

Appendix A

4.9 GHz Mask Issues

Prepared for NPSTC Petition for Reconsideration
3rd Report & Order, FCC WTB Docket 00-32

by

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802.11 Standards

- **4.9 GHz 802.11 OFDM equipment is available now**
 - ... in Japan, giving a huge market to leverage
 - 20 MHz Channels, with 10 MHz on the way
 - Huge US chipset market for 5GHz, these can also be used at 4.9 GHz
- **ITS (DRSC) equipment will use 802.11 OFDM**
 - Also on 10 MHz channels, and another huge market
 - Includes 5.9 GHz Public Safety Spectrum
 - ...and comes with an enhanced MAC layer
- **There is more IEEE 802.11 work in progress**
 - Enhanced MAC with priority, authentication, and QoS (802.11e)
 - Enhanced security (802.11i)
 - Power Control and Dynamic Channel Selection (802.11h/k)
 - 10 MHz Channels at 4.9 GHz (802.11j)
 - 5 MHz bandwidth....(allows cellular reuse, 7 cell cluster plus one everywhere)



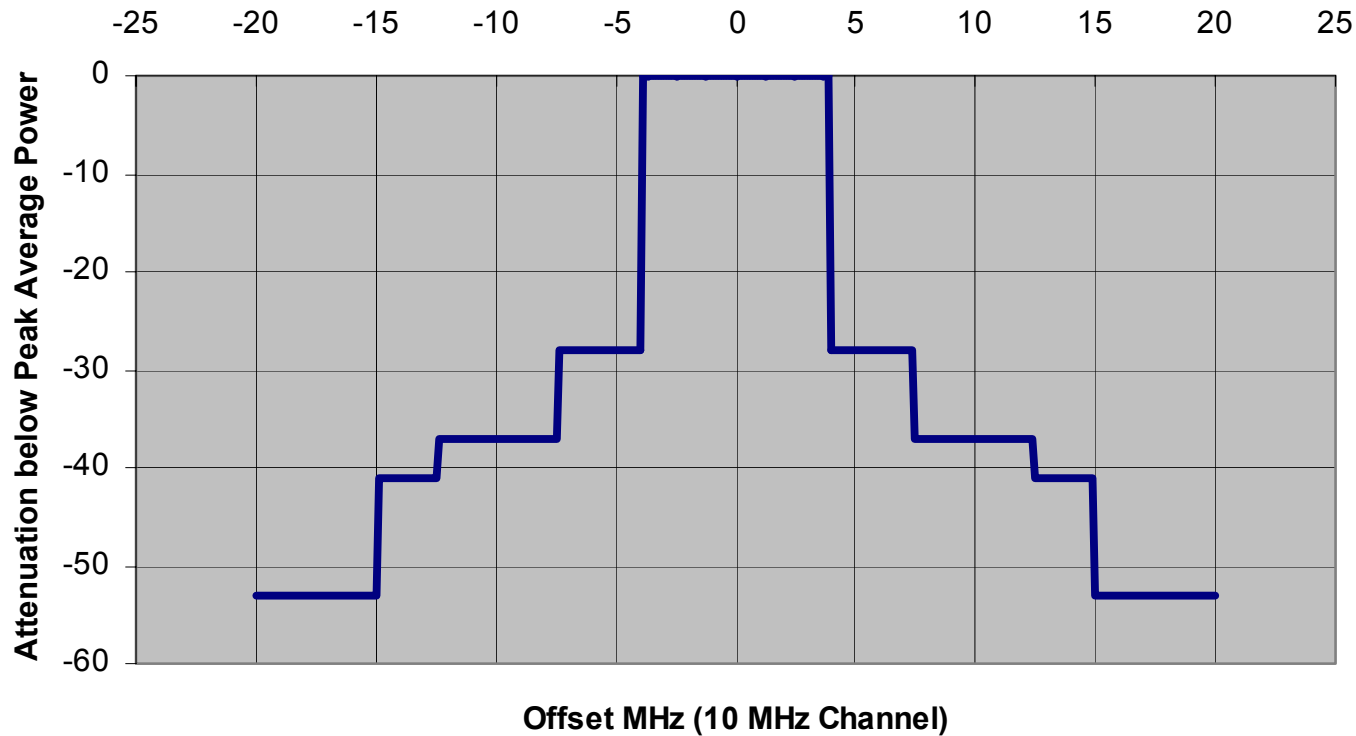
802 Standards

- **Other exciting standards-based technologies may help in 4.9 GHz**
 - Metropolitan area networks (MAN), 802.16, for site interconnect
 - MOBILE MAN, 802.16e and 802.20
- **NPSTC has taken the initiative to get involved with IEEE 802 activities**
 - To ensure that Public Safety requirements are considered to the greatest extent possible
 - To ensure that Public Safety is aware of “next gen” capabilities
 - To cooperatively interact with industry (they will support our recon)
- **The key is to not limit our options**
 - And to leverage larger markets to in order to obtain lower pricing and better capabilities



4.9 GHz FCC Mask

Part 90 4.9 GHz Emission Mask



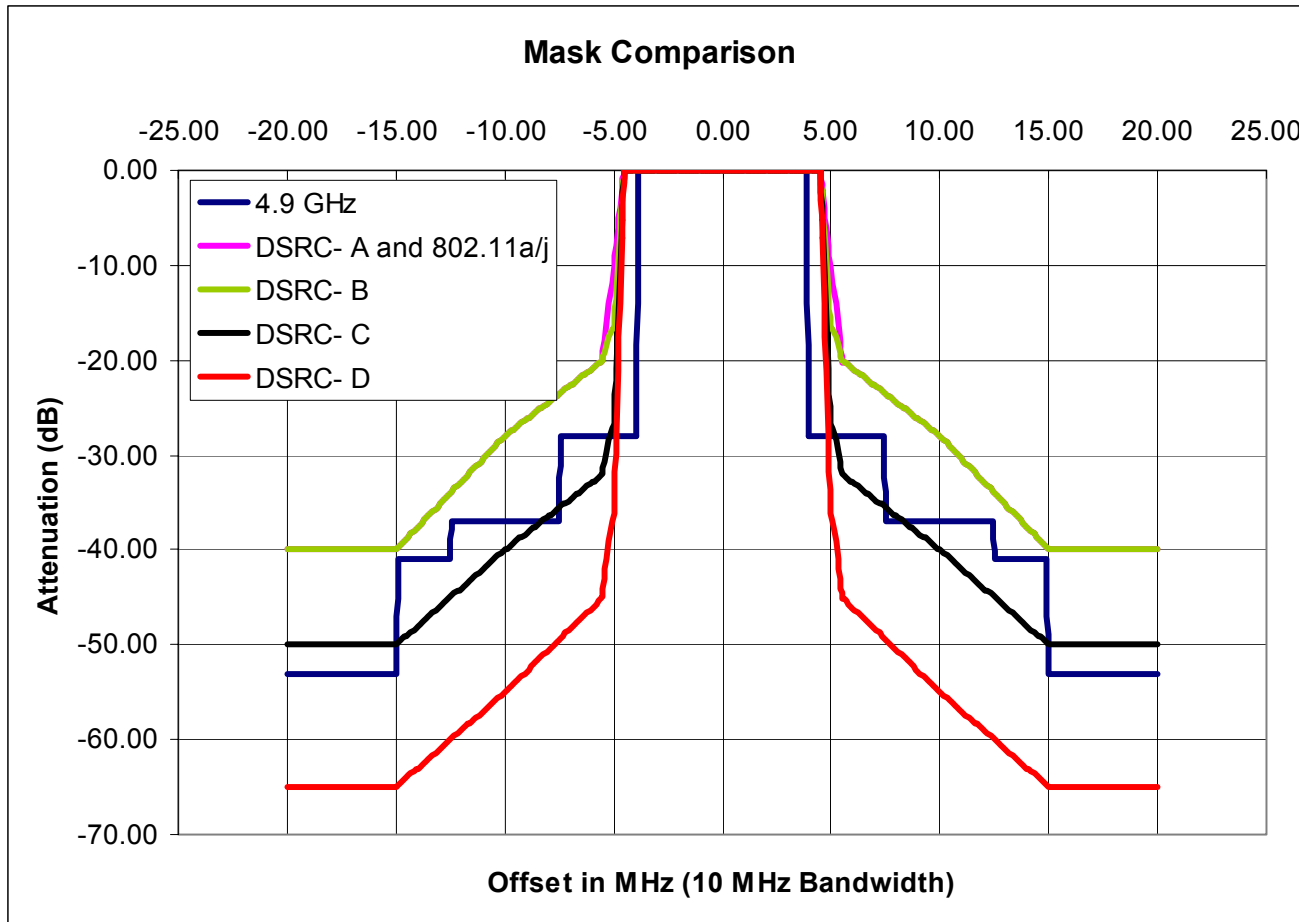
Mask scales to
bandwidth

1 and 5 MHz
channels
available, can
combine up to
20 MHz



4.9 GHz FCC Mask Comparison

- to existing standards

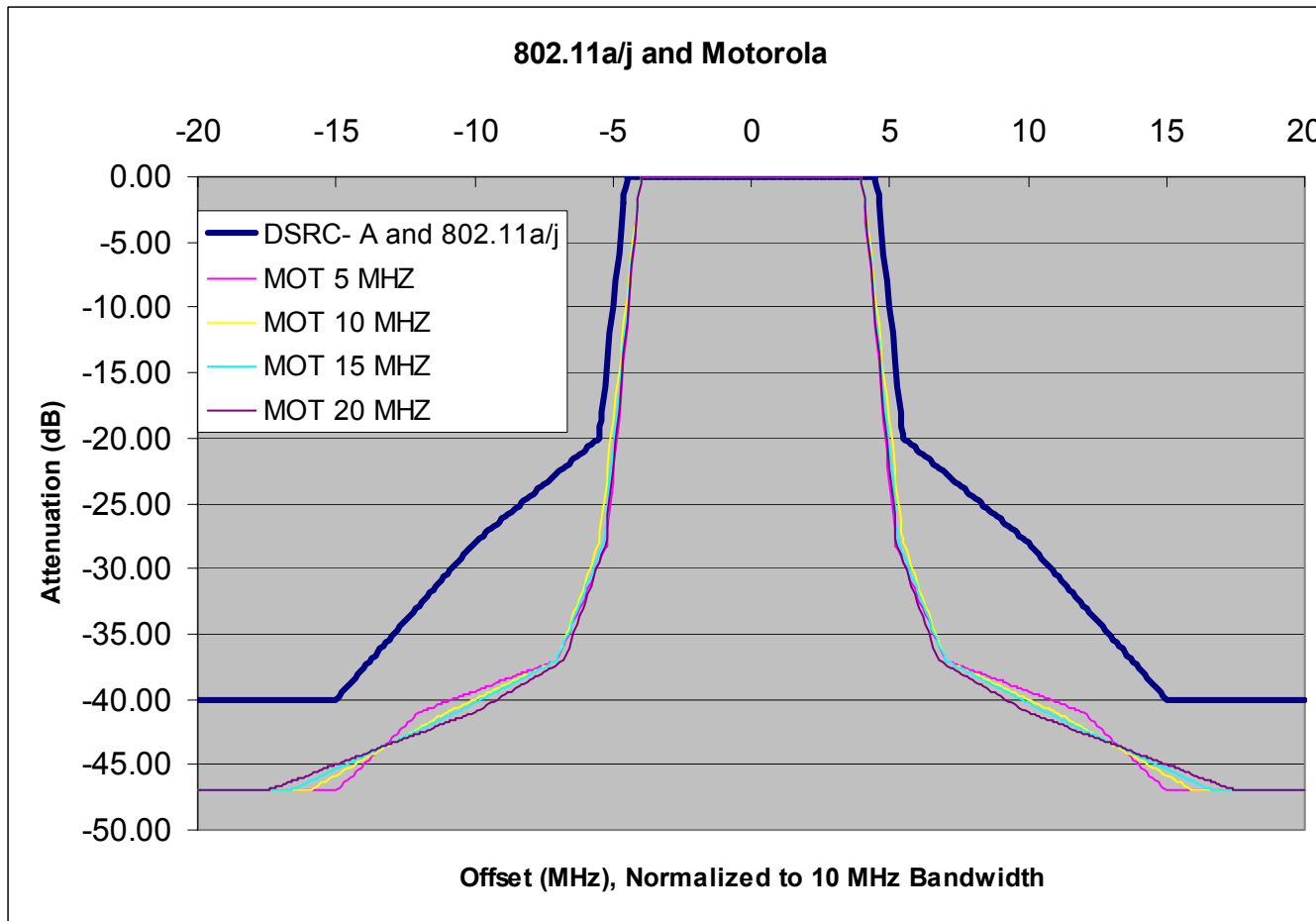


The FCC Mask is much tighter than the 802.11a/j and DSRC masks



4.9 GHz FCC Mask Comparison

-Motorola filing and existing standards



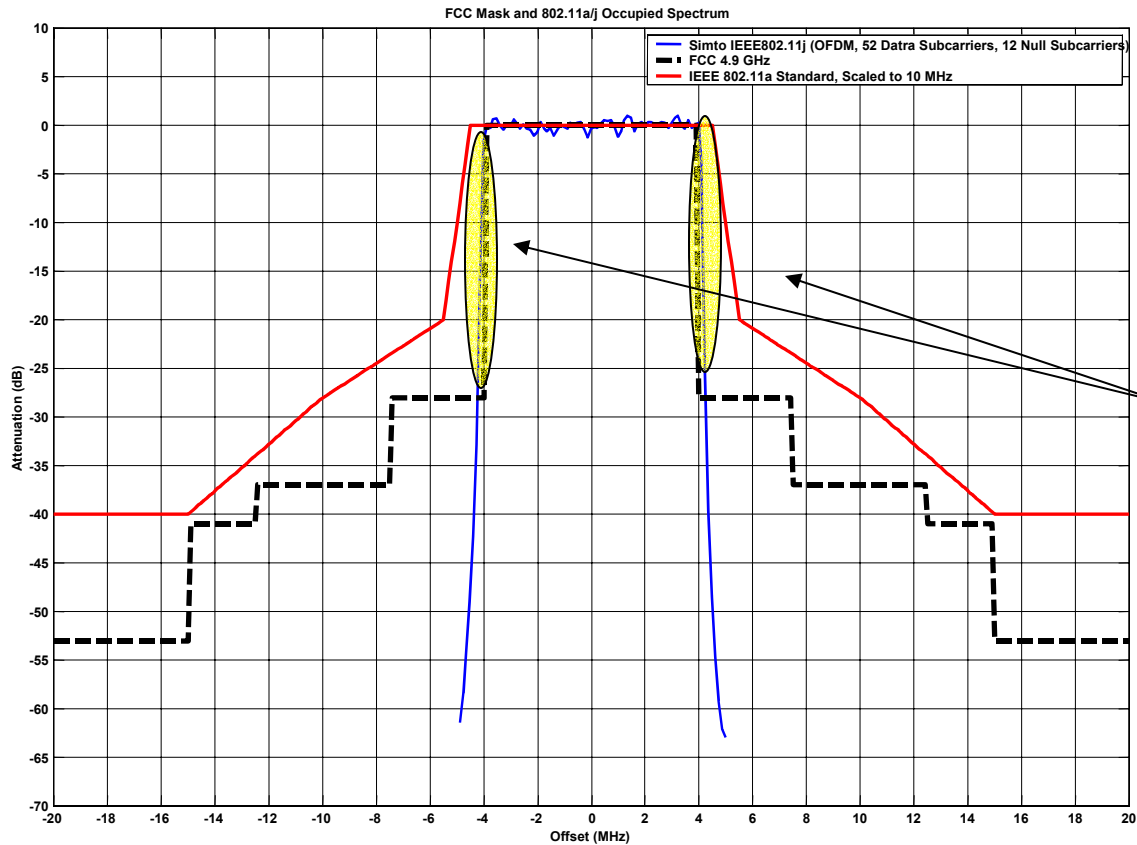
The FCC Mask is similar to the one that Motorola recommended in their filing

i.e. much tighter than the 802.11a/j and DSRC masks



4.9 GHz FCC Mask Comparison

-802.11a/j and 52 Subcarrier OFDM



Bottom Line:

**There is a
problem with the
Motorola and
FCC Masks**

**The Outer OFDM
Subcarriers will
not fit in the
Masks**



The Need for a Petition for Reconsideration

- **The emissions mask requirements under these Rules will prohibit the use of any scaled 802.11 OFDM-based technology without serious modification.**
- **Our analyses, along with industry feedback, indicates that significant additional baseband processing, sub-carrier nulling, and software changes will be necessary to allow 802.11a-based physical layer technologies to operate in this band.**
- **As a result of this, our ability to use many of the open standards-based technology in the band will be severely hindered**
 - **As will our capability to leverage the wider commercial market in order to reduce equipment costs.**
- **Furthermore, the creation of a niche broadband Public Safety market will only tend to stifle innovation within the allocation - ultimately limiting Public Safety's access to new technologies and capabilities, and increasing costs.**

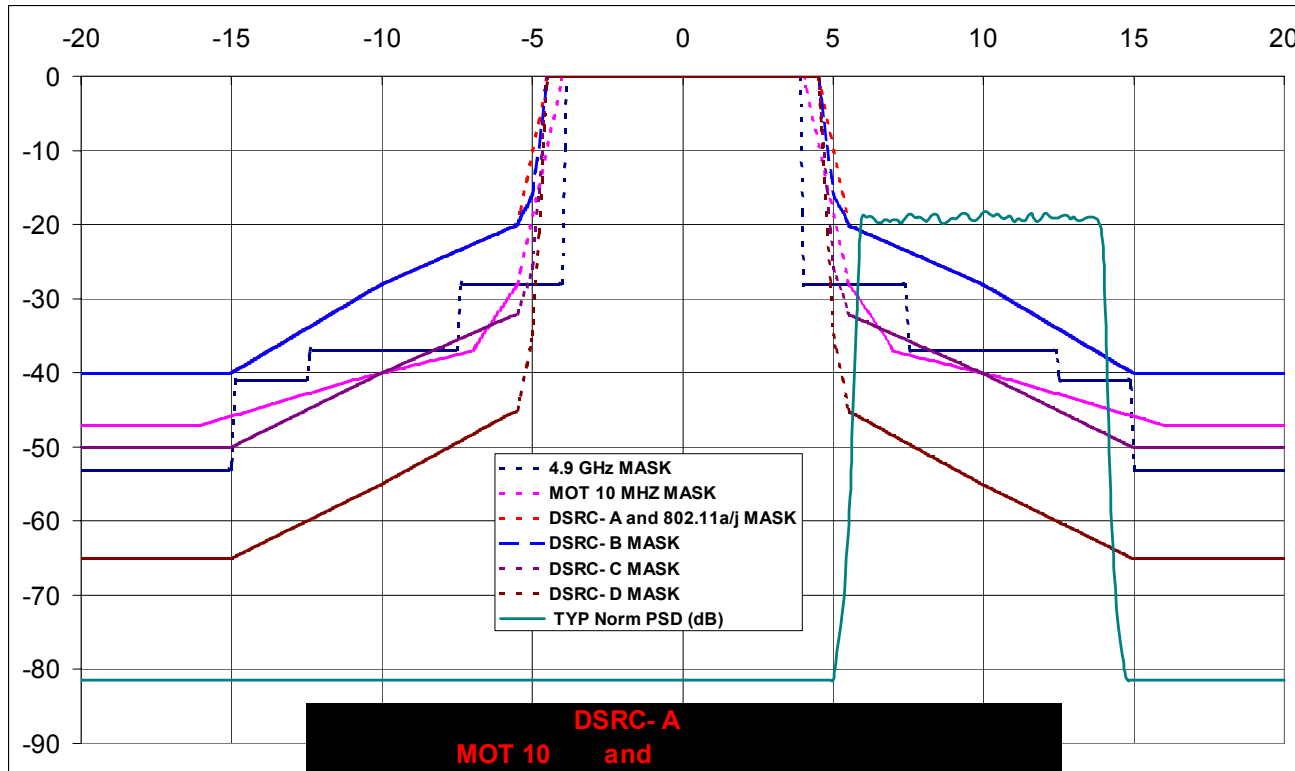


Examination of Adjacent Channel Performance

- **We needed to look at adjacent channel performance in order to examine the costs and benefits of a “looser” mask**
- **Several approaches were taken, and the results compared**
 - ACCPR, with transmitter emissions fitted to worst case Mask, and receiver filter to 802.11 OFDM-like waveform
 - ACPPR, with transmitter emissions fitted to worst case Mask, and receiver filter also fitted to Mask
 - ACP, with transmitter emissions fitted to worst case Mask
- **All results compare favorably**



Approximate ACCPR for Masks



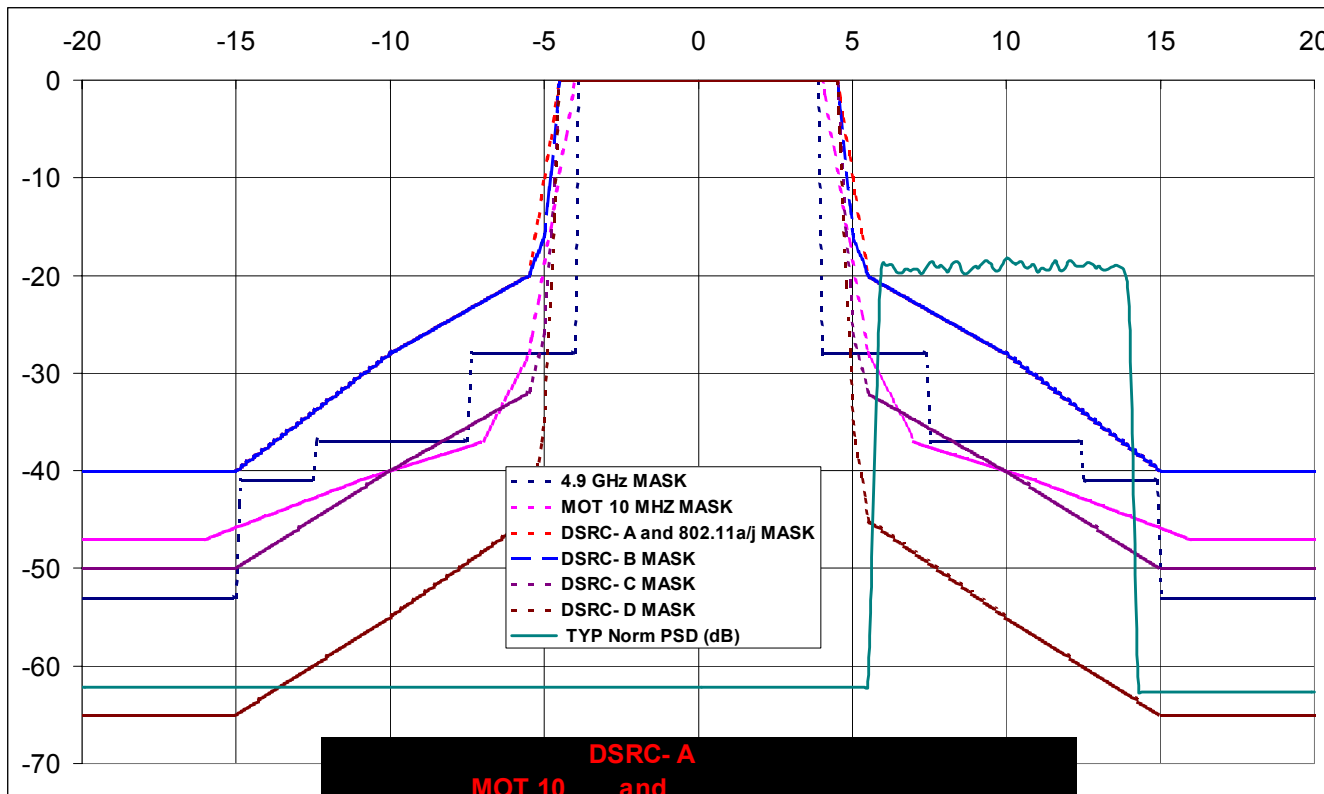
| | DSRC- A | | | | | |
|---------|---------|-----------|---------|---------|---------|---------|
| | MOT 10 | and | DSRC- B | DSRC- C | DSRC- D | |
| | MHZ | 802.11a/j | (ACCPR) | (ACCPR) | (ACCPR) | (ACCPR) |
| 4.9 GHz | (ACCPR) | (ACCPR) | -33.63 | -38.20 | -26.21 | -26.21 |
| | | | | | | -38.11 |
| | | | | | | -51.66 |

Transmitter emissions fitted to worst case Mask, and receiver filter to 802.11 OFDM-like waveform

Can be lower when actual parameters are known and considered



Approximate ACCPR for Masks



| | 4.9 GHz | MOT 10 MHz | DSRC-A and 802.11a/j | DSRC-B | DSRC-C | DSRC-D |
|-------|---------|------------|----------------------|---------|---------|---------|
| ACCPR | (ACCPR) | (ACCPR) | (ACCPR) | (ACCPR) | (ACCPR) | (ACCPR) |
| Value | -33.18 | -36.94 | -26.10 | -26.11 | -36.78 | -42.07 |

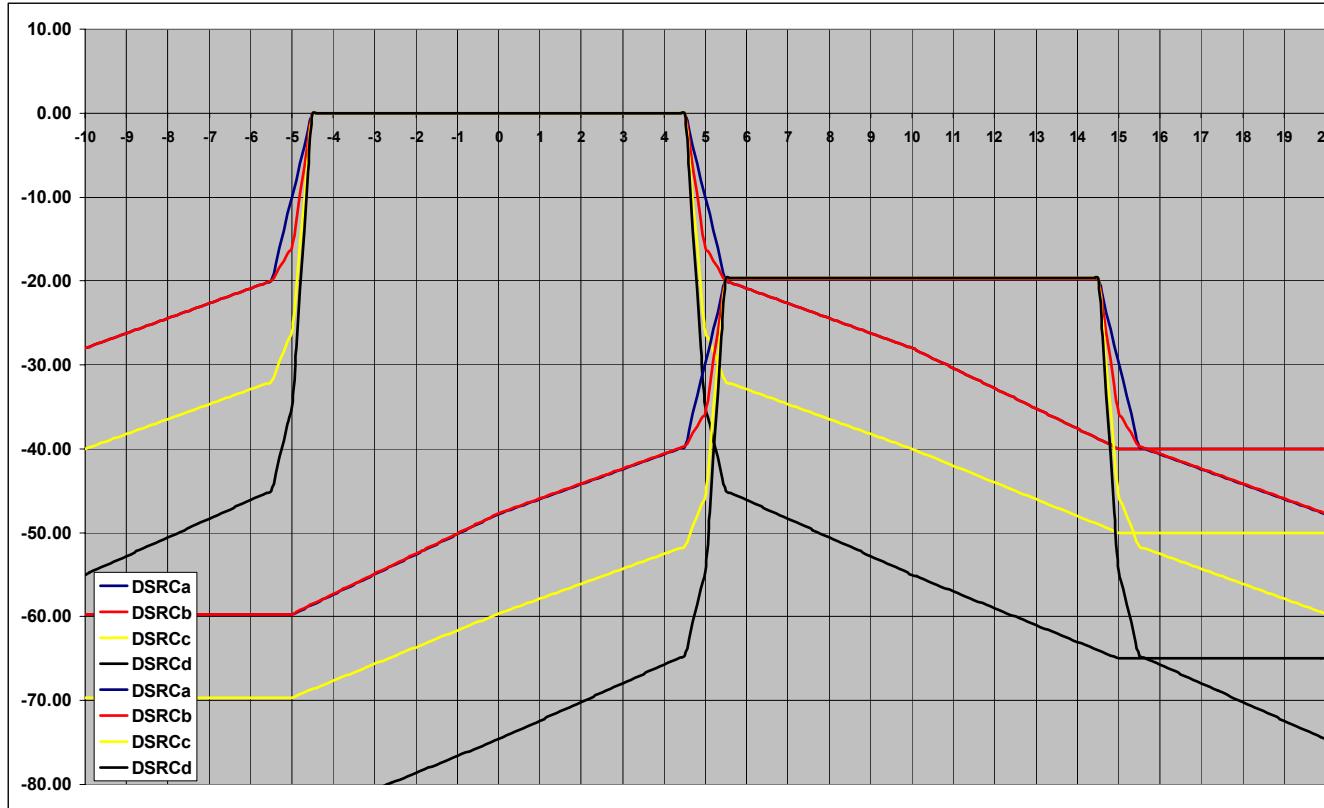
Transmitter emissions fitted to worst case Mask, and receiver filter to 802.11 OFDM-like waveform

Can be lower when actual parameters are known and considered



Approximate ACCPR

- 802.11a/j and DSRC Masks



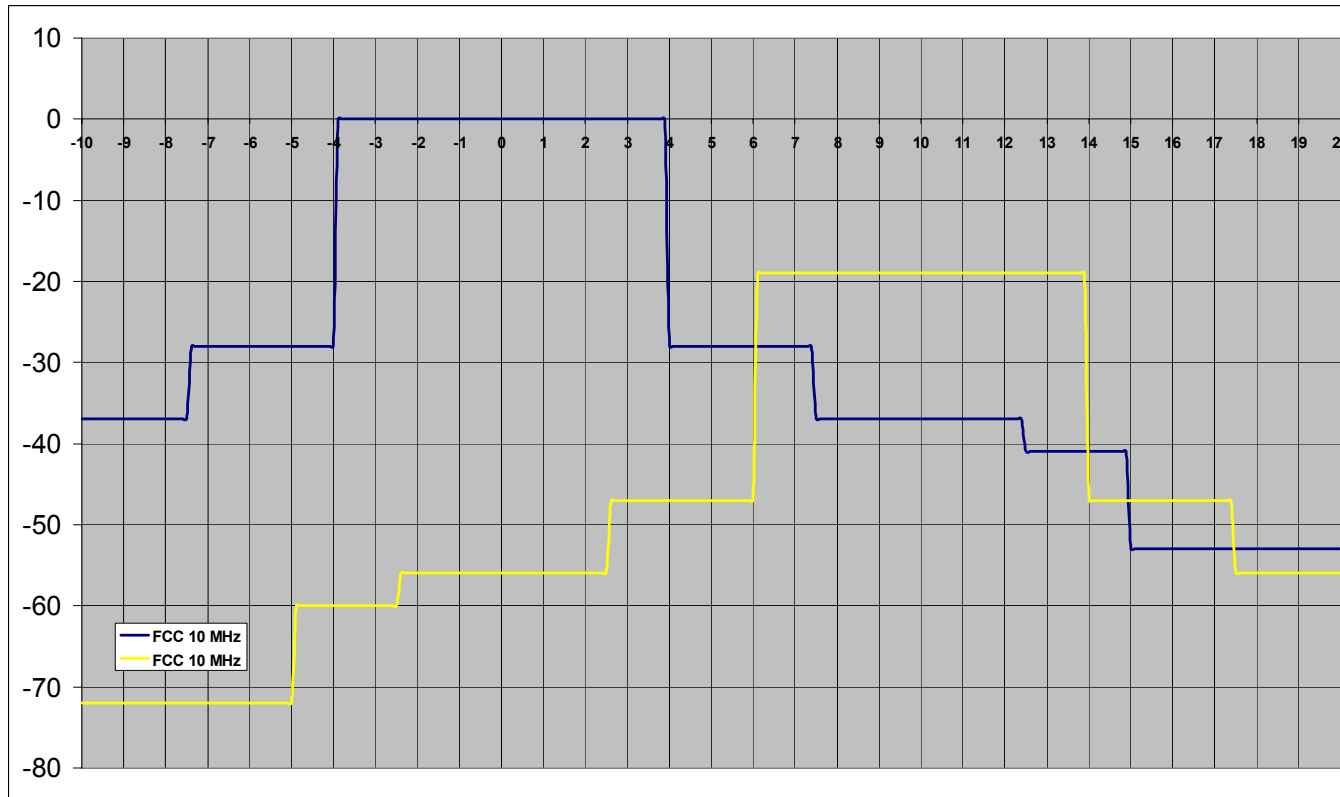
ACPPR, with transmitter emissions fitted to worst case Mask, and receiver filter also fitted to Mask

Can be lower when actual parameters are known and considered



Approximate ACCPR

- FCC MO&O Mask



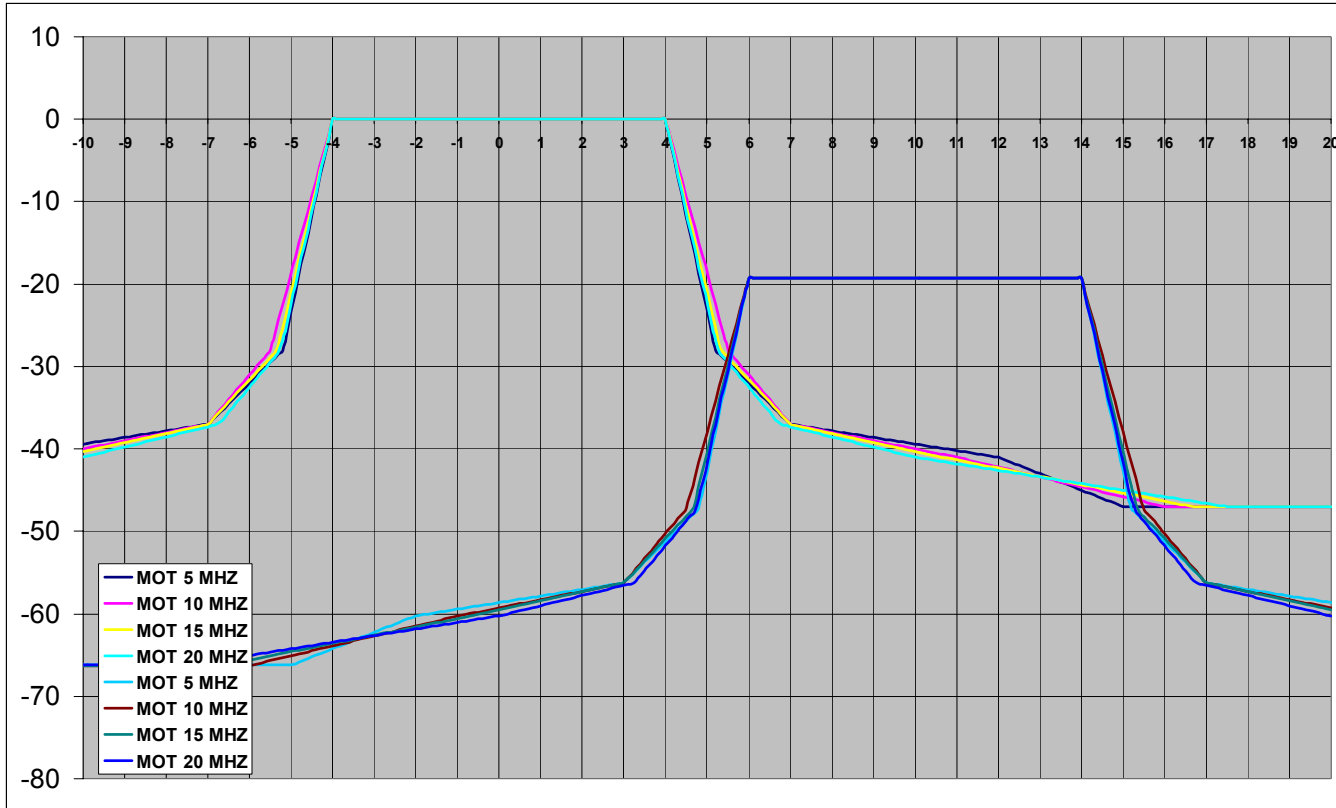
ACPPR, with transmitter emissions fitted to worst case Mask, and receiver filter also fitted to Mask

Can be lower when actual parameters are known and considered



Approximate ACCPR

- Motorola Filing Masks

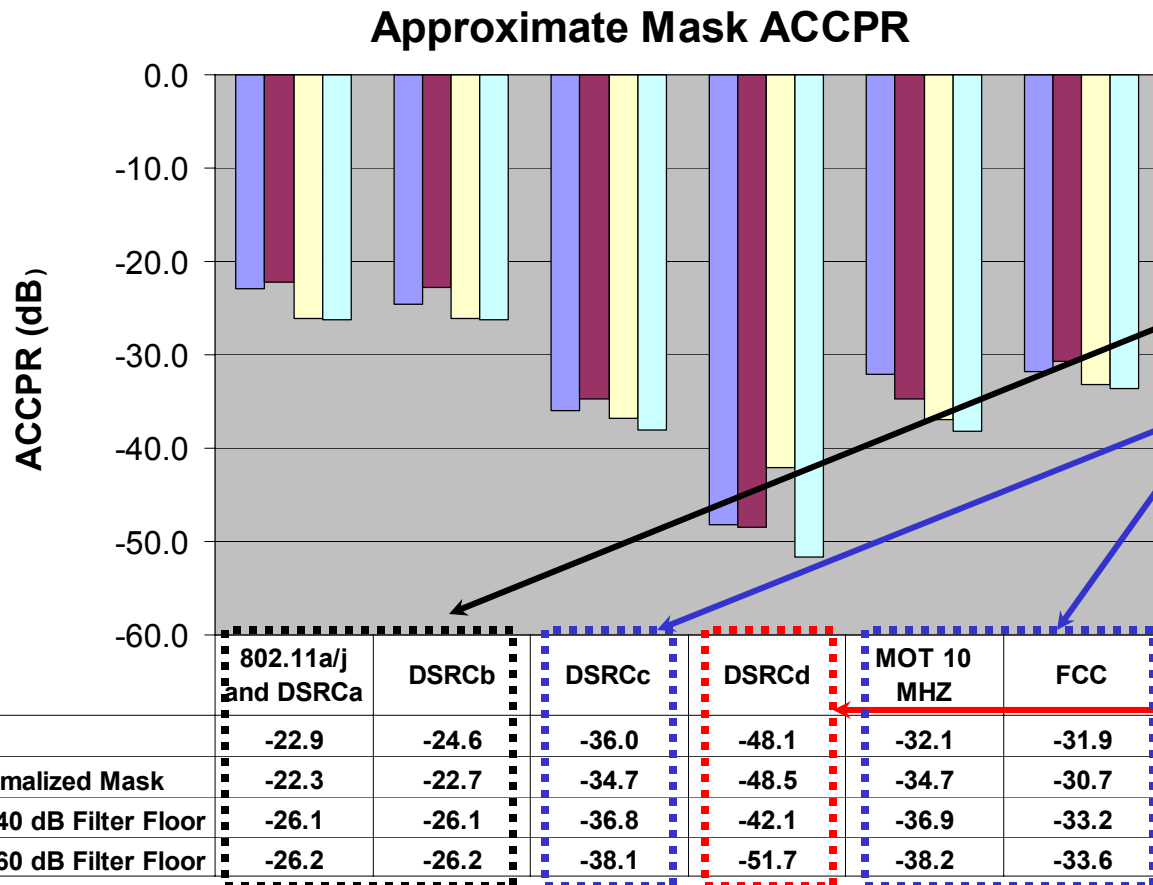


ACPPR, with transmitter emissions fitted to worst case Mask, and receiver filter also fitted to Mask

Can be lower when actual parameters are known and considered



Approximate ACCPR for Masks



It is reasonable to look at three mask classes:
a “loose” mask (~25 dB ACCPR),

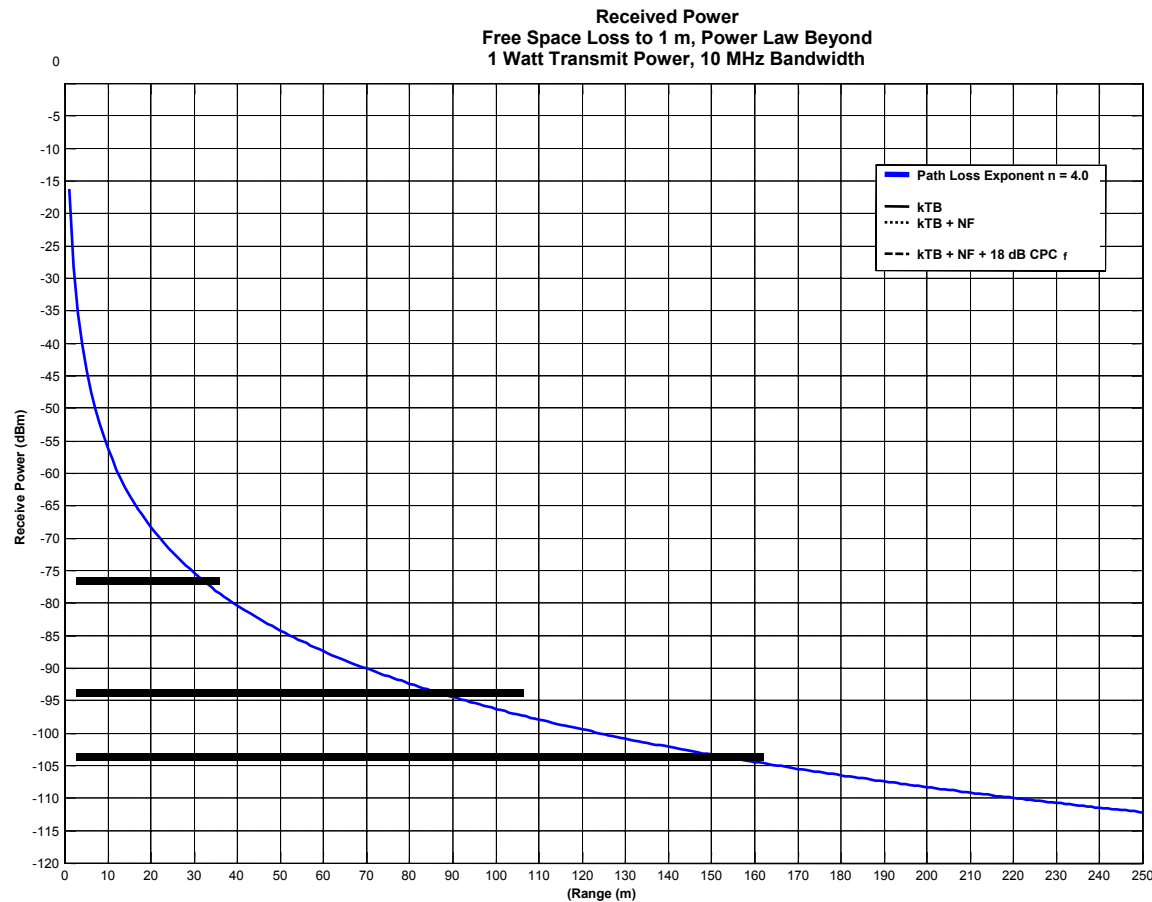
a “tight” mask (~35 dB ACCPR),

and a “very tight” mask (~45 dB ACCPR)



Approximate Range

-High Reliability Case



Example:

10 MHz Bandwidth,
1 W Transmit Power,
0 dBi Antennas

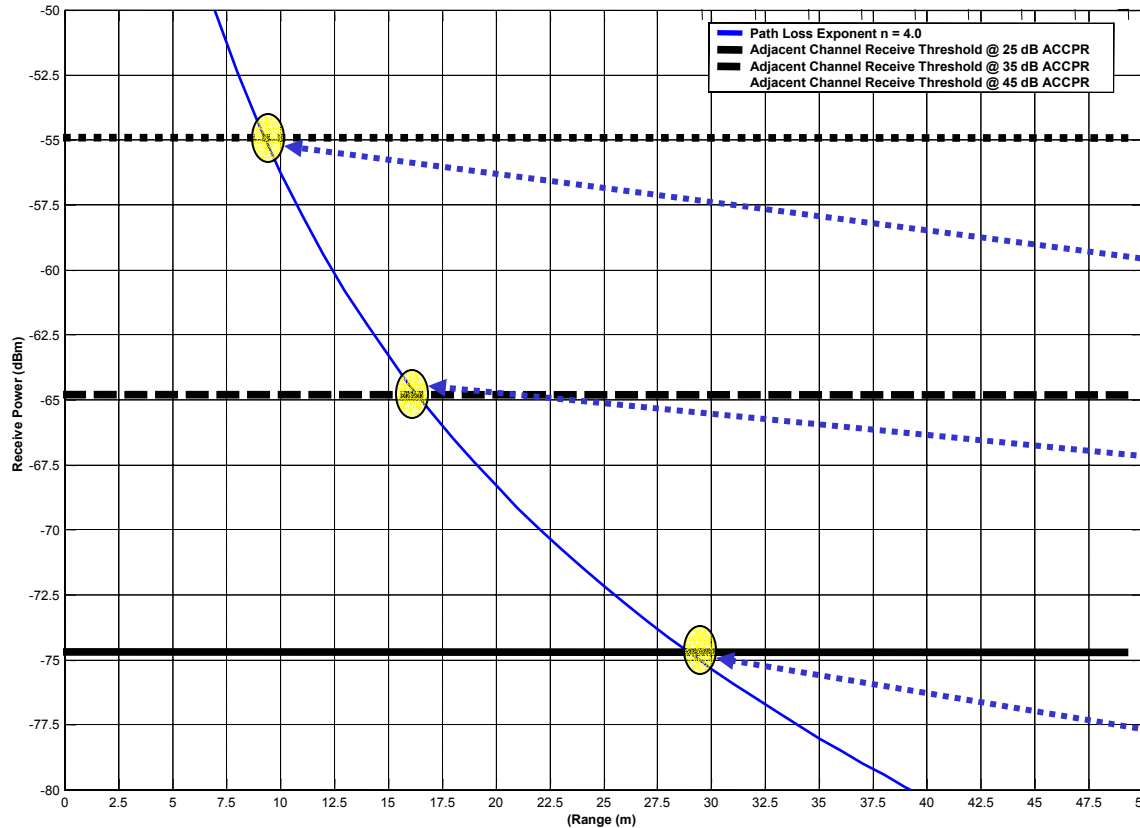
Receiver Noise Floor
of ~ 94 dBm

NOTE:
*In band interference
Should be kept at
least 6 dB below the
noise floor or < -100
dBm*



Adjacent Channel Effects

-High Reliability Case



Adjacent Channel Interference Range

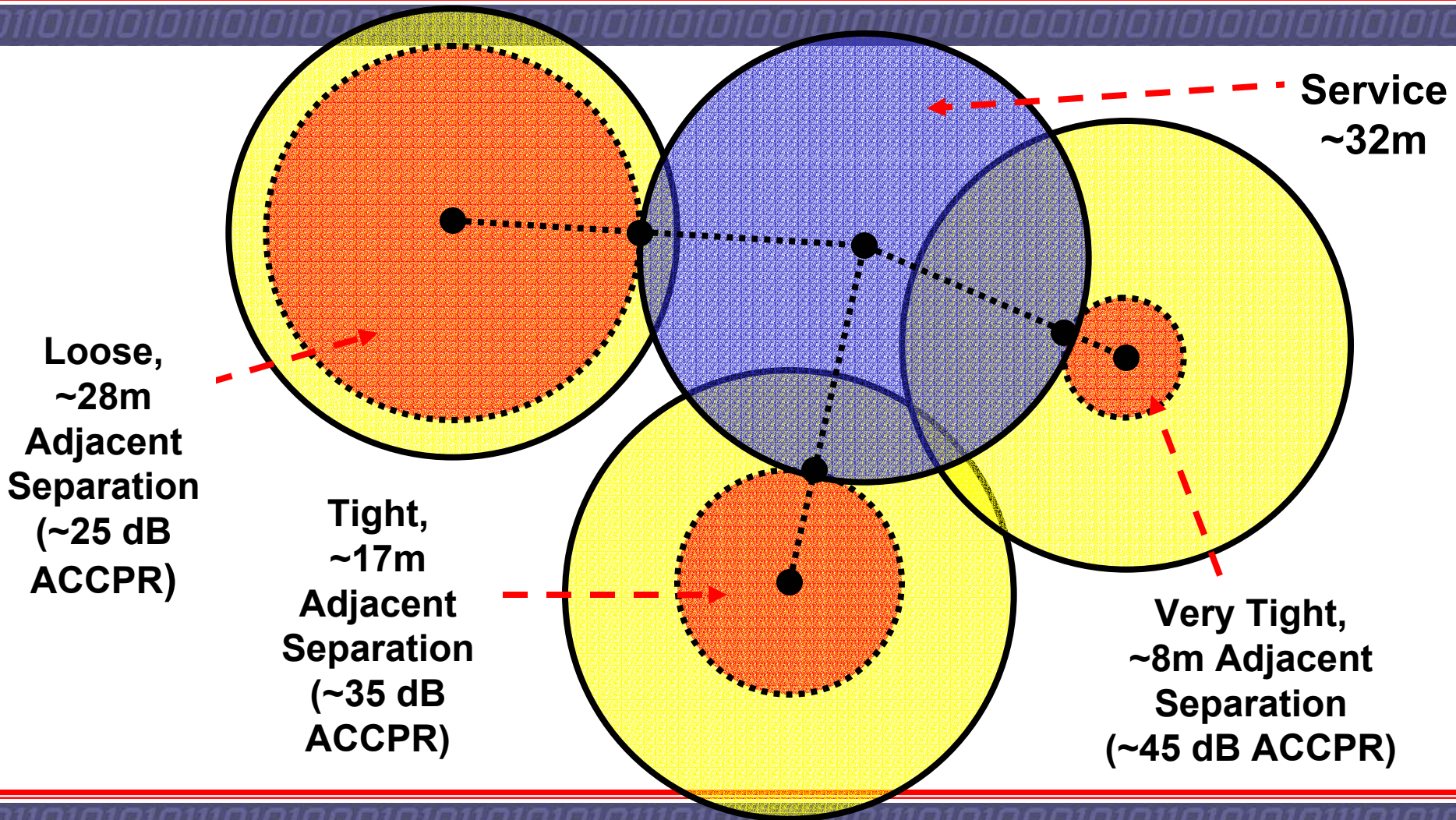
Very Tight Mask
e.g. Mot or DSRC-d
~45 dB ACCPR, ~ 8 m

Tighter Mask
e.g. FCC, Mot, or DSRC-c
~35 dB ACCPR, ~ 17 m

Loose Mask
e.g. 802.11a/j or DSRC-a/b
~25 dB ACCPR, ~ 28 m



Adjacent Channel Reuse Effects



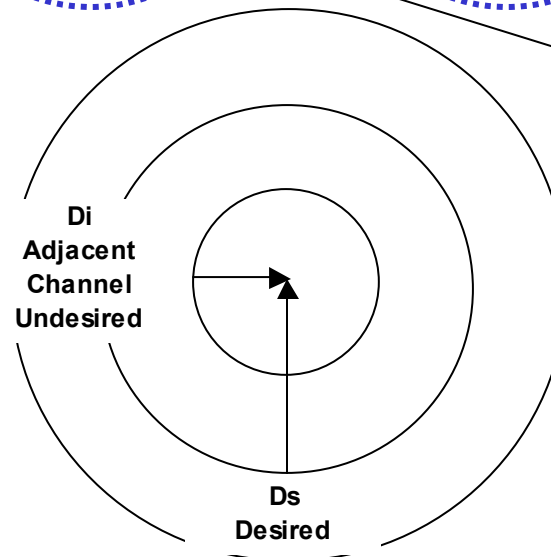
Adjacent Channel Reuse Effects

-Other Scenarios

| | Do (m) | P (dBm) | G (dBi) | Power | | | | Po (dBm) | ACCPR (dB) | | | | Po (dBm) | ACCPR (dB) | | | | Notes |
|----------|-----------|------------|------------|------------|------------|------------|------------|-------------|------------|----|----|----|-------------|------------|----|-----------|--------------|----------------------|
| | | | | Law Exp | P (dBm) | G (dBi) | Law Exp | | 25 | 35 | 45 | 25 | | 35 | 45 | | | |
| | | | | | | | | | | | | | | | | Rs (m) | Rint (m)* | |
| Case I | 1 | 30.00 | 2.15 | 3.00 | 30.00 | 2.15 | 4.00 | -14.00 | 137 | 86 | 40 | 19 | -14.00 | 40 | 28 | 16 | 9 | AP to Mobile |
| Case II | 1 | 30.00 | 2.15 | 4.00 | 30.00 | 2.15 | 4.00 | -14.00 | 40 | 28 | 16 | 9 | -14.00 | 40 | 28 | 16 | 9 | Mobile to Mobile |
| Case III | 1 | 30.00 | 2.15 | 3.00 | 20.00 | 0.00 | 4.00 | -14.00 | 137 | 86 | 40 | 19 | -26.00 | 18 | 14 | 8 | 5 | AP to Portable |
| Case IV | 1 | 30.00 | 2.15 | 4.00 | 20.00 | 0.00 | 4.00 | -14.00 | 40 | 28 | 16 | 9 | -26.00 | 18 | 14 | 8 | 5 | Mobile to Portable |
| Case V | 1 | 20.00 | 0.00 | 4.00 | 20.00 | 0.00 | 4.00 | -26.00 | 18 | 14 | 8 | 5 | -26.00 | 18 | 14 | 8 | 5 | Portable to Portable |

* To 2.15 dBi Receiver

| Colocated AP Case | | | | | | |
|------------------------------------|------------|------|------|----------------------------------|----|----|
| Talk-In Interference Ratio (Di/Ds) | ACCPR (dB) | | | Talk-In Interference Probability | | |
| | 25 | 35 | 45 | 25 | 35 | 45 |
| n = 3 | 0.58 | 0.27 | 0.13 | 19% | 5% | 1% |
| n = 4 | 0.67 | 0.38 | 0.21 | 25% | 8% | 2% |



Results for “longer range” cases scale proportionally with the previous slides

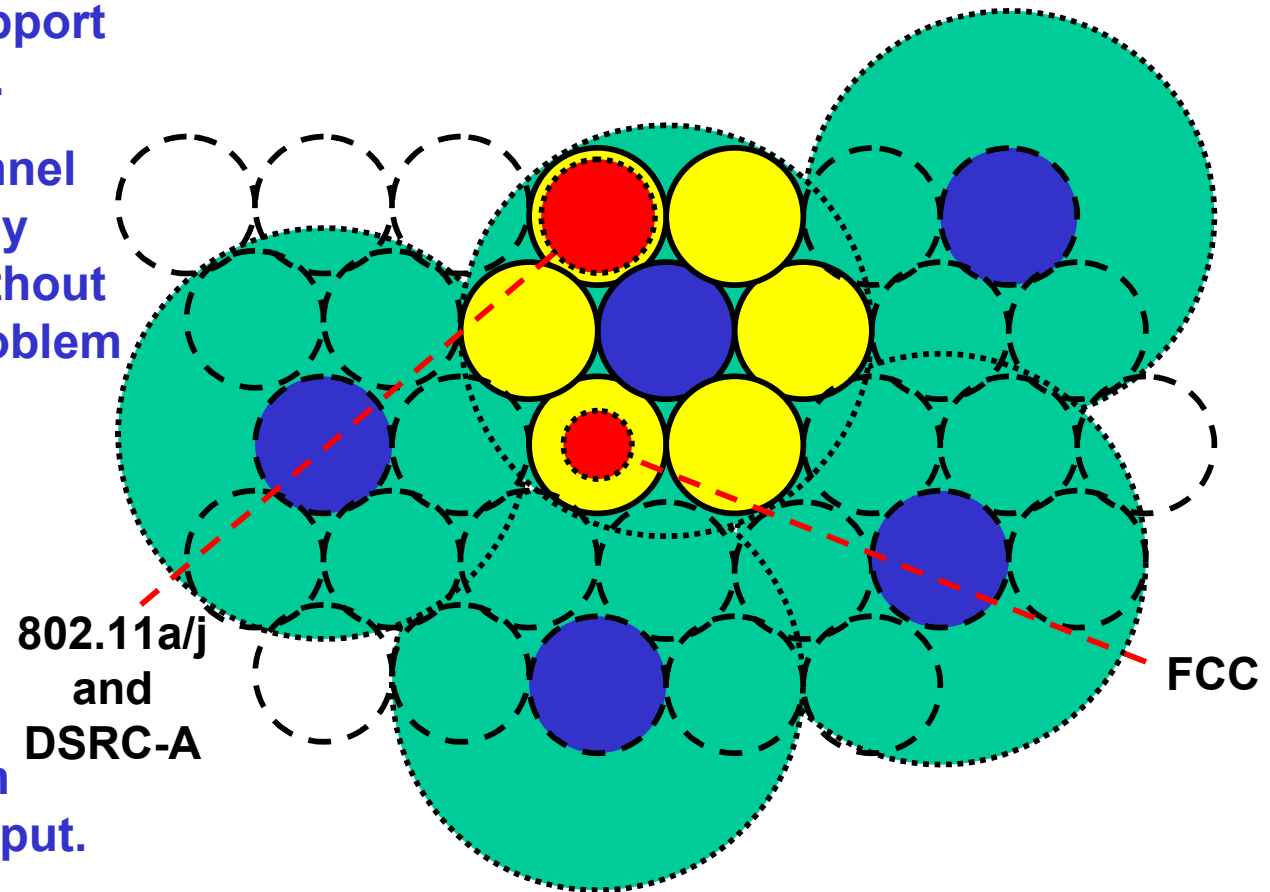


Adjacent Channel Reuse Effects

All of the Masks Can Support a Cellular Reuse Pattern.

A Co- and Adjacent channel cannot be simultaneously active in service area without interference (near far problem again).

However, note that the 802.11a/j MAC senses the environment before transmitting, therefore interference is either imperceptible, or is seen only as reduced throughput.



Adjacent Channel Reuse Effects

FCC Mask - Pro:

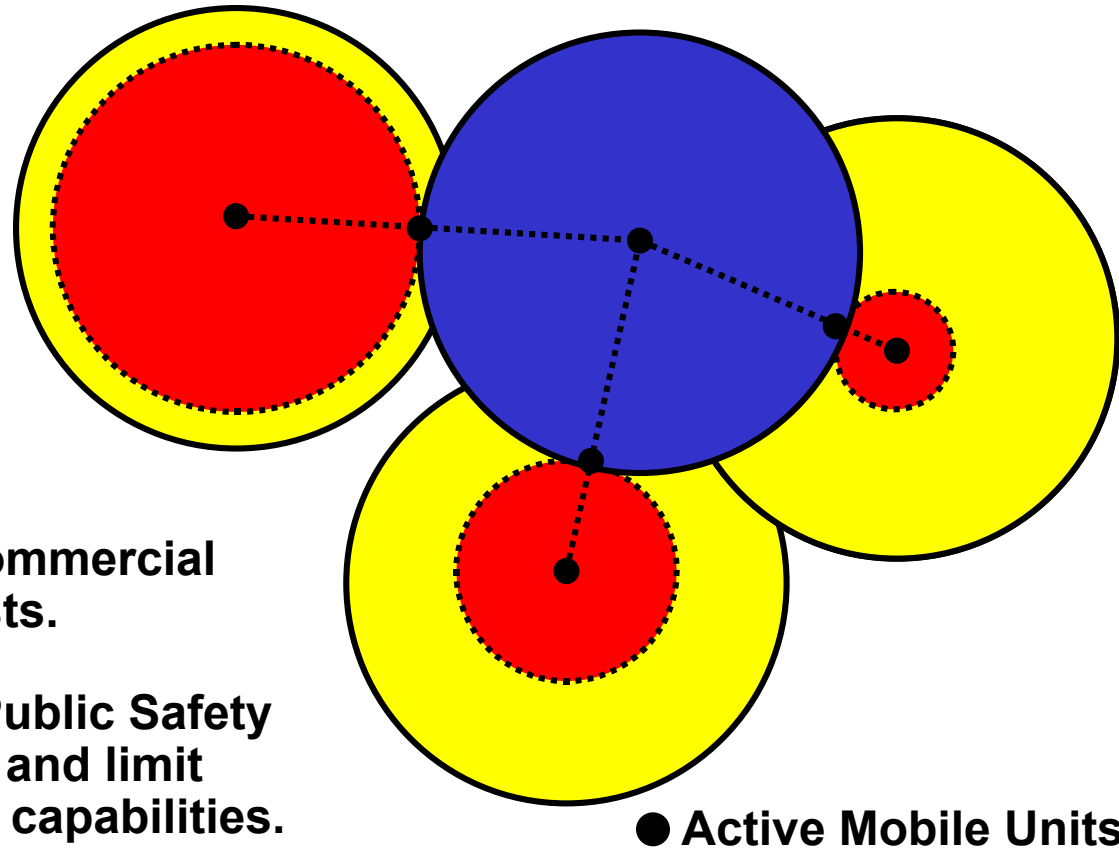
Adjacent channel users
Can get ~30 feet closer *when active*. **NOT A BIG DEAL!**

FCC Mask Con:

Inability to use 802.11a-based standards

Inability to leverage the wider commercial market to reduce equipment costs.

Creation of a niche broadband Public Safety market, which stifles innovation and limit access to new technologies and capabilities.



Recommendations

- **Petition for Reconsideration on the mask issue**
 - May still allow a tighter mask on the outer channels (10-1 MHz channels) in order to protect Navy and RA operations
 - These will not see a scaled 802.11 OFDM anyway
- **Propose that the FCC use the 802.11a/j & DSRC-a masks instead**
 - Does not limit our technology options
 - Reserve the right to impose a tighter mask (e.g. DSRC b/c/d) at the RPC level - for cases where interference becomes an issue

