The effective eirp for each additional radio operating in a band is determined by looking at the increase in total eirp within that band as the additional radio comes on-line. In the 5150-5250 MHz band the effective eirp of the additional radios is 0 since the output power is backed off on the existing radios to maintain the total power below 17dBm and eirp below 23dBm.

Radios operating in band	Band	Total EIRP (dBm)	Total EIRP (mW)	EIRP per additional radio	
1	NII 3	26.7	468	468	NII 3 (#1)
2	NII 3	29.7	933	466	NII 3 (#2)
3	NII 3	30.0	1000	67	NII 3 (#3)
4	NII 3	30.0	1000	0	NII 3 (#4)
5	NII 3	30.0	1000	0	NII 3 (#5)
6	NII 3	30.0	1000	0	NII 3 (#6)
7	NII 3	30.0	1000	0	NII 3 (#7)
8	NII 3	30.0	1000	0	NII 3 (#8)
1	NII 2	26.5	447	447	NII 2 (#1)
2	NII 2	29.5	891	445	NII 2 (#2)
3	NII 2	30.0	1000	109	NII 2 (#3)
4	NII 2	30.0	1000	0	NII 2 (#4)
1	NII 1	22.6	182	182	NII 1 (#1)
2	NII 1	23.0	200	18	NII 1 (#2)
3	NII 1	23.0	200	0	NII 1 (#3)
4	NII 1	23.0	200	0	NII 1 (#4)
1	5.7 DTS	27.6	575	575	5.7 DTS (#1)
2	5.7 DTS	30.6	1151	575	5.7 DTS (#2)
3	5.7 DTS	32.4	1726	575	5.7 DTS (#3)
4	5.7 DTS	33.6	2302	575	5.7 DTS (#4)
5	5.7 DTS	34.6	2877	575	5.7 DTS (#5)
1	2.4 DTS	28.2	661	661	2.4 DTS (#1)
2	2.4 DTS	31.2	1318	658	2.4 DTS (#2)
3	2.4 DTS	33.0	1995	677	2.4 DTS (#3)

As this application is requesting grant notes to allow multiple radio modules to be collocated the rf exposure calculation needs to account for multiple radios being operational simultaneously. The following page provides calculations for the power density 20cm from the host system with 4, 8, 12 and 16 co-located modules.
The calculations are conservative as they assume all radios would be transmitting at 100% duty cycle and does not consider the separation distance between the individual modules' antennas.

Band	EIRP	Ranking
NII 3 #1	468	9
NII 3 #2	466	10
NII 3 #3	67	15
NII 3 #4	0	17
NII 3 #5	0	17
NII 3 #6	0	17
NII 3 #7	0	17
NII 3 #8	0	17
NII 2 #1	447	11
NII 2 #2	445	12
NII 2 #3	109	14
NII 2 #4	0	17
NII 1 #1	182	13
NII 1 #2	18	16
NII 1 #3	0	17
NII 1 #4	0	17
5.7 DTS #1	575	5
5.7 DTS #2	575	5
5.7 DTS #3	575	4
5.7 DTS #4	575	7
5.7 DTS #5	575	7
2.4 DTS #1	661	2
2.4 DTS #2	658	3
2.4 DTS #3	677	1

This table shows the eirp increase when a radio is turned on in a specific band. For example, the first radio truned on in NII band 3 adds 468mW of eirp to the total eirp from the host device, the second radio in that band adds 466mW, the third 67mW and the fourth 0mW.

Listing the eirps in order of power, highest first, we can then determine the maximum eirp from the complete device with multiple radios operating. This allows the rf exposure hazard to be evaluated based on a maximum power density of 1mW/cm^2 allowed for devices operating in either 2.4GHz or 5GHz bands:

Band	EIRP	Ranking	Total eirp
2.4 DTS #3	677	1	677
2.4 DTS #1	661	2	1338
2.4 DTS #2	658	3	1995
5.7 DTS #3	575	4	2571
5.7 DTS #1	575	5	3146
5.7 DTS #2	575	5	3722
5.7 DTS #4	575	7	4297
5.7 DTS #5	575	8	4872
NII 3 #1	468	9	5340
NII 3 #2	466	10	5806
NII 2 #1	447	11	6252
NII 2 #2	445	12	6697
NII 1 #1	182	13	6879
NII 2 #3	109	14	6988
NII 3 #3	67	15	7054
NII 1 #2	18	16	7072
NII 3 #4	0	17	7072
NII 3 #5	0	18	7072
NII 3 #6	0	19	7072
NII 3 #7	0	20	7072
NII 3 #8	0	21	7072
NII 2 #4	0	22	7072
NII 1 #3	0	23	7072
NII 1 #4	0	24	7072

Once there are a total of 16 radios operational the total eirp remains constant (i.e the maximum eirp per band has been reached)

For 4 radios operating simultaneously:

Total EIRP:	2571	mW	
S @ 20cm:	**0.51**	**mW/cm^2**	5.1 W/m^2
Minimum separation distance for 1mW/cm^2:	**14.3**	**cm**	

For 8 radios operating simultaneously:

Total EIRP:	4872	mW	
S @ 20cm:	**0.97**	**mW/cm^2**	9.7 W/m^2
Minimum separation distance for 1mW/cm^2:	**19.7**	**cm**	

For 12 radios operating simultaneously:

Total EIRP:	6697	mW	
S @ 20cm:	**1.33**	**mW/cm^2**	13.3 W/m^2
Minimum separation distance for 1mW/cm^2:	**23.1**	**cm**	

For 16 radios operating simultaneously:

Total EIRP:	7072	mW	
S @ 20cm:	**1.41**	**mW/cm^2**	14.1 W/m^2
Minimum separation distance for 1mW/cm^2:	**23.7**	**cm**	

Note: Power Density (S) is calculated from:

$S = \frac{EIRP}{4\pi d^2}$ where d is the distance from the device.

Note: The 3x3 module has higher eirp than the 2x2 radio and so the MPE values for a host system containing either 2x2 or 3x3 modules would use the 3x3 MPE values as a conservative estimate for the rf exposure hazard.

The following tables list the maximum output power per channel for each operating mode.
Yellow highlighted cells indicate a channel with power reduced from the nominal power to meet band edge requirements
Additional information is provided to show how the total output power with multiple radios operating in a band is still compliant with the limits.

Blue highlighted cells indicate power reduction (implemented in the host system) is required when mutliple modules are operating in the same band.

2400-2483.5MHz

Total power allowed is 1 Watt, with EIRP limited to 4 Watts (effective MIMO gain is 4dBi)
No power reduction when module is co-located with other modules and the other modules are operating in the same band.
Host system firmware will not permit multiple radios to operate on the same channel or overlapping channels
Total of three available 20MHz non-overlapping channels or one 40MHz and one 20MHz channel
Table lists measured output power and the (*ART power setting*)

	1	2	3	4	5	6	7	8	9	10	11	
802.11b	21.4 *(18.5)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	23.2 *(20)*	22.8 *(20)*	
802.11g	16.4 *(13.5)*	19.0 *(16)*	20.1 *(17)*	20.1 *(17)*	20.1 *(17)*	20.1 *(17)*	20.1 *(17)*	20.1 *(17)*	20.1 *(17)*	18.8 *(16)*	14.4 *(12)*	
802.11n20	15.0 *(12.5)*	19.0 *(16)*	20.0 *(17)*	20.0 *(17)*	20.0 *(17)*	20.0 *(17)*	20.0 *(17)*	20.0 *(17)*	20.0 *(17)*	18.2 *(15.5)*	13.7 *(11.5)*	
802.11n40			16.4 *(8)*	17.3 *(8.5)*	21.8 *(12)*	21.8 *(12)*	21.7 *(12)*	21.7 *(12)*	19.2 *(10.5)*			Peak

Number of radios operating in the band	Max Power per transceiver (MIMO)	Max Power per transceiver (SISO)	Total Power in Band		Total EIRP	Allocation of channels
			Pout	EIRP	mW	
1	23.2		23.2	28.2	661	802.11b #6
2	23.2		26.2	31.2	1321	802.11b #6, #2
3	23.2		28.0	33.0	1982	802.11b #6, #2, #10

5725-5850MHz

Total power allowed is 1 Watt, with EIRP limited to 4 Watts (effective MIMO gain is 7dBi)
No power reduction when module is co-located with other modules and the other modules are operating in the same band.
Host system firmware will not permit multiple radios to operate on the same channel or overlapping channels
Total of five available 20MHz non-overlapping channels, two 40MHz channels or one 40MHz and three 20MHz channels
Table lists measured output power and the (*ART power setting*)

	5745	5755	5765	5785	5795	5805	5825	
802.11a	19.8 *(17.0)*		20.6 *(17.0)*	20.6 *(17.0)*		20.2 *(17.0)*	20.2 *(17.0)*	Average powers
802.11n20	17.8 *(17.0)*		18.6 *(17.0)*	18.6 *(17.0)*		18.3 *(17.0)*	18.3 *(17.0)*	Average powers
802.11n40		26.7 *(17.0)*			26.9 *(17.0)*			These are peak powers, average power is < 20dBm.

Number of radios operating in the band	Max Allowed Power per transceiver (MIMO)		Power Setting (0.5dB increments)		Total Power in Band		Total EIRP	Allocation of channels
	40MHz	20MHz	HT40	a, HT20	Pout (dBm)	EIRP (dBm)	mW	
1	26.9	20.6	17.0	17.0	26.9	33.9	2455	1 x 40 MHz
2	26.0	20.6	16.0	17.0	29.0	36.0	3981	2 x 40 MHz
3	24.2	20.6	14.0	17.0	29.0	36.0	3981	1 x 40MHz and 2 x 20MHz
4		20.6		17.0	26.6	33.6	2302	4 x 20MHz
5		20.6		17.0	27.6	34.6	2877	5 x 20 MHz

Calculations for EIRP - using average power for HT40 mode (peak power - 8dB)

Number of radios operating in the band	Max Allowed Power per transceiver (MIMO)		Power Setting (0.5dB increments)		Total Average Power		Total EIRP	Allocation of channels
	40MHz	20MHz	HT40	a, HT20	Pout (dBm)	EIRP (dBm)	mW	
1	18.9	20.6	17.0	17.0	20.6	27.6	575	1 x 40 MHz
2	18.0	20.6	16.0	17.0	23.6	30.6	1151	2 x 40 MHz
3	16.2	20.6	14.0	17.0	25.4	32.4	1726	1 x 40MHz and 2 x 20MHz
4		20.6		17.0	26.6	33.6	2302	4 x 20MHz
5		20.6		17.0	27.6	34.6	2877	5 x 20 MHz

Host system firmware will reduce output power per radio to ensure that the total eirp and/or total output power do not exceed the limits of 30dBm and 36dBm respectively.

5150-5250 MHz

Maximum permitted total power for legacy (SISO) modes is 17dBm (antenna gain = 4dBi)
Maximum permitted total output power for MIMO modes is 16dBm (effective antenna gain = 7dBi)
Host system firmware will not permit multiple radios to operate on the same channel or overlapping channels
Total of four 20MHz channels or one 40MHz and two 20MHz channels or two 40MHz channels
Table lists measured output power and the (*ART power setting*)

	5180	5190	5200	5220	5230	5240	
802.11a S	14.4 *(16.5)*		14.5 *(16.5)*	14.5 *(16.5)*		15.5 *(16.5)*	SISO Legacy Mode
802.11a M	15.1 *(13.5)*		15.6 *(14.0)*	15.6 *(14.0)*		15.0 *(13.0)*	MIMO Legacy Mode
802.11n20	14.7 *(13.5)*		15.4 *(14.0)*	15.4 *(14.0)*		15.5 *(13.5)*	
802.11n40		7.1 *(6.0)*			15.4 *(14.0)*		

Number of radios operating in the band	Max Power (MIMO)		Max Power (SISO)		Total Power in Band		Total EIRP (mW)	
	dBm	*Setting*	dBm	*Setting*	Pout (dBm)	EIRP (dBm)		
1	15.6	*14.0*	15.5	*16.5*	15.6	22.6	182	
2	13.0	*11.0*	14.0	*15.0*	17.0	23.0	200	
3	11.2	*9.5*	12.2	*13.0*	17.0	23.0	200	MIMO givese highest eirp
4	10.0	*8.0*	11.0	*12.0*	17.0	23.0	200	MIMO givese highest eirp

Host system firmware will reduce output power per radio to ensure that the total eirp and/or total output power do not exceed the limits of 17dBm and 23dBm respectively

5250-5350 MHz

Maximum permitted total power for legacy (SISO) modes is 24dBm (antenna gain = 4dBi)
Maximum permitted total output power for MIMO modes is 23dBm (effective antenna gain = 7dBi)
Host system firmware will not permit multiple radios to operate on the same channel or overlapping channels
Total of four 20MHz channels or one 40MHz and two 20MHz channels or two 40MHz channels
Table lists measured output power and the (*ART power setting*)

	5260	5270	5280	5300	5310	5320
802.11a S	16.4 *(17.0)*		15.8 *(17.0)*	15.8 *(17.0)*		15.6 *(17.0)*
802.11a M	19.5 *(17.0)*		19.5 *(17.0)*	19.0 *(17.0)*		16.7 *(15.0)*
802.11n20	19.3 *(17.0)*		19.3 *(17.0)*	18.9 *(17.0)*		15.1 *(13.5)*
802.11n40		18.7 *(17.0)*			9.3 *(8.5)*	

Number of radios operating in the band	Max Power per transceiver (MIMO)		Max Power per transceiver (SISO)		Total Power in Band		Total EIRP (mW)	
	dBm	*Setting*	dBm	*Setting*	Pout (dBm)	EIRP (dBm)		
1	19.5	*17.0*	15.8	*17.0*	19.5	26.5	447	SISO Legacy Mode
2	19.5	*17.0*	15.8	*17.0*	22.5	29.5	893	MIMO Legacy Mode
3	18.2	*15.5*	15.8	*17.0*	23.0	30.0	1000	
4	17.0	*14.5*	15.8	*17.0*	22.5	30.0	1000	

Host system firmware will reduce output power per radio to ensure that the total eirp and/or total output power do not exceed the limits of 23dBm and 30dBm respectively

5470-725 MHz

Maximum permitted total power for legacy (SISO) modes is 24dBm (antenna gain = 4dBi)
Maximum permitted total output power for MIMO modes is 23dBm (effective antenna gain = 7dBi)
Host system firmware will not permit multiple radios to operate on the same channel or overlapping channels
Total of eight 20MHz channels or one 40MHz and six 20MHz channels or two 40MHz and four 20MHz channels or three 40MHz channels
Maximum power per channel is limited to the lowest powers listed in the tables below.
Table lists measured output power and the (*ART power setting*)

	5500	5510	5520	5540	5550	5560	5580	5660	5670	5680	5700	
802.11a S	15.9 *(17.0)*		15.9 *(17.0)*	15.9 *(17.0)*		15.9 *(17.0)*	15.8 *(17.0)*	15.8 *(17.0)*		15.4 *(17.0)*	15.4 *(17.0)*	SISO
802.11a M	19.7 *(17.0)*		19.7 *(17.0)*	19.7 *(17.0)*		19.7 *(17.0)*	19.1 *(17.0)*	19.1 *(17.0)*		18.4 *(17.0)*	18.4 *(17.0)*	MIMO
802.11n20	18.4 *(16.5)*		17.8 *(17.0)*	17.8 *(17.0)*		17.8 *(17.0)*	17.8 *(17.0)*	17.8 *(17.0)*		18.0 *(17.0)*	18.0 *(16.5)*	
802.11n40		12.3 *(11.0)*			16.6 *(15.0)*				16.2 *(15.0)*			

Number of radios operating in the band	Max Power per transceiver (MIMO)		Max Power per transceiver (SISO)		Total Power in Band		Total EIRP (mW)
	dBm	Setting a,n20,n40	dBm	Setting	Pout (dBm)	EIRP (dBm)	
1	19.7	*17.0*	15.9	*17.0*	19.7	26.7	468
2	19.7	*17.0*	15.9	*17.0*	22.7	29.7	935
3	18.2	*15.5*	15.9	*17.0*	23.0	30.0	1000
4	17.0	*14.0*	15.9	*17.0*	23.0	30.0	1000
5	16.0	*13.0*	15.9	*17.0*	23.0	30.0	1000
6	15.2	*12.5*	15.9	*17.0*	23.7	30.0	1000
7	14.5	*11.5*	15.5	*16.5*	24.0	30.0	1000
8	14.0	*11.0*	15.0	*16.0*	24.0	30.0	1000

Host system firmware will reduce output power per radio to ensure that the total eirp and/or total output power do not exceed the limits of 17dBm and 23dBm respectively