted to be co-located the with PMP 100 system.

If, for example, the downlink data parameter in the PMP 450 system is changed from 75% to 79%, then both conditions are now met, as shown in Figure 12.

900 MHz PMP 450 - PMP 100 CO-LOCATION TOOL

PMP 450		PMP 100	
PMP 450 Inputs		**PMP 100 Inputs**	
Channel Bandwidth	5	Channel Bandwidth	8
Max Range (mi)	10	Max Range (mi)	10
Dowlink Data	79%	Downlink Data	75%
Contention slots	4	Contention Slots	4
PMP 450 Timing (ms)		**PMP 100 Timing (ms)**	
AP Antenna Transmit End	3.278	AP Antenna Transmit End	3.366
AP Antenna Receive Start	3.453	AP Antenna Receive Start	3.477

CHECKS					
PMP 450 DL End	3.278	<	PMP 100 UL Start	3.477	OK
PMP 100 DL End	3.366	<	PMP 450 UL Start	3.453	OK

Figure 12 - PMP 450 – PMP 100 co-location tool Example 1: valid parameters

Figure 12 shows how both conditions are now valid, and these parameters can be used for co-location.

Example 2

In this example, a PMP 100 system is deployed with the following parameters:

- Max range: 8 miles
- Downlink data: 65%
- Contention slots: 2

One of the PMP 100 sectors is replaced with a PMP 450 sector. Because of the higher sector capacity offered by the PMP 450 system, the max range of the PMP 450 sector is now 12 miles. Also, as more SMs are served in the wider area, the number of contention slots in the PMP 450 sector needs to be increased. The PMP 450 sector should be deployed with the following parameters:

- Max range: 12 miles
- Downlink data: 65%
- Contention slots: 4
- Channel bandwidth: 7 MHz

900 MHz PMP 450 - PMP 100 CO-LOCATION TOOL

PMP 450		PMP 100	
PMP 450 Inputs		**PMP 100 Inputs**	
Channel Bandwidth	7	Channel Bandwidth	8
Max Range (mi)	12	Max Range (mi)	8
Dowlink Data	65%	Downlink Data	65%
Contention slots	4	Contention Slots	2
PMP 450 Timing (ms)		**PMP 100 Timing (ms)**	
AP Antenna Transmit End	2.857	AP Antenna Transmit End	3.091
AP Antenna Receive Start	3.052	AP Antenna Receive Start	3.180

CHECKS					
PMP 450 DL End	2.857	<	PMP 100 UL Start	3.180	OK
PMP 100 DL End	3.091	<	PMP 450 UL Start	3.052	NOT OK

Figure 13 - PMP 450 – PMP 100 co-location tool Example 2: invalid parameters

900 MHz PMP 450 - PMP 100 CO-LOCATION TOOL

PMP 450		PMP 100	
PMP 450 Inputs		**PMP 100 Inputs**	
Channel Bandwidth	7	Channel Bandwidth	8
Max Range (mi)	12	Max Range (mi)	8
Dowlink Data	67%	Downlink Data	65%
Contention slots	4	Contention Slots	2
PMP 450 Timing (ms)		**PMP 100 Timing (ms)**	
AP Antenna Transmit End	2.925	AP Antenna Transmit End	3.091
AP Antenna Receive Start	3.120	AP Antenna Receive Start	3.180

CHECKS					
PMP 450 DL End	2.925	<	PMP 100 UL Start	3.180	OK
PMP 100 DL End	3.091	<	PMP 450 UL Start	3.120	OK

Figure 14 - PMP 450 – PMP 100 co-location tool Example 2: valid parameters

Figure 13 shows how the PMP 450 – PMP 100 co-location tool is used to check if the selected parameters allow co-location. Figure 13 shows that the second of the two conditions is not met, meaning that the PMP 450 AP starts receiving before the PMP 100 AP stops transmitting.

Figure 14 shows how it is again possible to change the PMP 450 downlink data parameter from 65% to 67%, and now both conditions are met, even if none of the configuration parameters are the same in the two systems.

Migration strategy

The strategy to migrate a PMP 100 network to a PMP 450 network depends on the specific deployment of the original PMP 100 network. Factors like number of sectors per site, frequency reuse, and guard band between adjacent channels, all affect the migration strategy.

In this section some examples of migration strategies are described. The examples assume the typical PMP 100 deployment with six sectors per site, using three channels, with 1 MHz of guard band between channels.

Note that the PMP 450 does not require any guard band between adjacent channels in adjacent sectors, regardless if the adjacent sector is a PMP 450 sector or a PMP 100 sector.

EXAMPLE 1: 6-SECTOR PMP 100 TO 6-SECTOR PMP 450

In this example, the existing PMP 100 system is deployed using six 60^0 sectors and three frequencies.

The PMP 100 channel bandwitdh is 8 MHz, which means that three channels use 24 MHz of spectrum. The total spectrum available in this band is 26 MHz, from 902 MHz to 928 MHz.

A typical deployment will use the following center frequencies:

- Channel A: 906 MHz
- Channel B: 915 MHz
- Channel C: 924 MHz

This selection leaves a 1 MHz of guard band between adjacent channels.

The PMP 450 system supports the following channel bandwidth options: 5 MHz, 7 MHz, 10 MHz and 20 MHz. As the band is 26 MHz wide, it is not possible to use three 10 MHz channel, but a channel bandwidth of 7 MHz is selected instead.

A simple migration is to replace each PMP 100 AP with a PMP 450 AP using the same center frequency, and a channel bandwitdh of 7 MHz. This results in a frequency separation of 1.5 MHz between adjacent channels, even if no guard band is required for operation in a PMP 450 system.

At the end of the migration, the PMP 450 system also uses six sectors and three frequencies, keeping the same center frequencies and frequency planning, as shown in Figure 15.

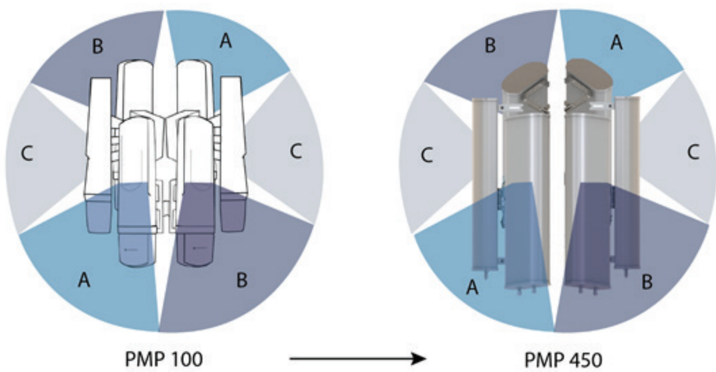


Figure 15 - Migration from six PMP 100 sectors to six PMP 450 sectors

Note that the front-to-back ratio of the AP antenna required for back-to-back operation of PMP 100 APs on the same frequency is not has high as the front-to-back ratio required for back-to-back operation of PMP 450 APs. The reason is that the PMP 450 AP can operate at higher order modulation, which requires a lower interference level. For this reason, it is recommended to replace the two back-to-back APs using the same frequency at the same time, or within a short period of time. For the time during which two back-to-back sectors on the same frequency use a PMP 100 AP on one side and a PMP 450 AP on the other, the PMP 450 AP performance is expected to be affected by the additional noise generated by the PMP 100 AP.

EXAMPLE 2: 6-SECTOR PMP 100 TO 4-SECTOR PMP 450

In this example, the existing PMP 100 system is deployed using six 60^0 sectors and three frequencies. At the end of the migration, the PMP 450 system uses four 90^0 sectors and two frequencies, as shown in Figure 16.

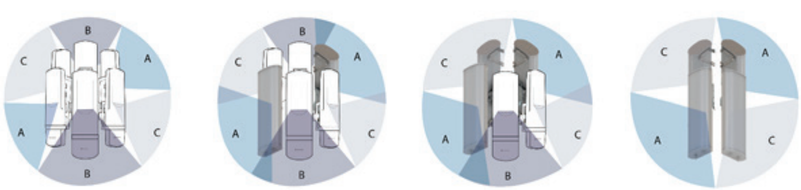


Figure 16 - Migration from six PMP 100 sectors to four PMP 450 sectors

For this migration, first replace the PMP 100 APs on one of the frequencies (60^0 sectors), for example frequency A, with PMP 450 APs also on frequency A (90^0 sectors).

Also, as explained above, it is recommended to replace the two back-to-back APs on the same frequency within a short period of time to achieve the full capacity of the PMP 450 system.

Next, replace the PMP 100 APs on frequencies B and C with PMP 450 APs on either frequency B or frequency C (Figure 16 shows frequency C). Note that the PMP 450 APs will now have a different orientation compared to the two original PMP 100 APs.

The PMP 450 system after migration only uses two of the original three channels. After the migration is complete, the operator can:

- Use the third channel to update the frequency planning. For example, one site uses channels ACAC, while another site uses channels ABAB, and a third site uses channels BCBC.
- Use the third channel to overlay a second AP in high traffic sectors
- Widen the two used channels to two 10 MHz channels

  This requires moving the center frequency 1 MHz to the right (for channel A) and to the left (for channel C)

  In this case, the two used channels (A and C) have the following center frequencies:

  Channel A: moved from 906 MHz to 907 MHz

  Channel C: moved from 924 MHz to 923 MHz

  This configuration leaves 6 MHz of unused spectrum in between channels A and C (from 912 MHz to 918 MHz). An additional 5 MHz channel can be used for deployment in the same area.

EXAMPLE 3: GREENFIELD DEPLOYMENT

Examples 1 and 2 assume an existing PMP 100 deployment, which needs to be upgraded to a PMP 450 systems. If the PMP 450 deployment is a Greenfield deployment, or the PMP 100 deployment can be upgraded without constraints on keeping the existing frequency planning, then operators have more options.

Five-sector deployment

As mentioned above, the total available spectrum in the 900 MHz band is 26 MHz. PMP 450 offers a channel bandwitdh of 5 MHz, which allows the use of five separate channels in five 72^0 sectors, as shown in Figure 14.

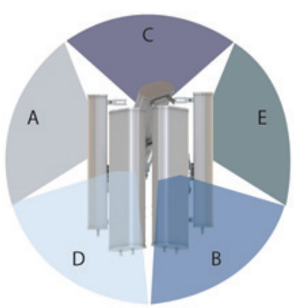


Figure 17 - Five-sector deployment

For this deployment, possible center frequencies are:

- Channel A: 905.5 MHz
- Channel B: 910.5 MHz
- Channel C: 915.5 MHz
- Channel D: 920.5 MHz
- Channel E: 925.5 MHz

This frequency selection leaves the unused 1 MHz at the lower end of the band, because the antenna gain is slightly higher in the mid to high part of the band.

Four-sector deployment

Four-sector deployments can support various frequency planning options.

- ABAB with A = 10 MHz and B = 10 MHz

  As PMP 450 allows back-to-back operation on the same frequency, the most efficient solution for a four-sector deployment is using two 10 MHz channels back-to-back.

  The additional 5 MHz of spectrum can be used, for example, for overlaying a second AP in sectors with high traffic.

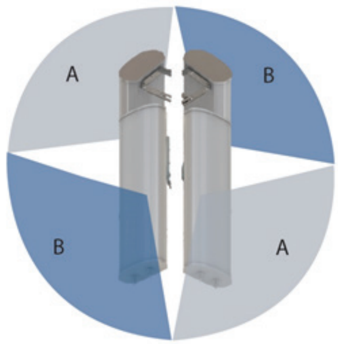


Figure 18 - Four-sector deployment example1

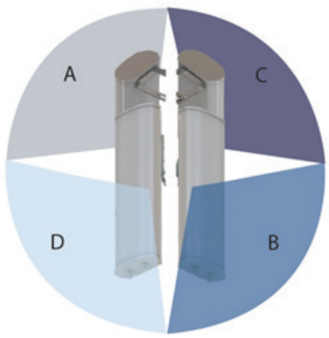


Figure 19 - Four-sector deployment example 2

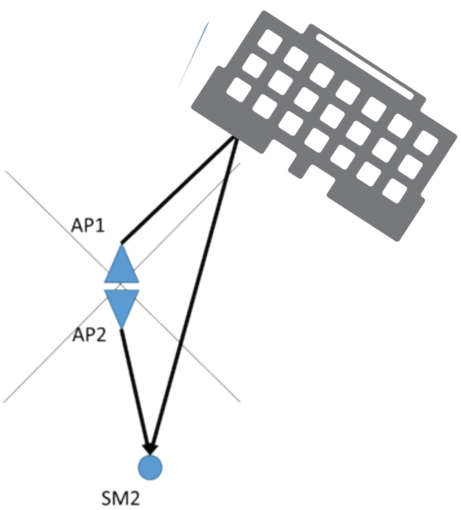


Figure 20 - Back-to-back sector interference in the downlink

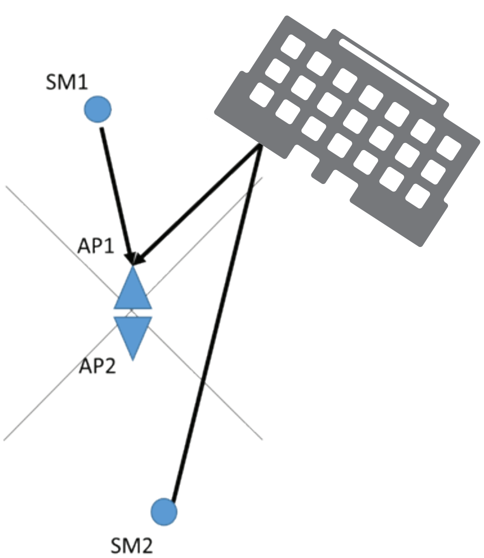


Figure 21 - Back-to-back sector interference in the uplink

- ABAB with A = 20 MHz and B = 5 MHz

  If the number of SMs in the four sectors is uneven (for example, for geographical reasons), it is possible to deploy one of the back-to-back channels with a 20 MHz bandwidth, and the other channel with a 5 MHz channel bandwidth.
- ABCD with A = 5 MHz, B = 5 MHz, C = 5 MHz, D = 5 MHz

  This configuration achieves a lower overall sector throughput, but it may be the best solution for deployments that suffer from interference due to strong reflections.

Let us consider for example the deployment scenario in Figure 20. Assume that the two back-to-back sectors with APs AP1 and AP2 use the same frequency. As the two APs are synchronized, their transmit and receive times are aligned. During the downlink time, AP2 communicates with SM2. At the same time AP1 is also transmitting, and its signal is reflected by a large building in the coverage area of AP1. The reflected signal is now received by SM2, interfering with the desired signal coming from AP2.

The fact that the SM antenna has a narrow beamwidth alleviates this problem, because the reflected signal interferes only if it arrives at the SM at an angle smaller than the antenna beamwidth. However, if this interference occurs, it is present all the time, as AP1 is always transmitting when SM2 is receiving.

A similar interfering situation can occur also in the uplink direction, as shown in Figure 21.

During the uplink time, SM1 communicates with AP1, while SM2 communicates with AP2.

The signal from SM2 is reflected from the same building located in the coverage area of AP1. The reflected signal is received by AP1, as it falls into the beamwidth of its antenna, at the same time the signal from SM1 is also received, creating interference.

In the two scenarios shown in Figure 20 and Figure 21, the front-to-back ratio of the antenna is no longer relevant, as the interfering signal from the back lobe of the antenna has a strength which is significantly lower than the interfering signal reflected by the building.

In these deployment scenarios, using four different frequencies for the four sectors in a site eliminates the interference issue.

Also, as four 5 MHz channels use 20 MHz of spectrum, an additional 6 MHz channel is available.

It is possible to use this additional spectrum in various ways.

- If one part of the spectrum is experiencing a lot of noise and interference, it is possible to leave the 6 MHz of spectrum unused in the portion of the spectrum suffering from the most interference, and selecting the four used channels from the cleaner part of the spectrum.
- If one of the four sectors supports a larger number of SMs, it is possible to use a 10 MHz channel for that sector, and 5 MHz channels in the other three sectors.

- The fifth channel can be used to vary the frequency pattern. For example, one site can use channels ABDE, another site channels ACDE, another site channels ABCE, and so on.
- The fifth channel can be used to overlay an area with higher traffic.

Six-sector deployment

For a six-sector deployment, it is necessary to reuse at least some channels in back-to-back sectors, as the 26 MHz do not allow the use of six separate 5 MHz channels.

- ACBACB, with A = 7 MHz, B = 7 MHz, C = 7 MHz

  This is the typical configuration used to upgrade an existing PMP 100 network to a PMP 450 network, as explained above.
- ABCABC, with A = 10 MHz, B = 10 MHz, C = 5 MHz

  This configuration can be selected if two of the six sectors are expected to support a smaller number of SMs.
- ABCABD, with A = 7 MHz, B = 7 MHz, C = 7 MHz, D = 5 MHz

  This configuration can be used if one of the back-to-back sectors experiences the type of interference shown in Figure 20 and Figure 21. In this case, back-to-back operation is not possible, and one of the interfering sectors (sector C in this example), uses frequency D instead. Note that channel D is only 5 MHz wide, as the total spectrum of 26 MHz does not allow the use of four 7 MHz channels.
- ABCADE, with A = 5 MHz, B = 5 MHz, C = 5 MHz, D = 5 MHz, E = 5 MHz

  This configuration can be used if two of the channels suffer from the type of interference shown in Figure 20 and Figure 21. In this case, two of the three back-to-back pairs use different frequencies. Note that all channels use a 5 MHz bandwidth in this case.

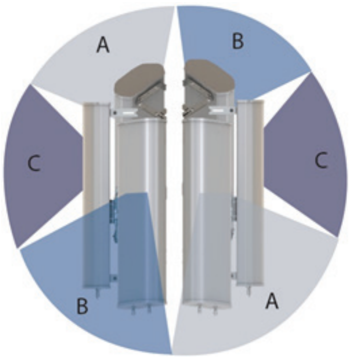


Figure 22 - Six-sector deployment example 1

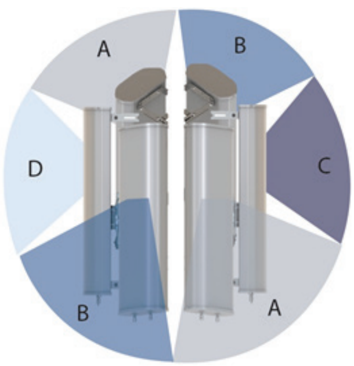


Figure 23 - Six-sector deployment example 2

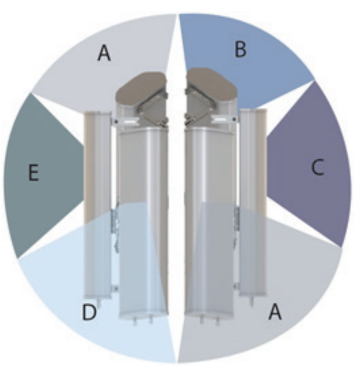


Figure 24 - Six-sector deployment example 3

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