m.it.sco
Morvarid. IT. Solutions Co.

MikroTik

MUM -Kathmandu, Nepal
June 2nd 2017

Wireless Fundamentals

By
Mani Raissdana

MANI RAISSDANA

MikroTik Certified Trainer

CTO & Co-Founder of

m.it.s co

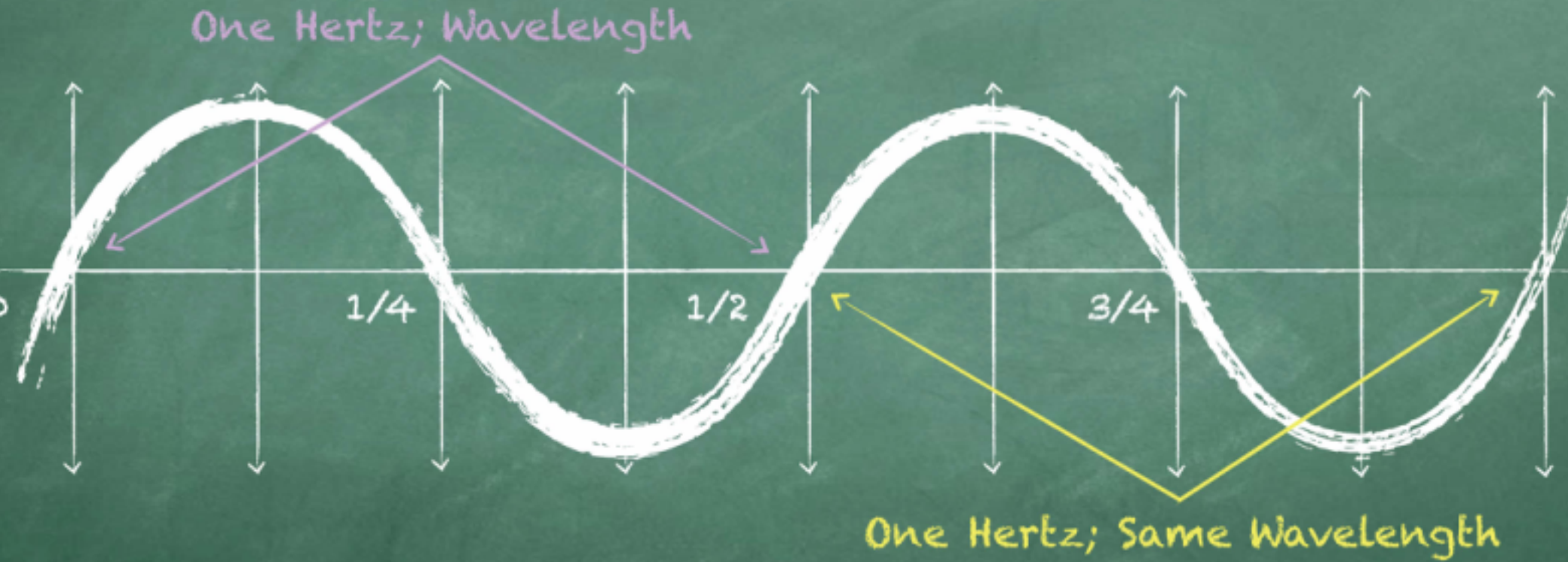
Morvarid. IT. Solutions Co.

Being in IT technology business roughly around 14 years

Support & instruct Engineers more than 8 years all over the globe

Wireless, Routing, QoS, Firewall, The Dude

"2 Hertz" Waveform

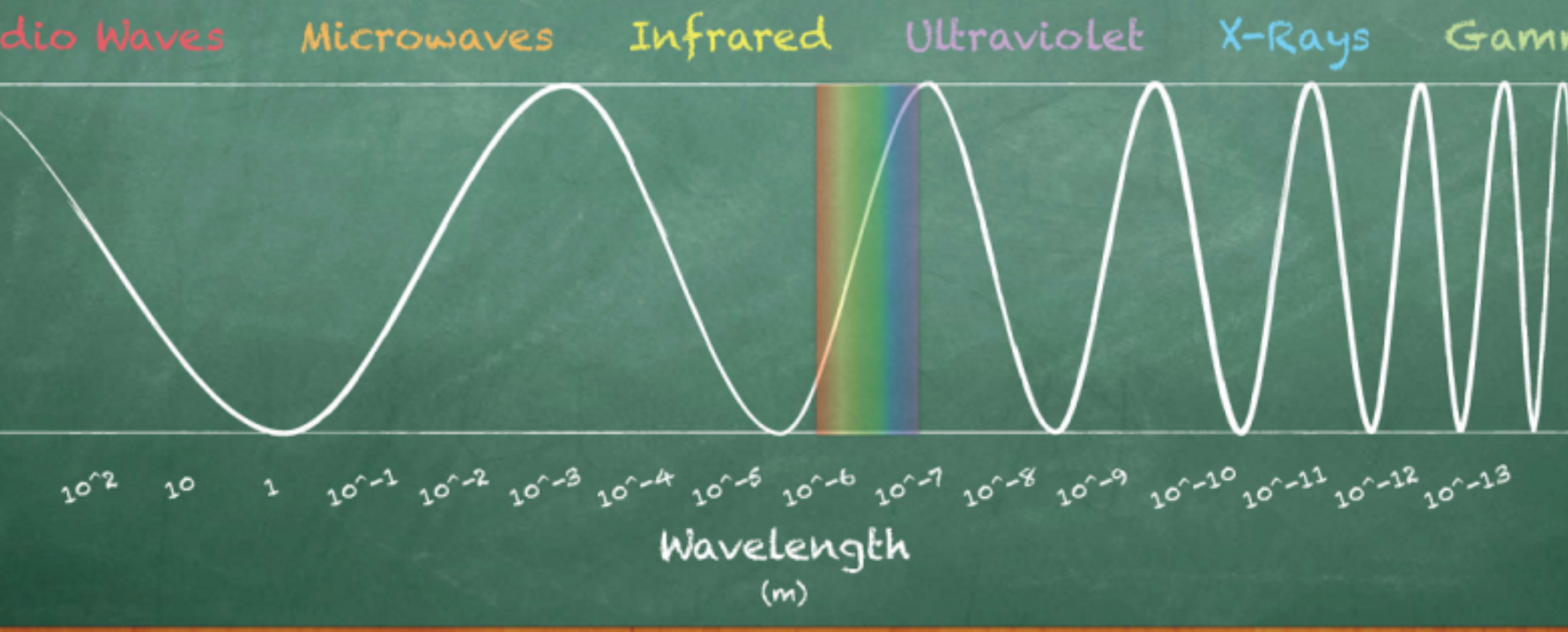


Time Domain

(seconds)

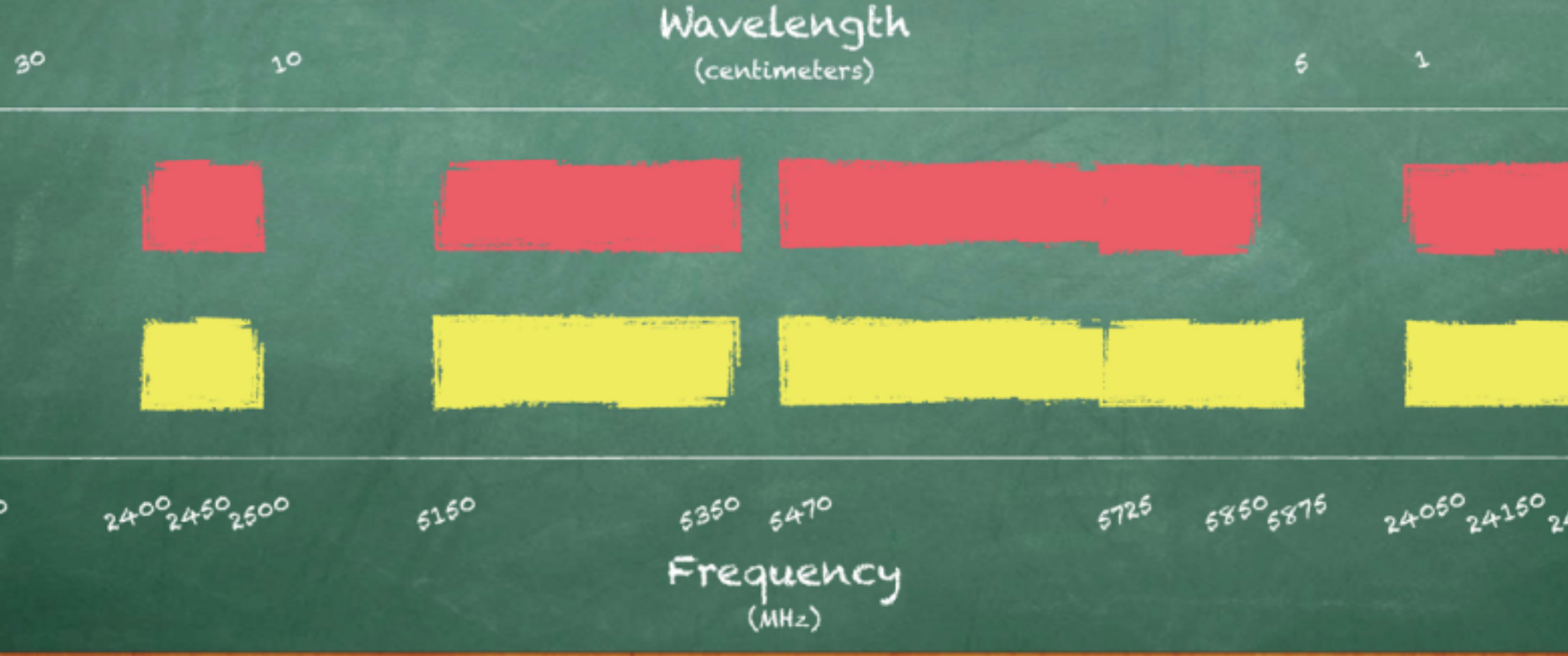
Electromagnetic Spectrum

"Range of Frequencies from Long to Short Wavelength"



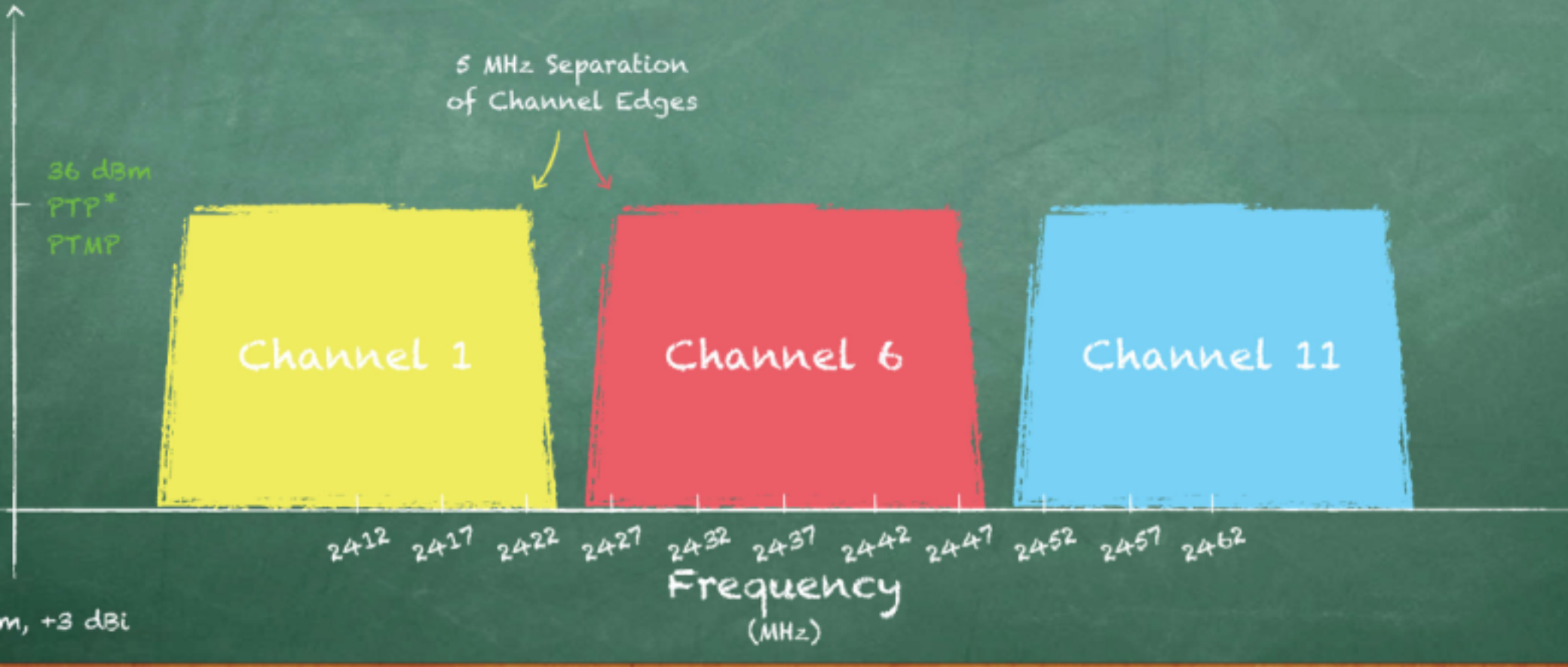
RF Spectrum

ange of FCC & CE Outdoor, Unlicensed Wireless Band



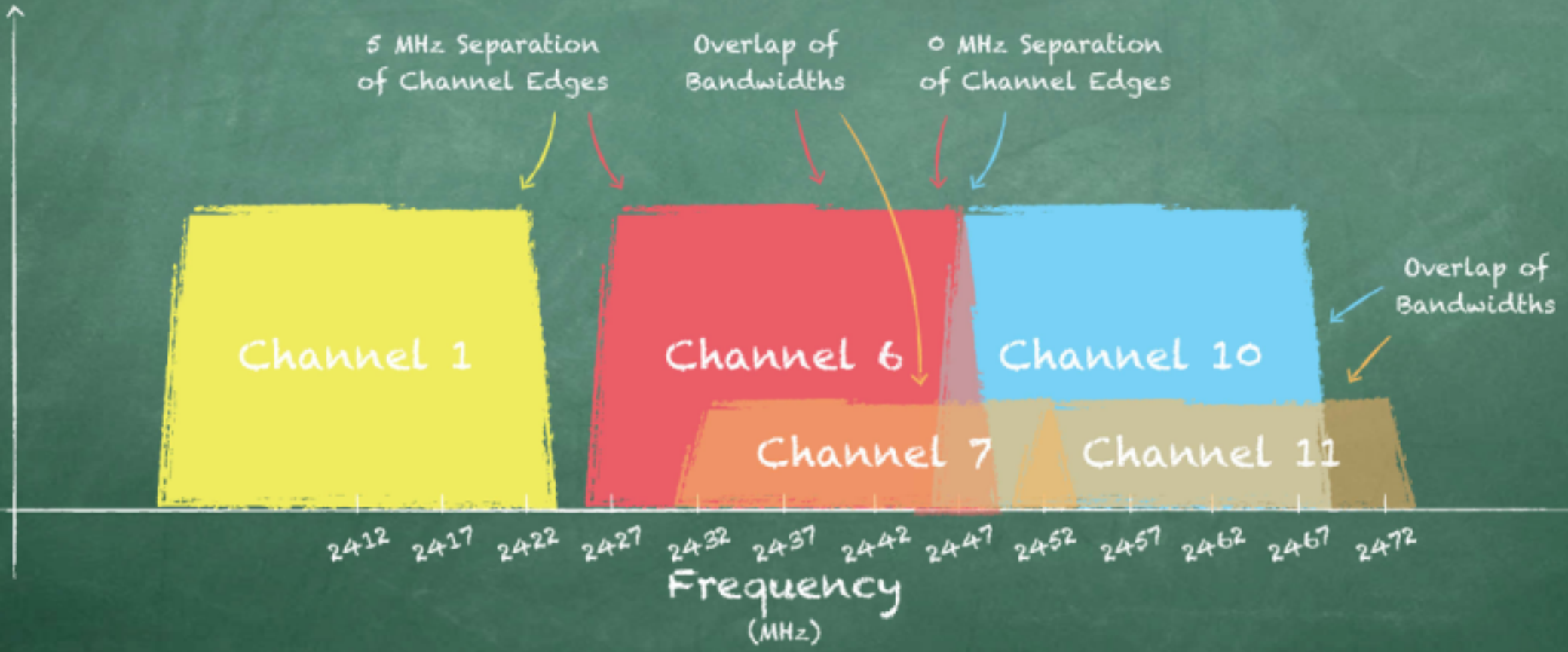
2.4 GHz Spectrum

Three Non-Overlapping 20 MHz Channels in ISM Band



2.4 GHz Spectrum

"Three 20 MHz & One 40 MHz Channel (Overlapping)"

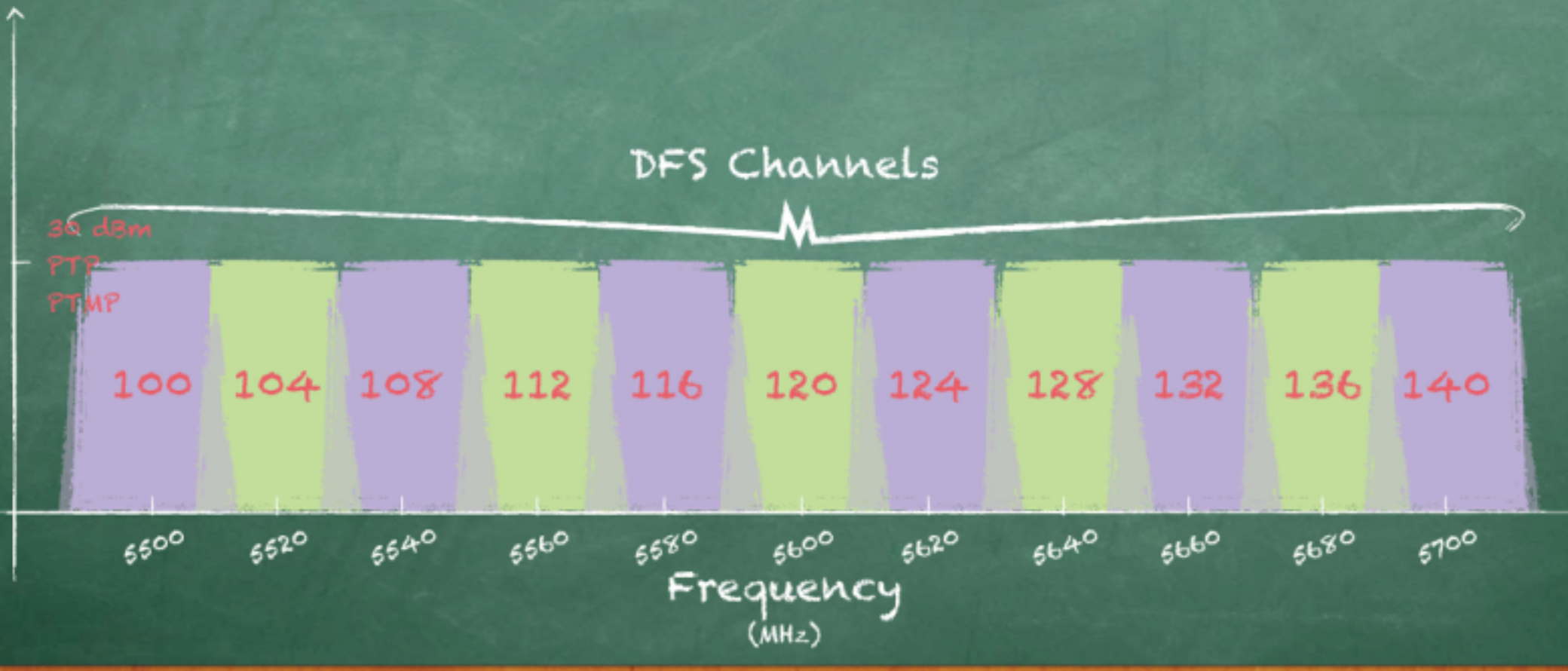


5 GHz Spectrum

"U-NII-1 & U-NII-2a Bands"

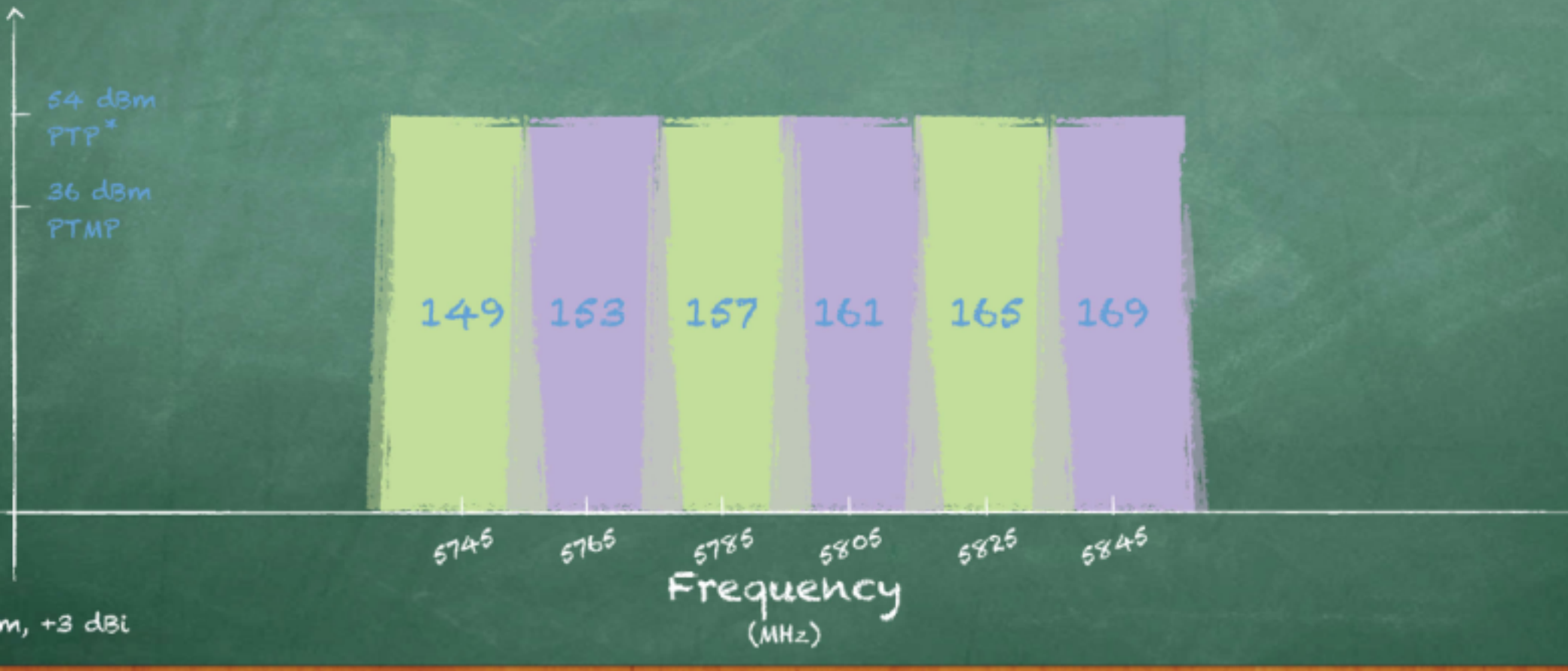
5 GHz Spectrum

"U-NII-2c Band"



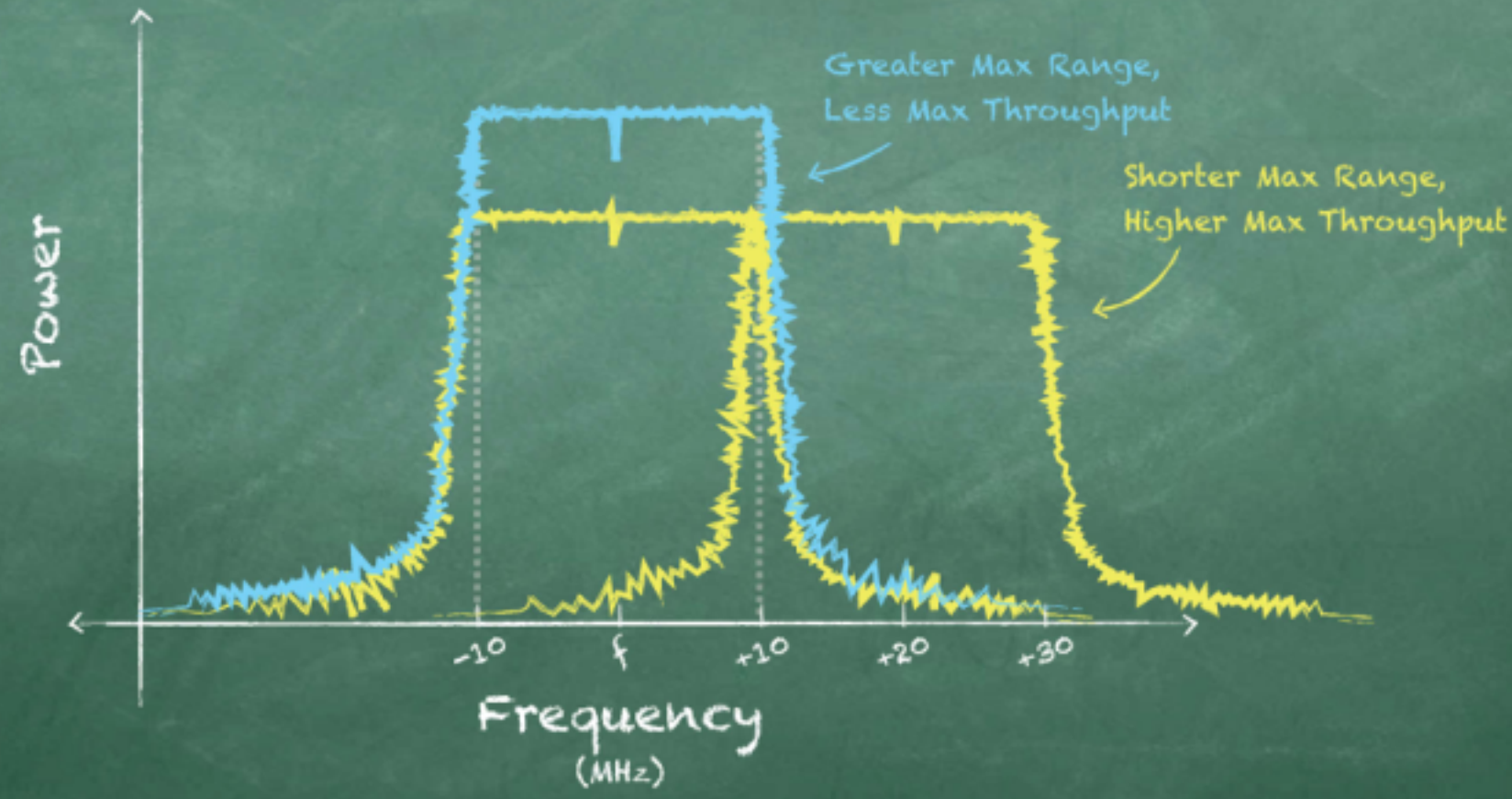
5 GHz Spectrum

"U-NII-3 Band"



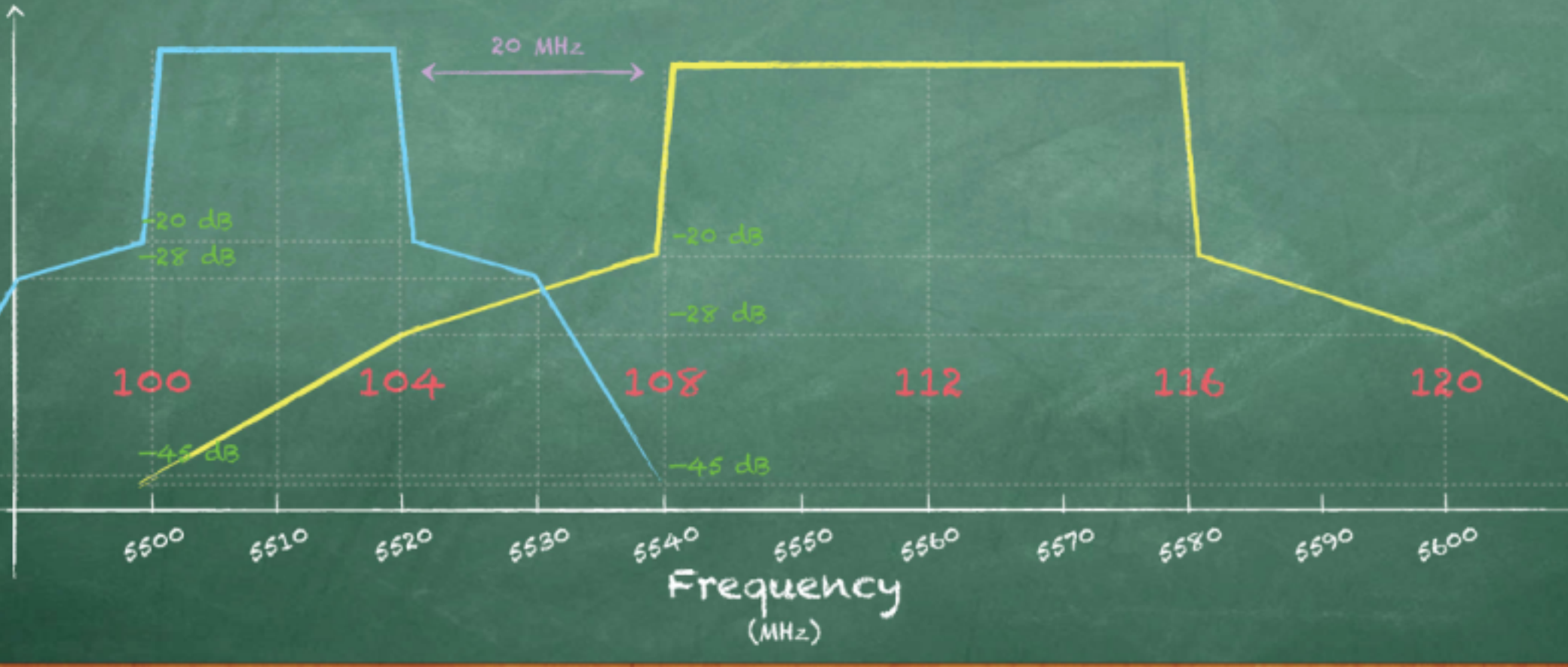
OFDM Spectral Masks

ower Spectral Density of 20 & 40 MHz Bonded Channe



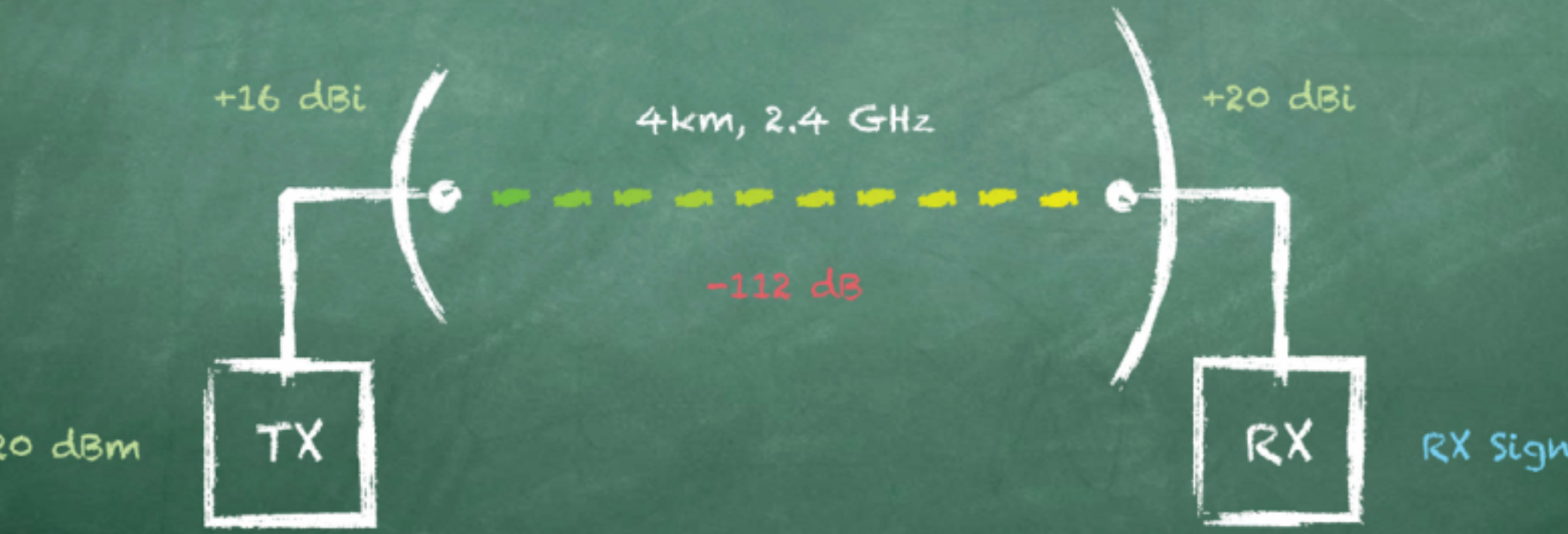
nannel Masks & Spacin

"PSD of 20 & 40 MHz Masks with 20 MHz Spacing"



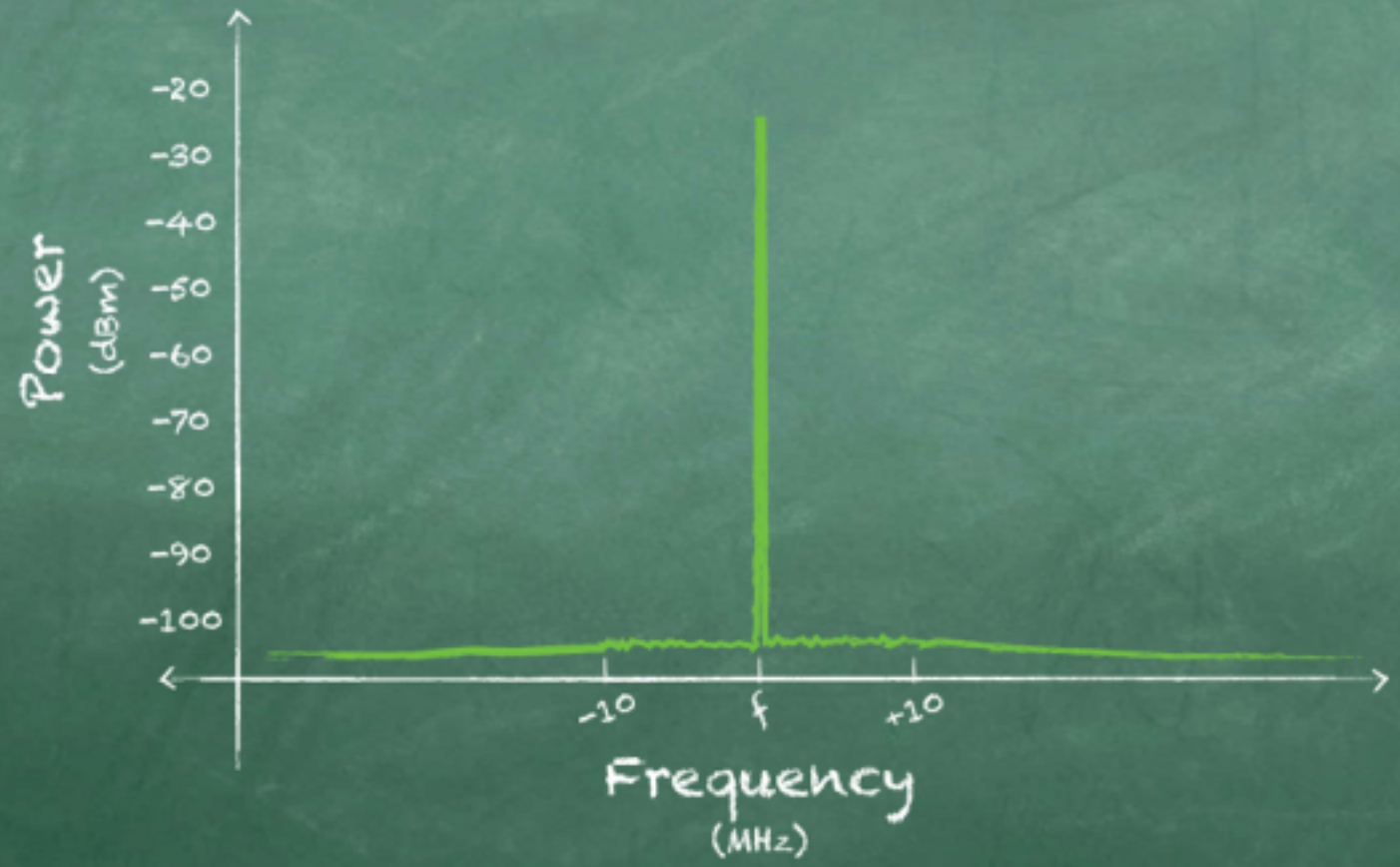
Link Power Budget

"RX Signal = TX Power + TX Gain - FSPL + RX Gain"



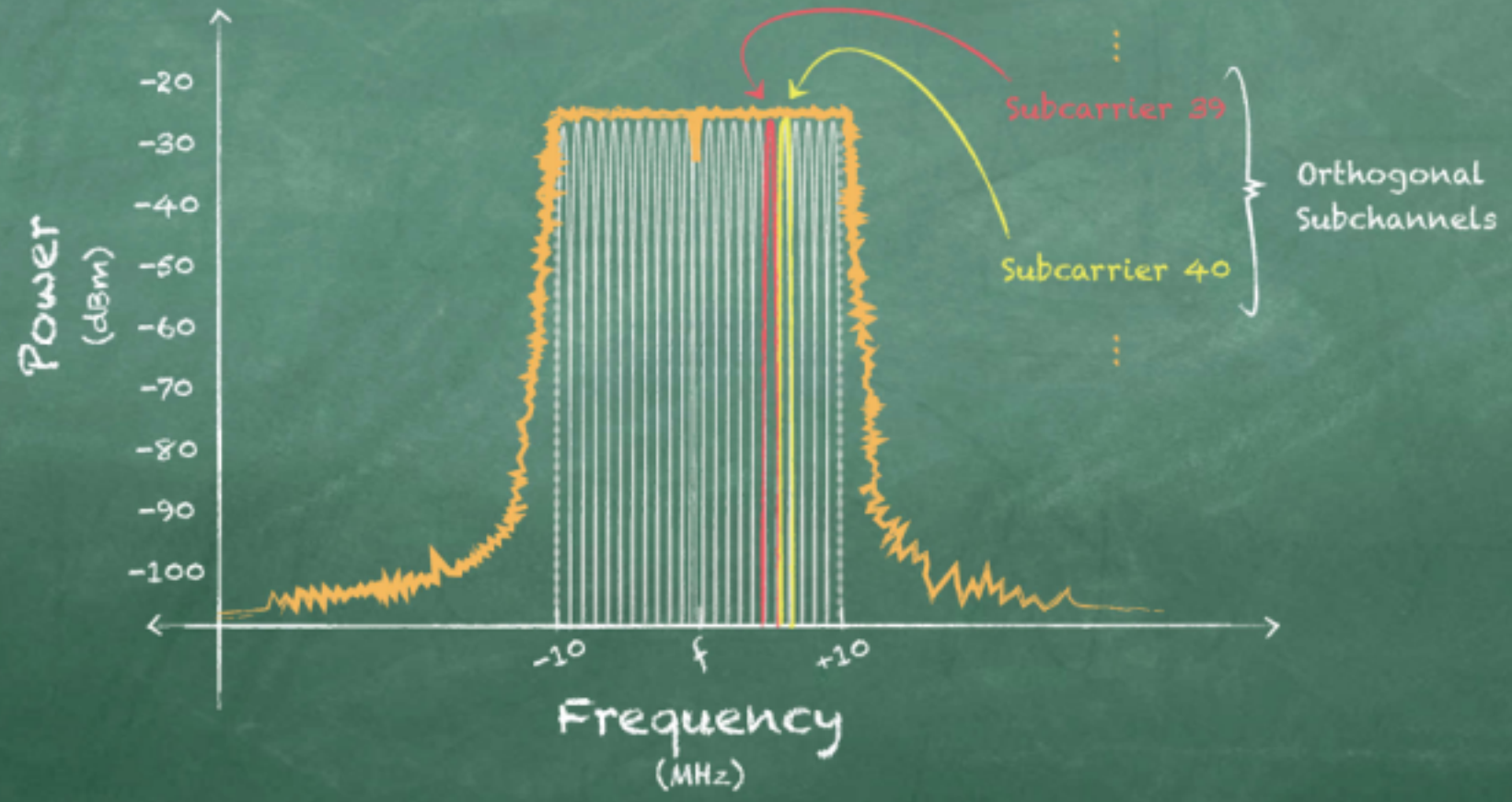
Single Carrier Signal

"Power Measurement of Continuous Waveform"



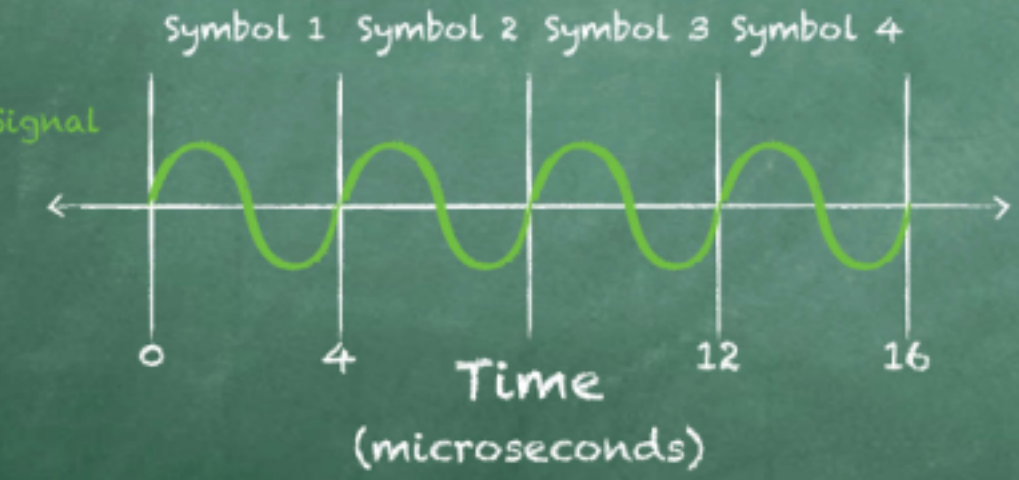
Multicarrier Signal

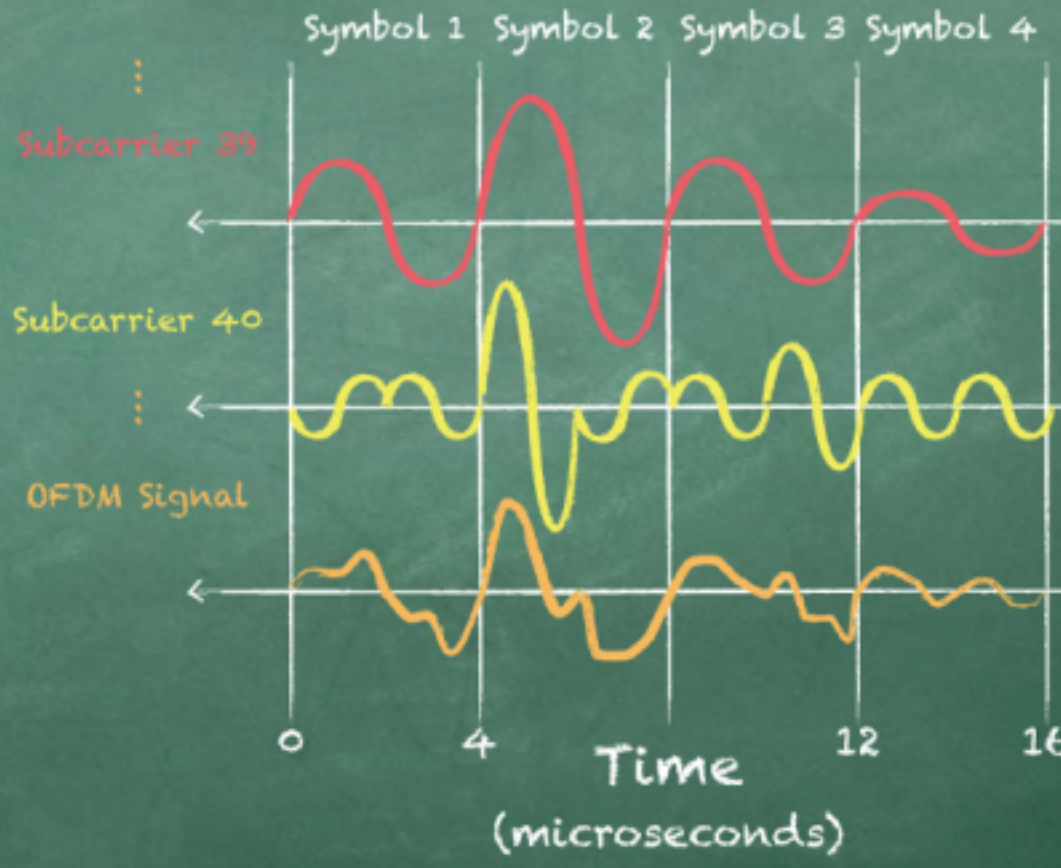
"Spectral Mask of an OFDM Channel"



Signal Comparison

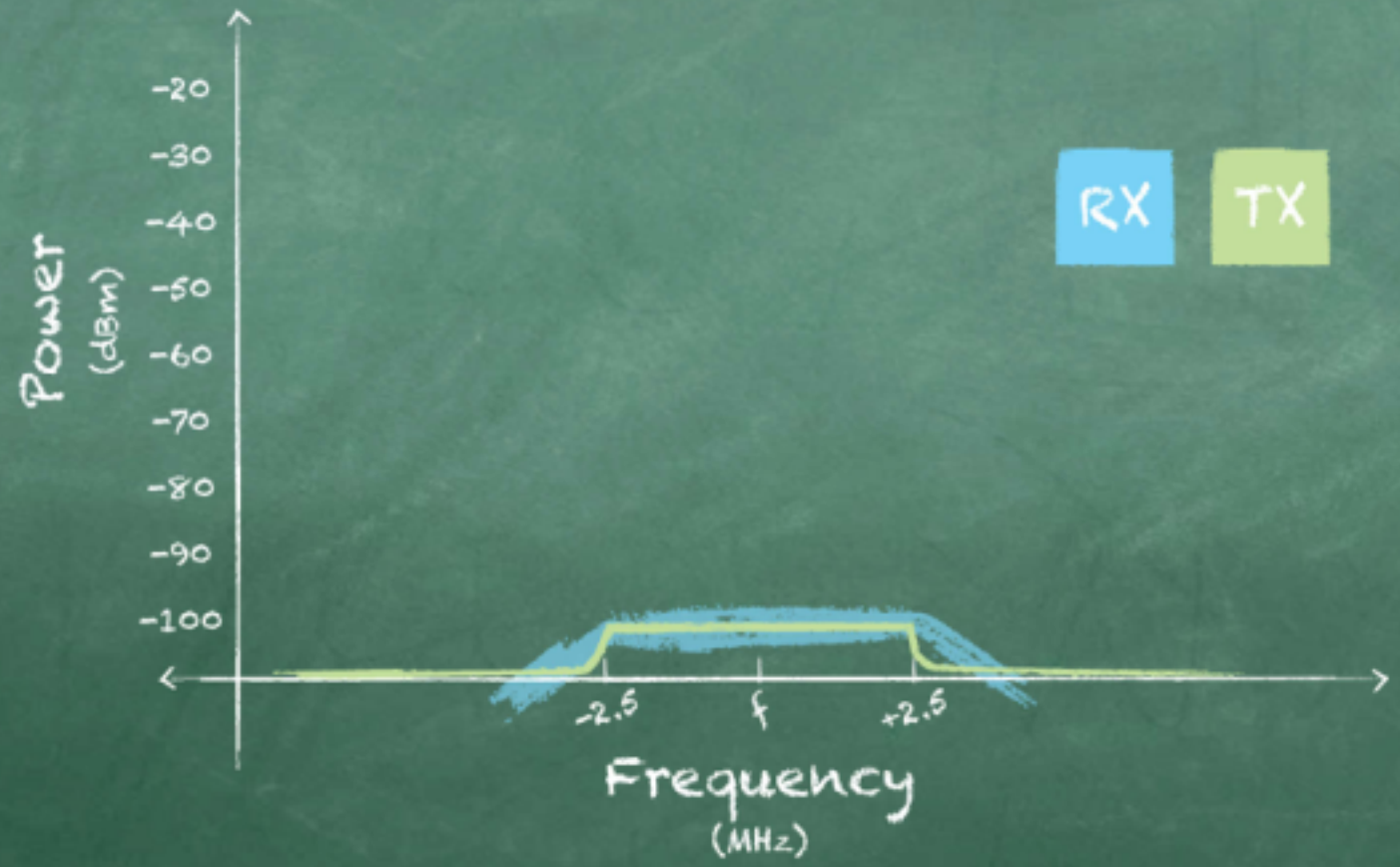
"Continuous Waveform vs. OFDM Signal"





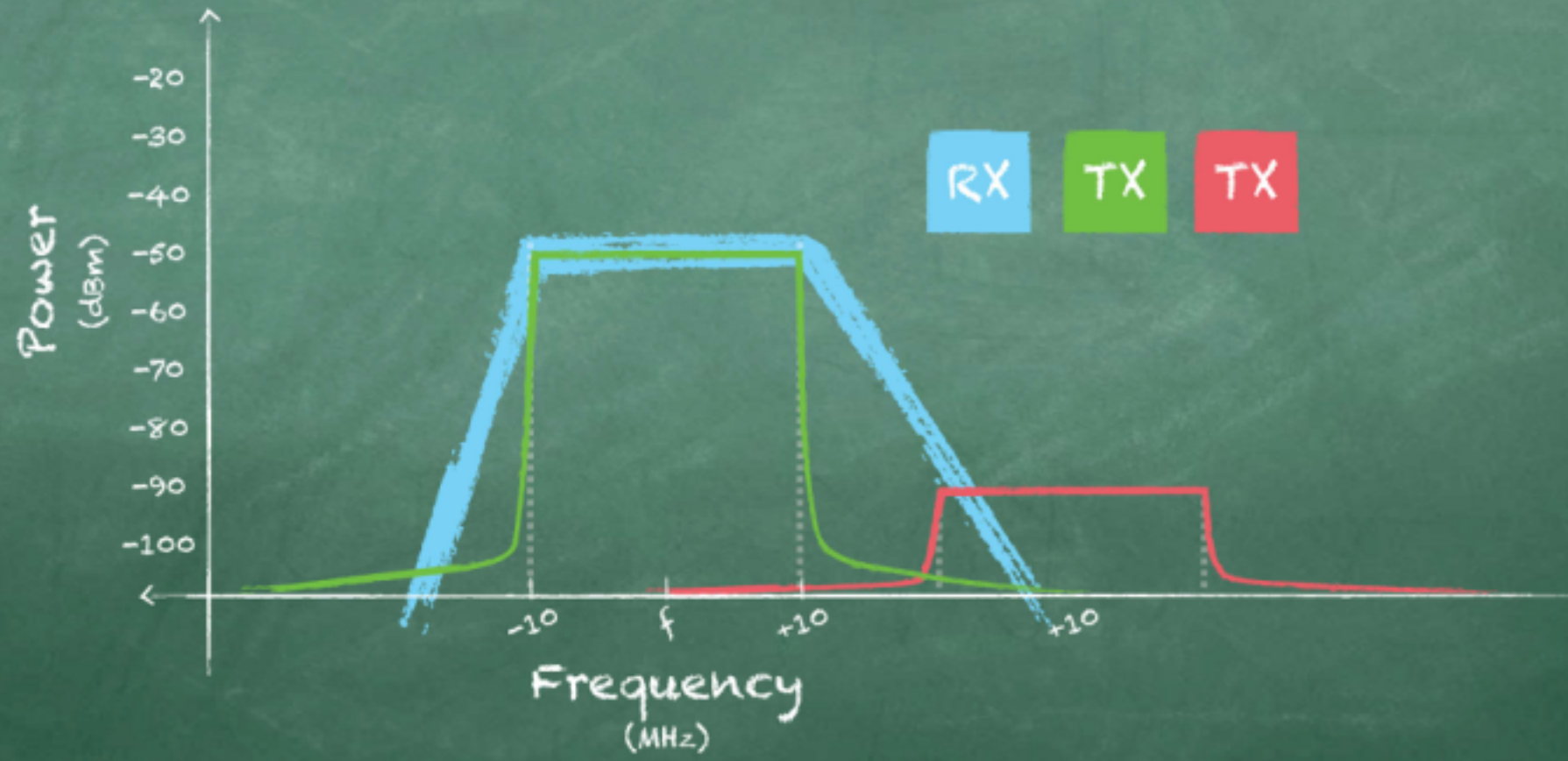
Radio Sensitivity

"Receiver ability to listen to weak, low power signals"



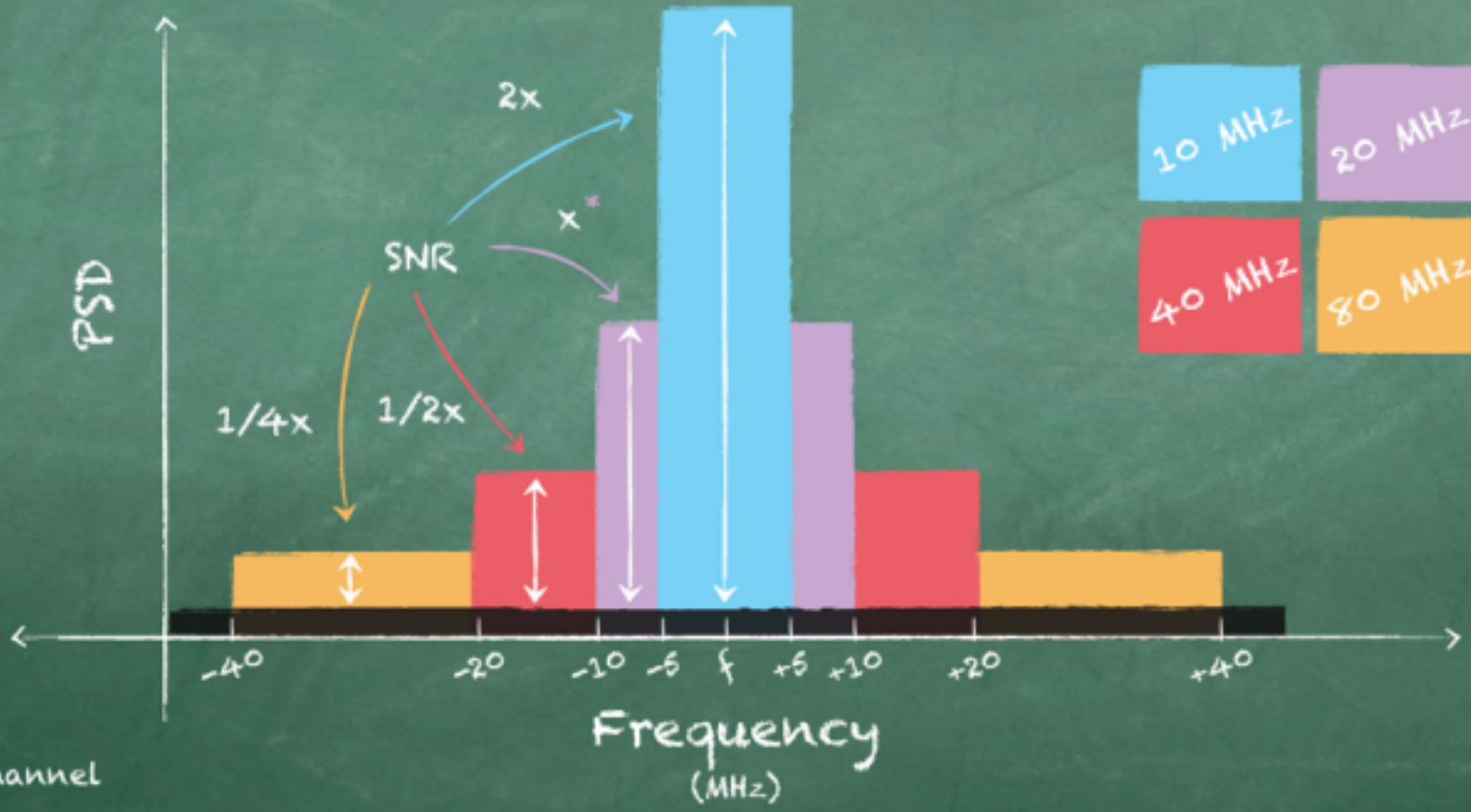
Radio Selectivity

"Receiver ability to listen to only desired channel"



Channel Flexing & SNR

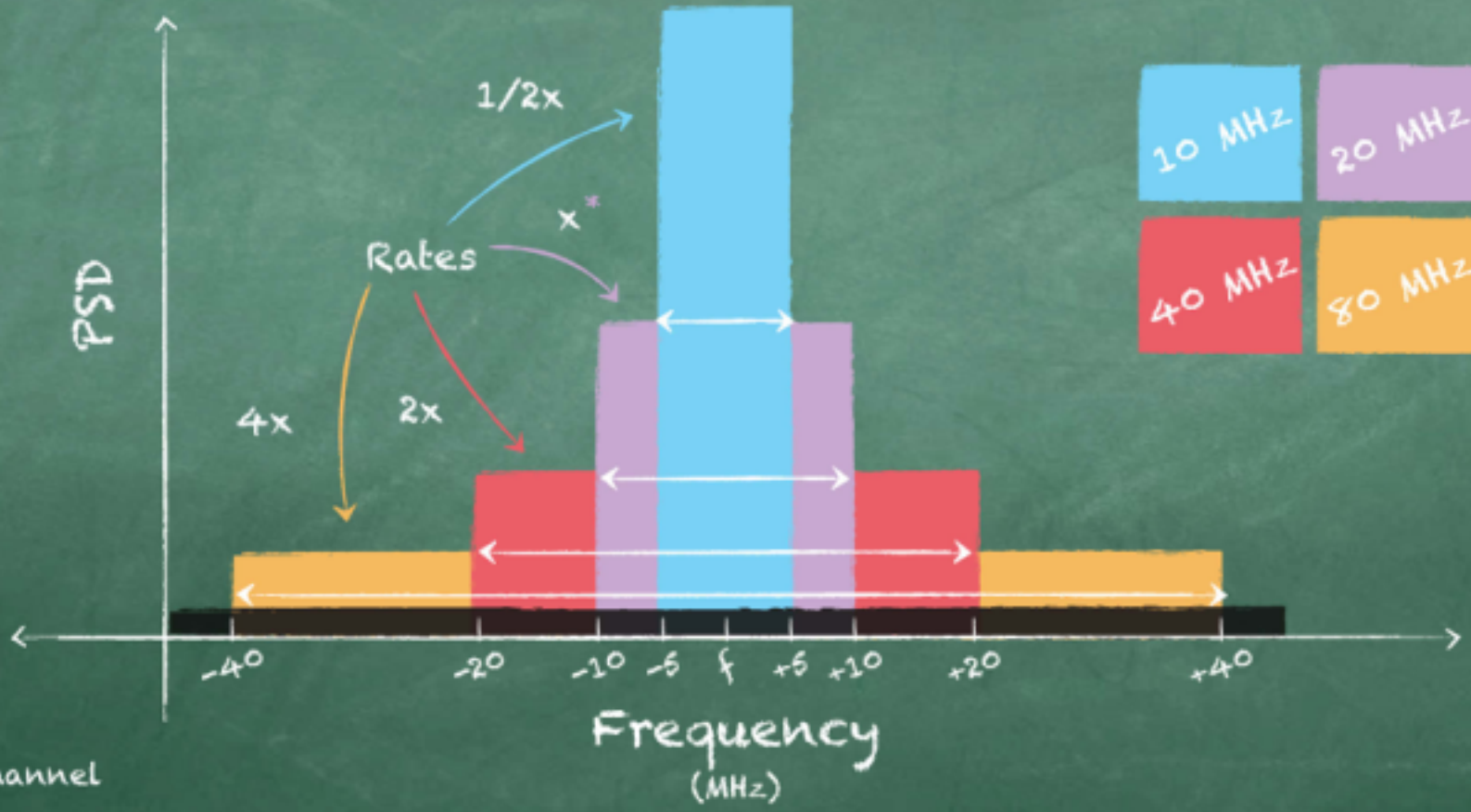
"Larger bandwidths have lower SNR"



z reference channel

hannel Flexing & Rate

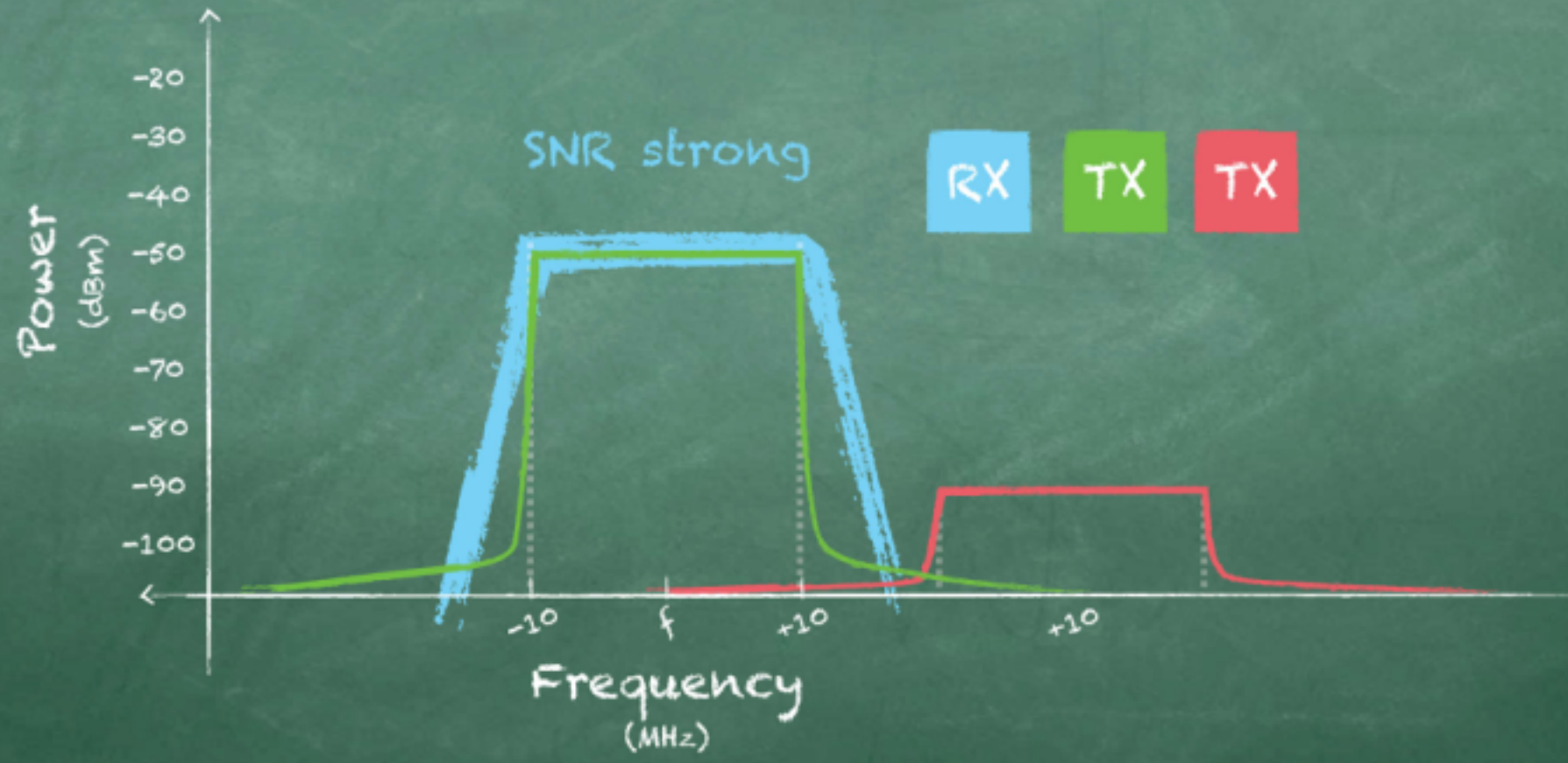
"Larger bandwidths have higher max data rates"



z reference channel

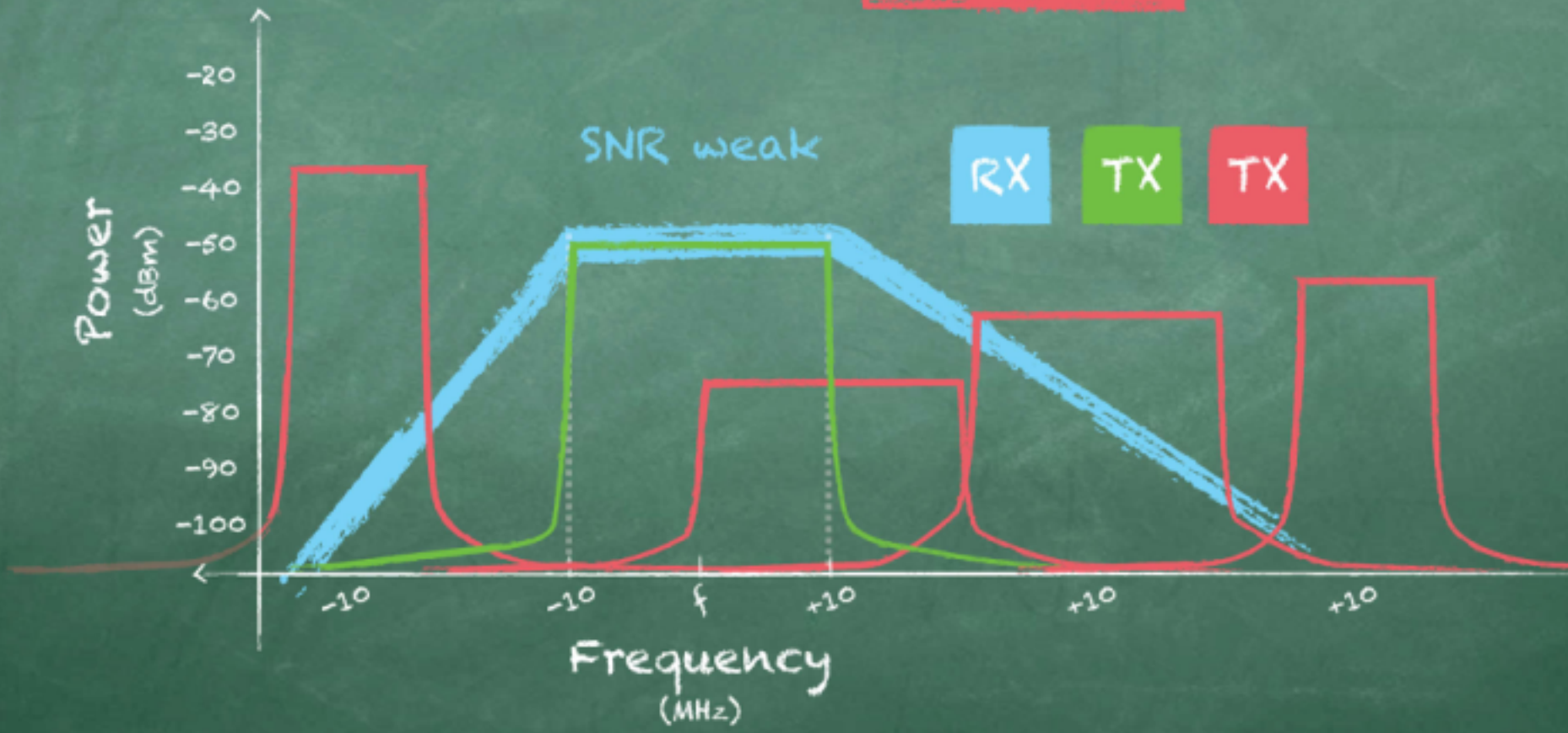
Low Noise Environment

"Receiver hears transmitter without problems"



ıgh Noise Environmen

eceiver's selectivity degrades in noisy RF environmen



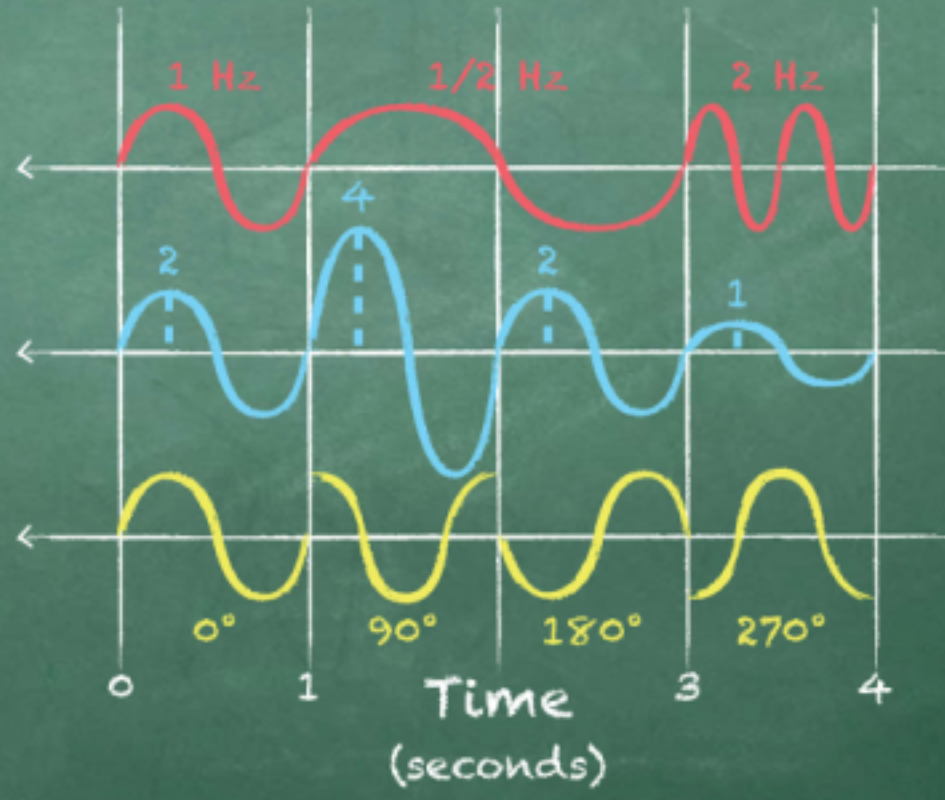
Modulation

"Types of Digital Signal Modulation"

FSK Frequency Shift Keying

ASK Amplitude Shift Keying

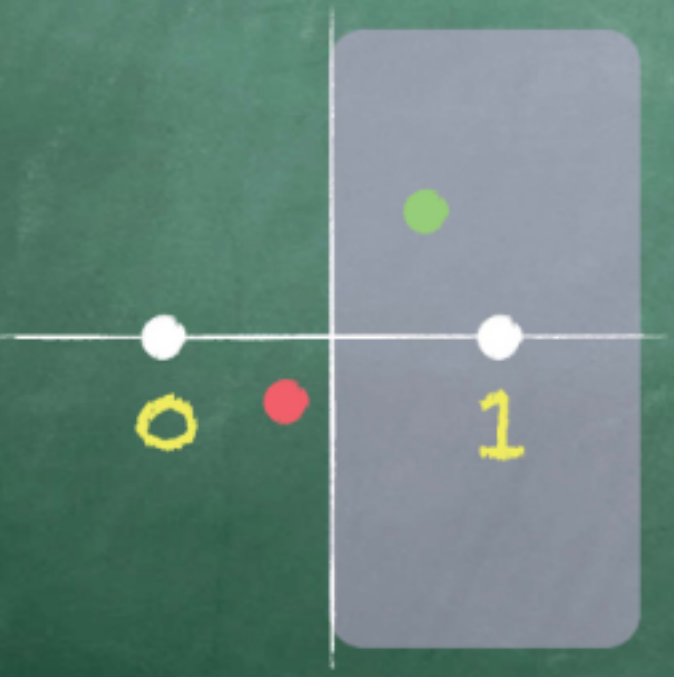
PSK Phase Shift Keying



Constellation Diagrams

omplex modulation schemes allow for higher data rat

BPSK

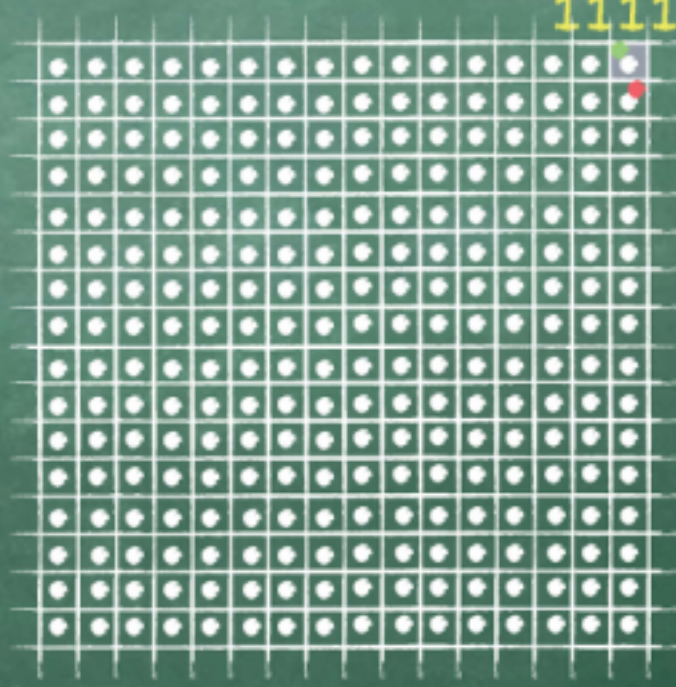


Margin for error

Successfully Transmitted Symbol

Symbol in Error

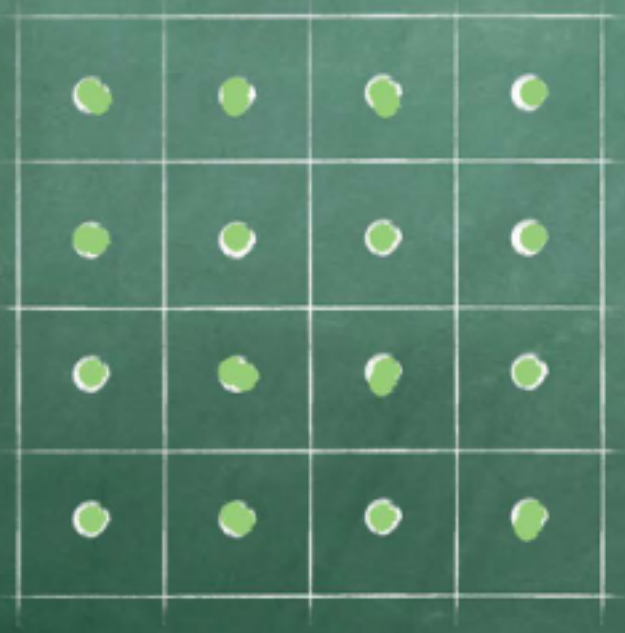
256QAM



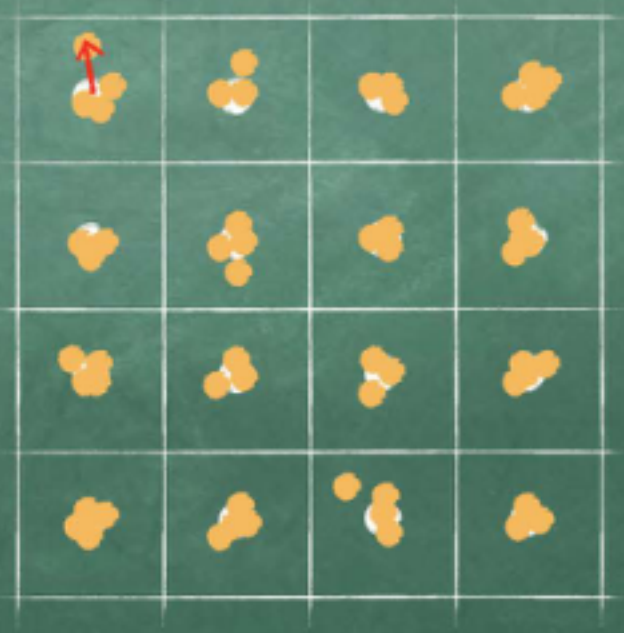
Error Vector Magnitude

EVM measures deviation from intended symbol positio

Excellent TX EVM



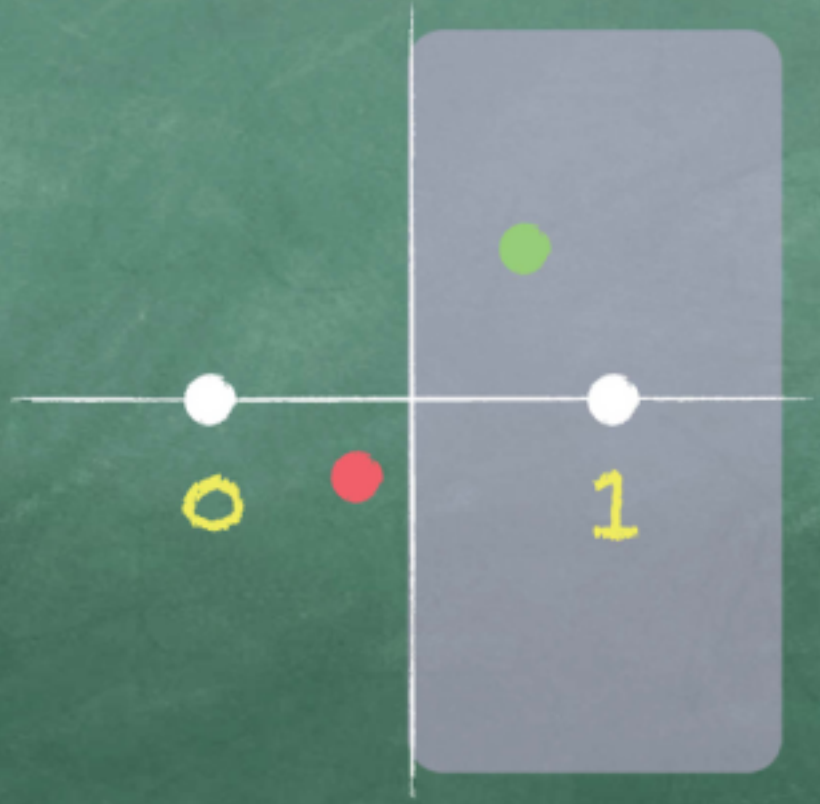
Poor TX EVM



Binary PSK

"Slowest, but requires lowest SNR"

Up to 32.5Mbps per 80 MHz Channel



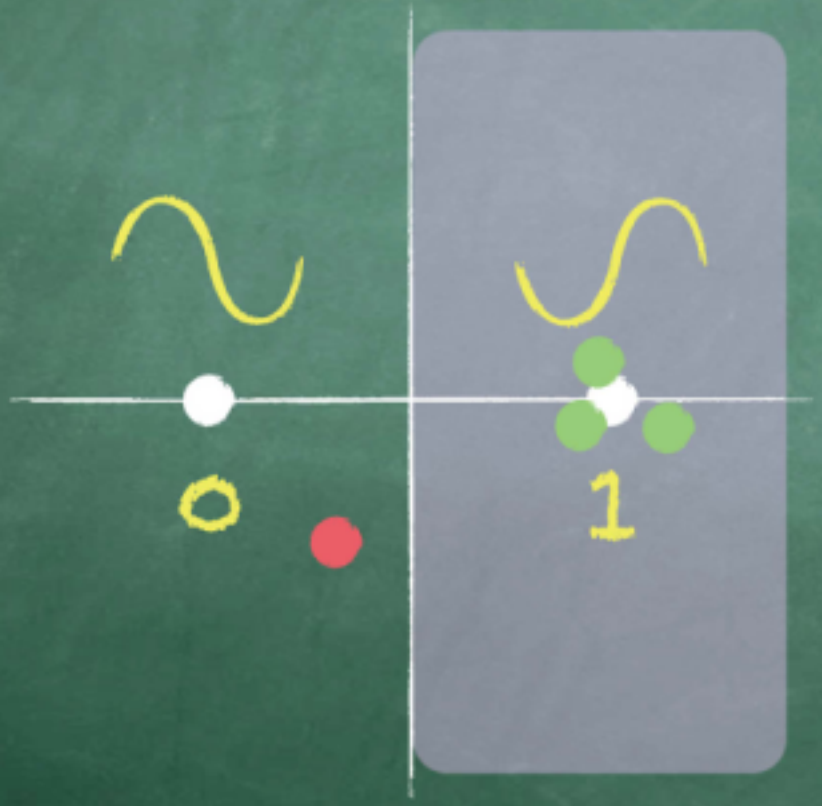
Margin for error

Successfully Transmitted Symbol

Symbol in Error

BPSK Waveform

"Slowest, but requires lowest SNR"



BPSK Binary Phase Shift Keying

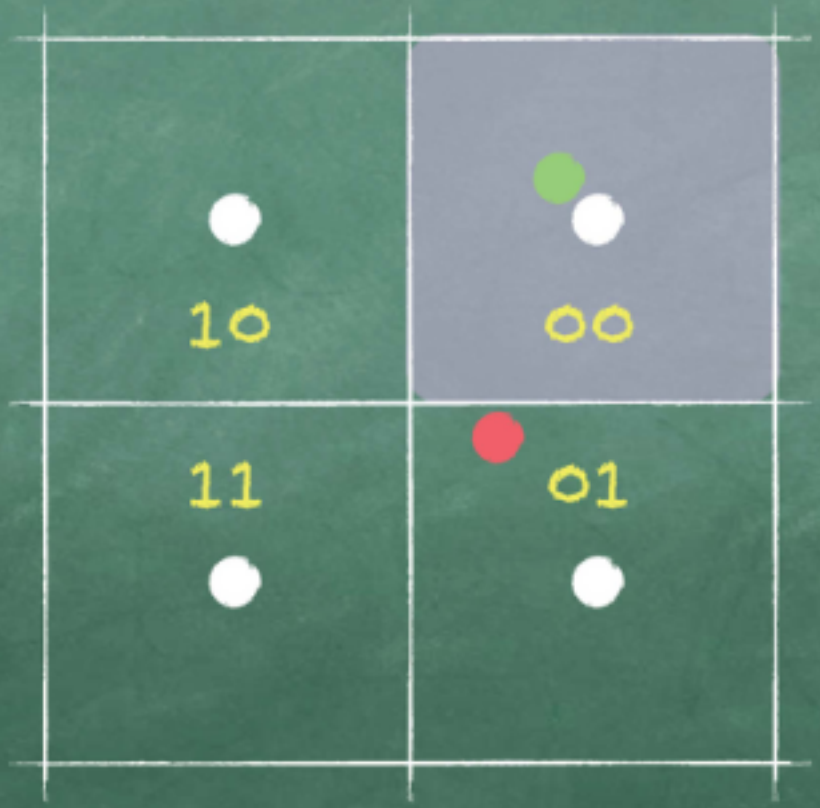
1 1 1 0

Bits

Quadrature PSK

"Slow, but requires low SNR"

Up to 87.8 Mbps per 80 MHz Channel



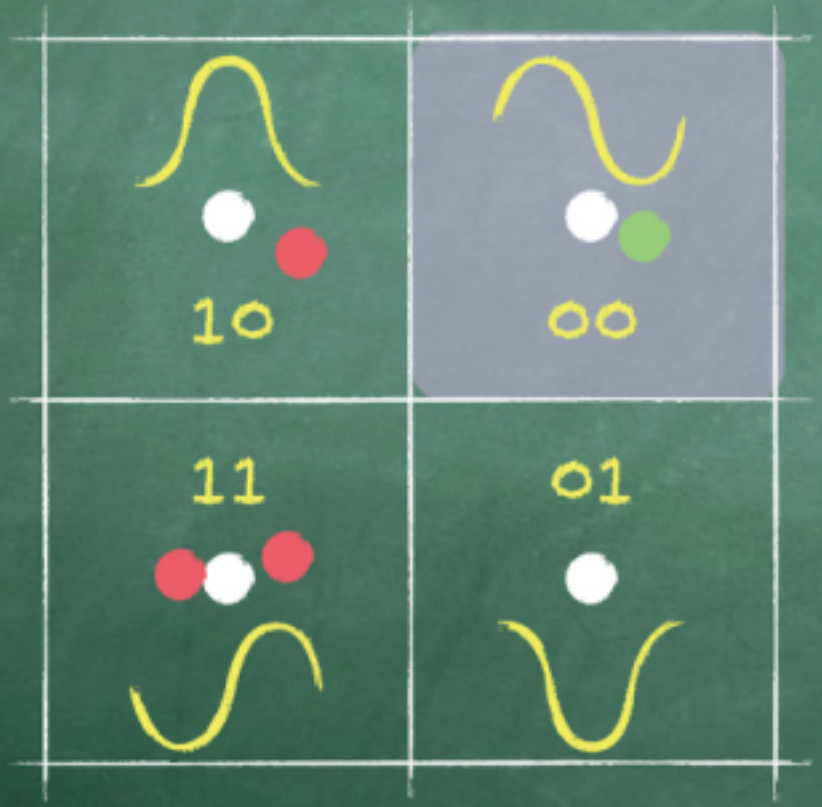
Margin for error

Successfully Transmitted Symbol

Symbol in Error

QPSK Waveform

"Slow, but requires low SNR"



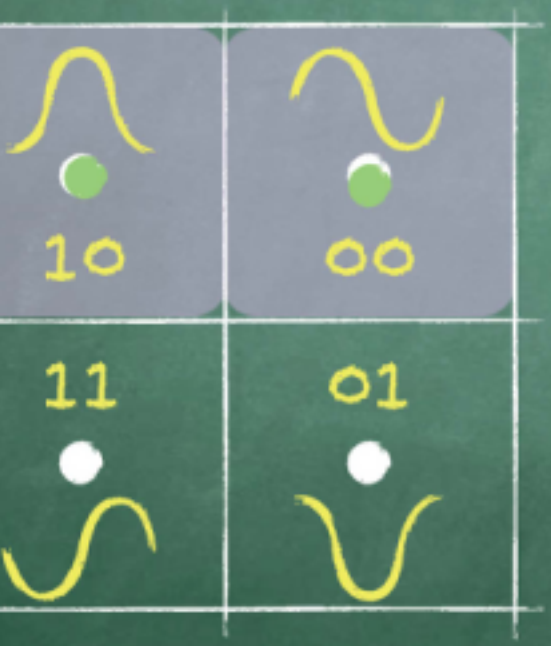
QPSK Quadrature Phase Shift Keying

11 11 10 00

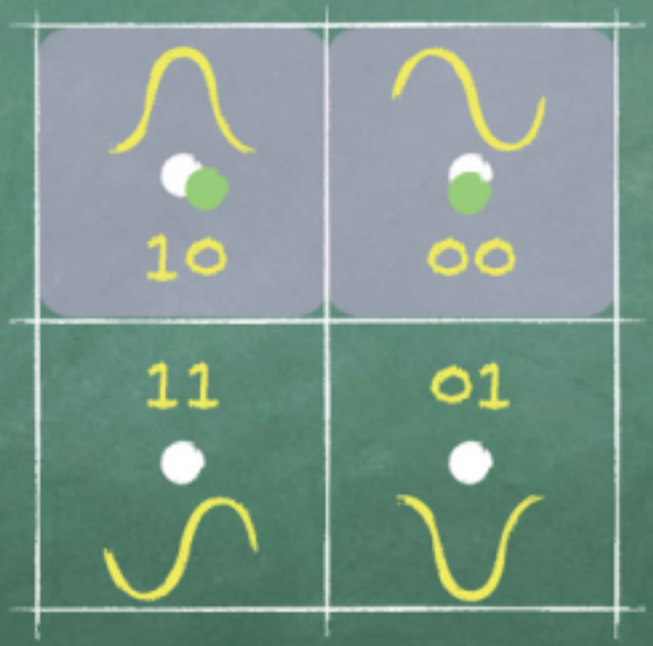
Bits

QPSK Operation

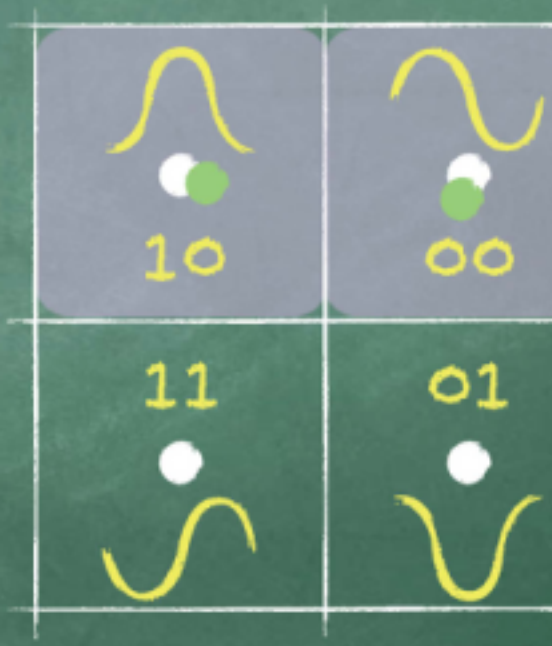
"Proper mapping of symbol sets from end-to-end"



1. Excellent TX EVM



2. Low Noise Environment

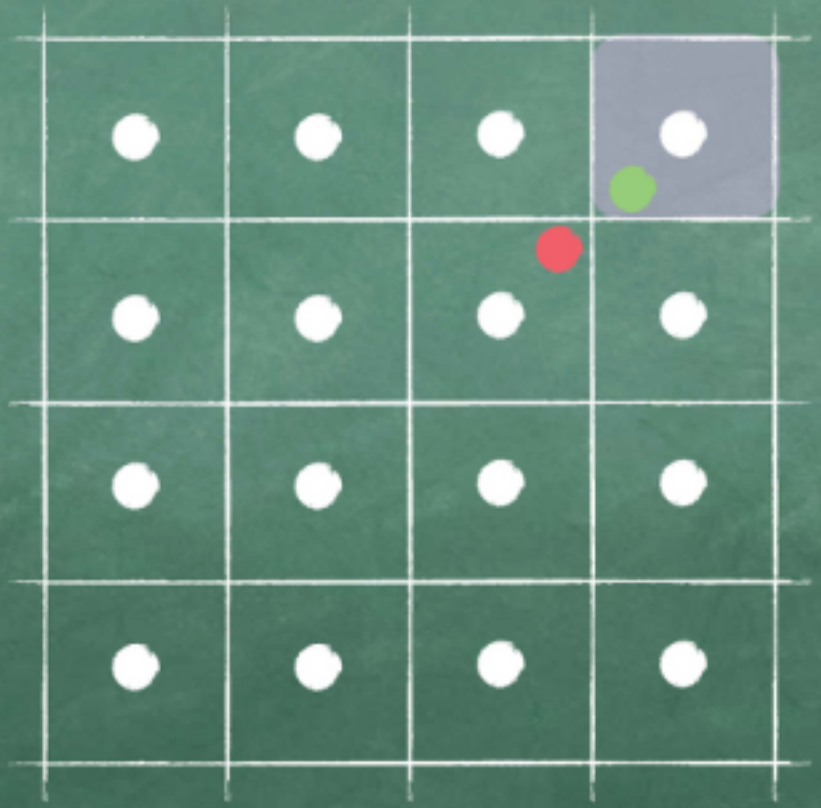


3. Strong RX Signa

16QAM Constellation

"Fast, but requires high SNR"

Up to 195Mbps per 80 MHz Channel



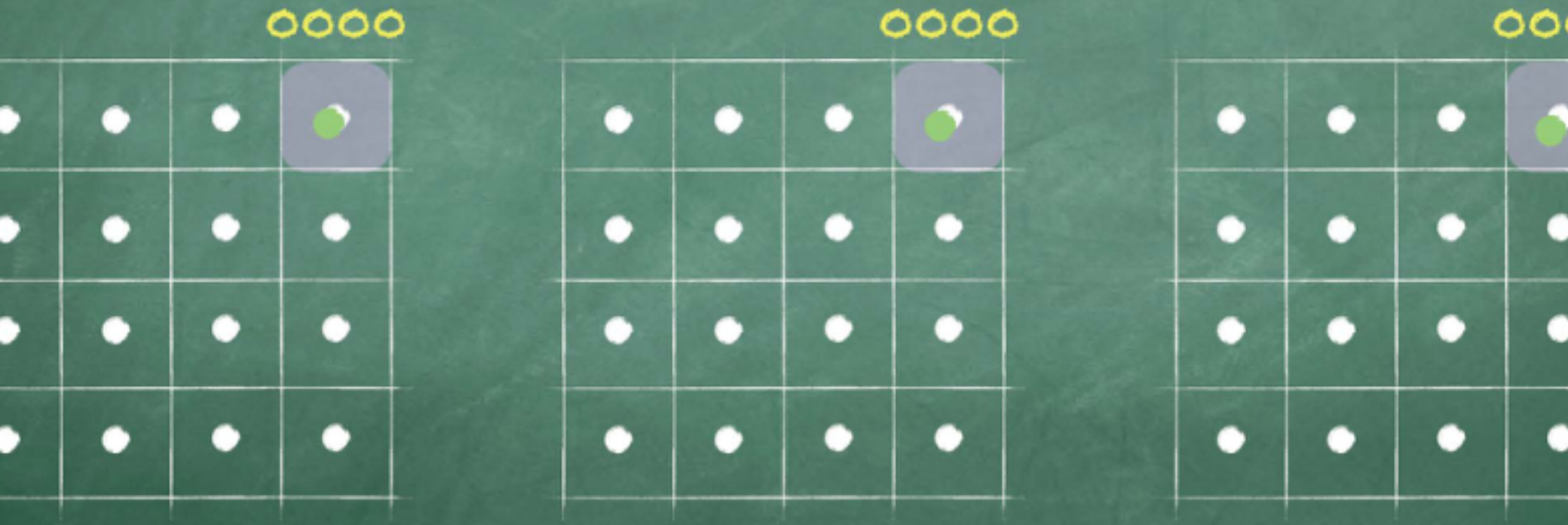
Margin for error

Successfully Transmitted Symbol

Symbol in Error

16QAM Operation

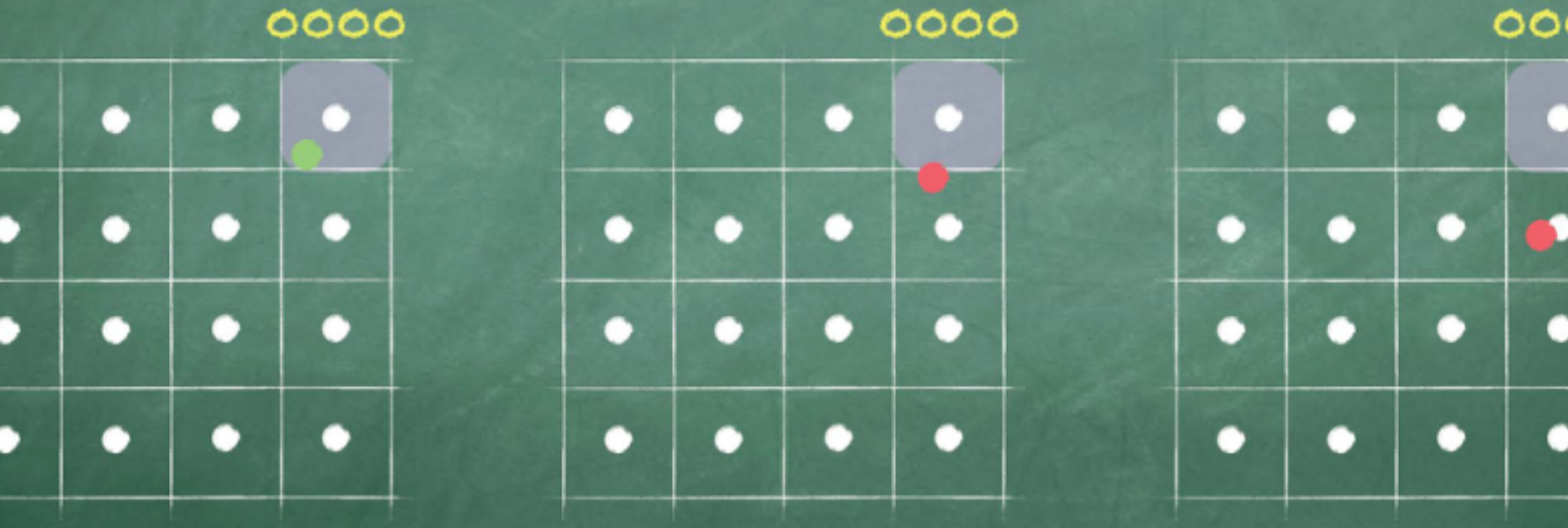
"Proper mapping of symbol set from end-to-end"



1. Excellent TX EVM
2. Low Noise Environment
3. Strong RX Signa

16QAM Error

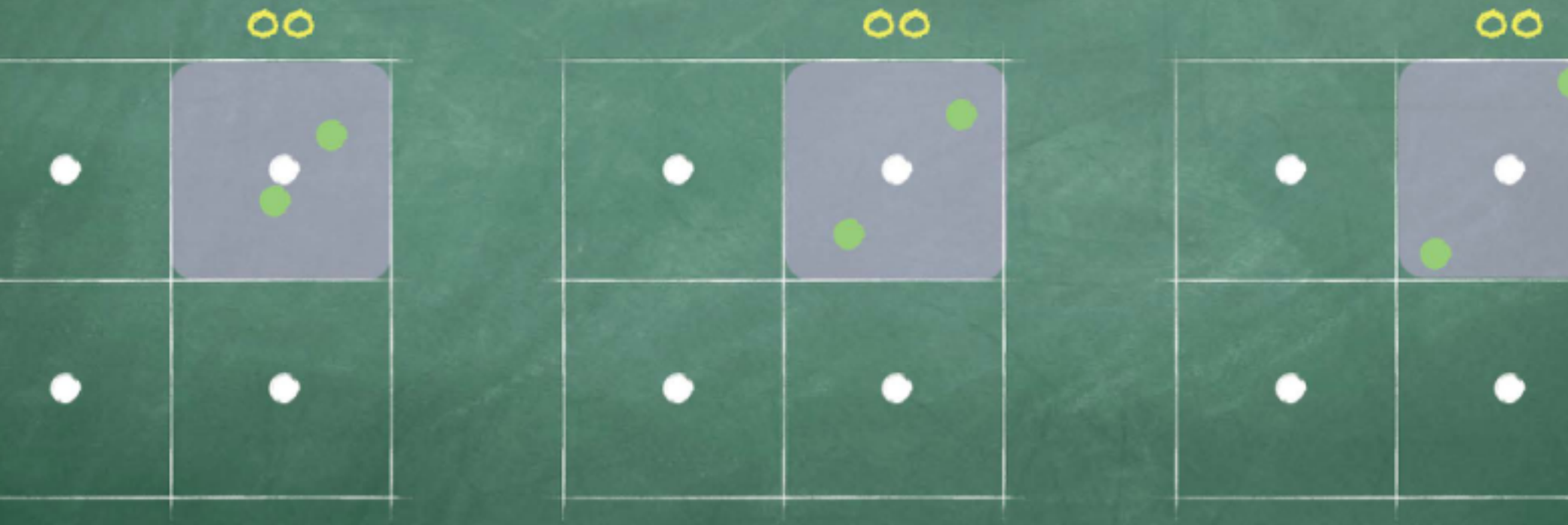
"Failed mapping of symbol set at RX radio"



1. Poor TX EVM
2. High Noise Environment
3. Low RX Signal

Retransmit with QPSK

"Successful mapping of symbol set at RX radio"

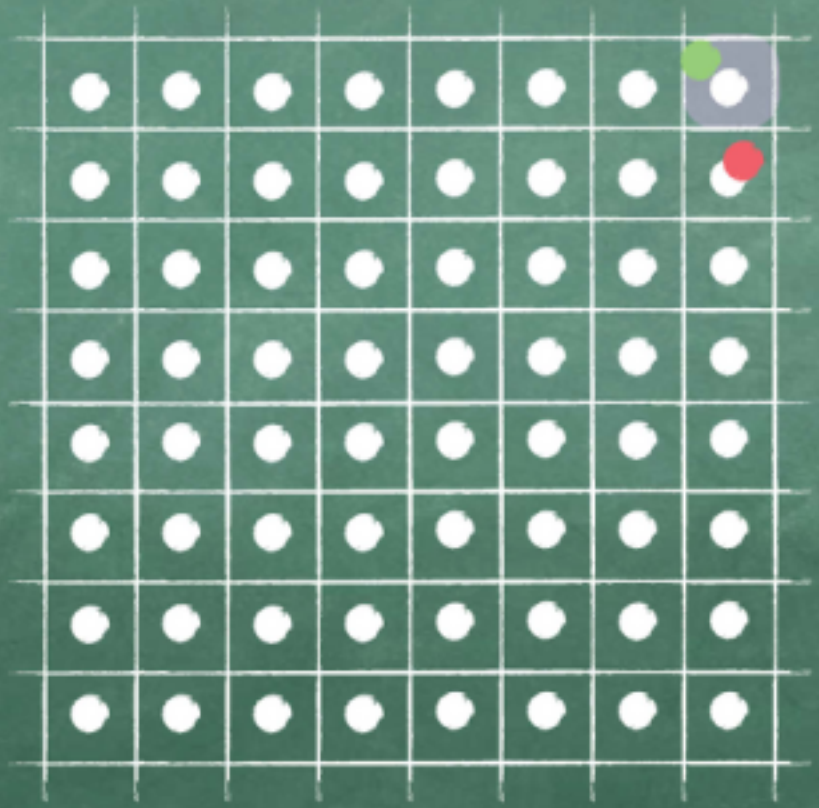


1. Poor TX EVM
2. High Noise Environment
3. Low RX Signal

64QAM Constellation

"Faster, but requires higher SNR"

Up to 325Mbps per 80 MHz Channel



Margin for error

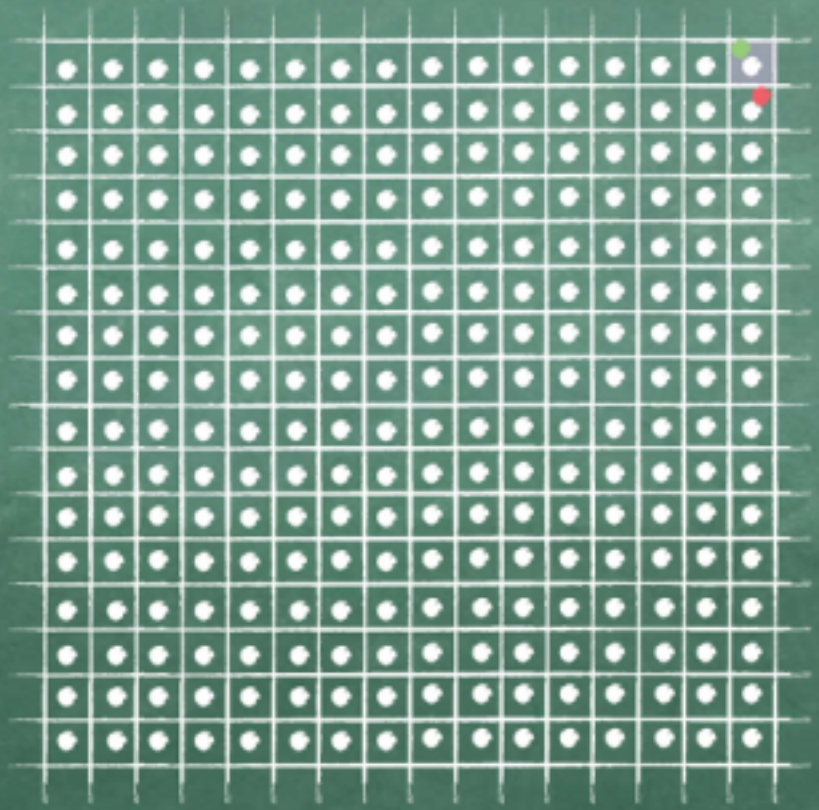
Successfully Transmitted Symbol

Symbol in Error

256QAM Constellation

"Fastest, but requires highest SNR"

Up to 433.3Mbps per 80 MHz Channel



Margin for error

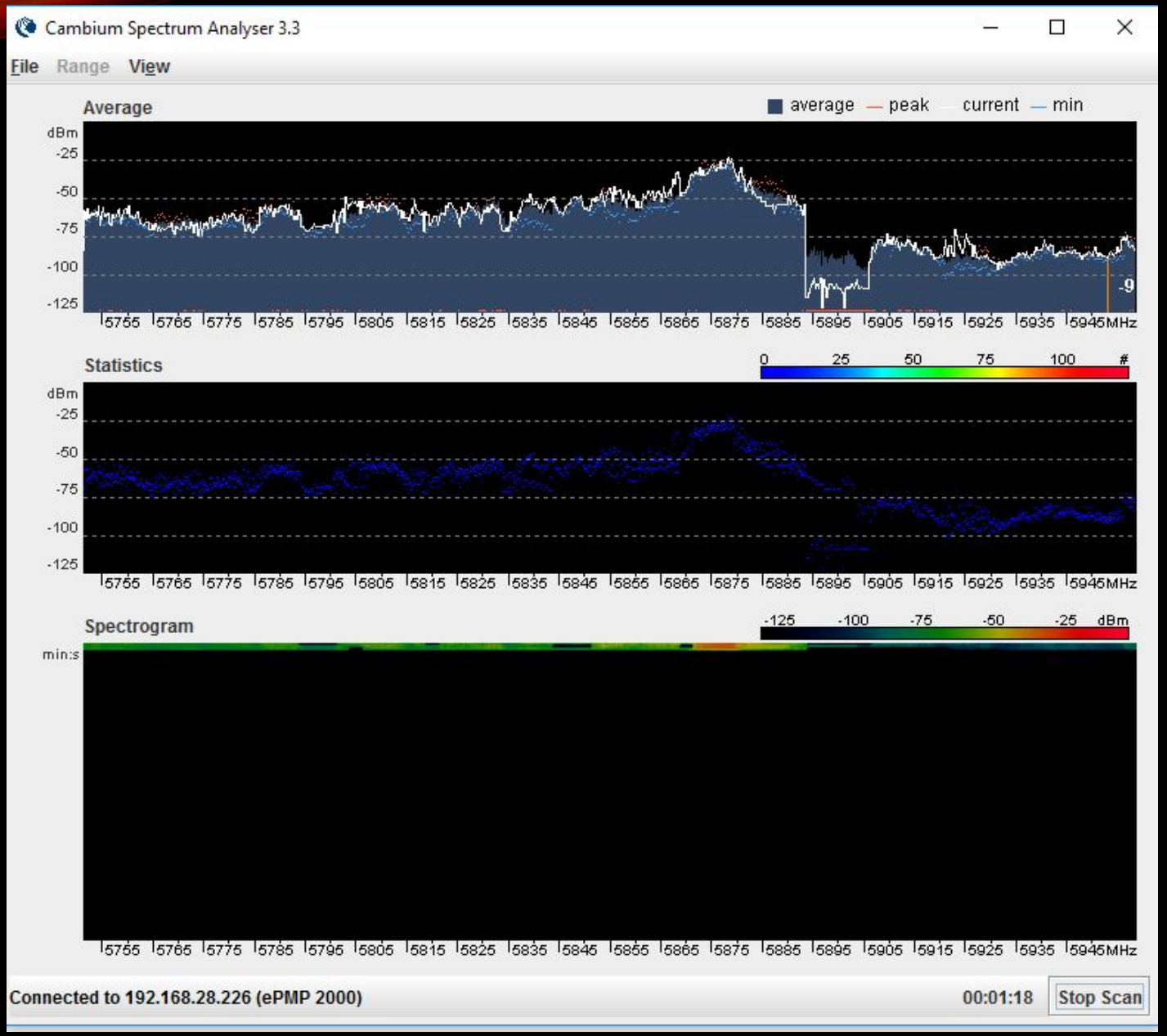
Successfully Transmitted Symbol

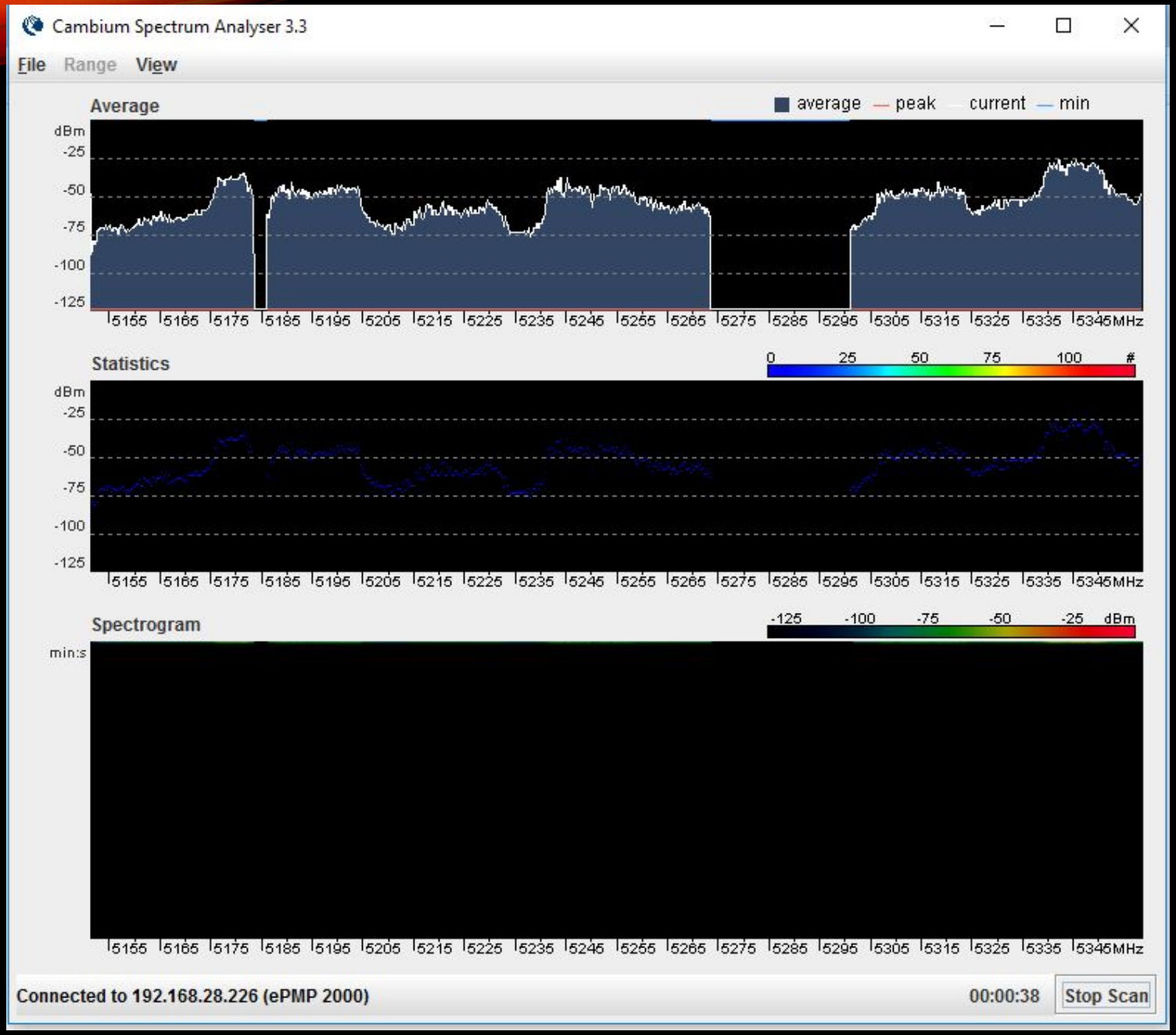
Symbol in Error

Thanks Mr. Jamie Higley for Slides

I just want to share with you how environment can crazily be **saturated**

IN LAGOS/NIGERIA


Cambium Spectrum Analyser 3.3
File
Range
View
Average
average
peak
current
min
dBm
-25
-50
-75
-100
-125
-9
5755 5765 5775 5785 5795 5805 5815 5825 5835 5845 5855 5865 5875 5885 5895 5905 5915 5925 5935 5945MHz
Statistics
0 25 50 75 100 #
dBm
-25
-50
-75
-100
-125
5755 5765 5775 5785 5795 5805 5815 5825 5835 5845 5855 5865 5875 5885 5895 5905 5915 5925 5935 5945MHz
Spectrogram
-125 -100 -75 -50 -25 dBm
min:s
5755 5765 5775 5785 5795 5805 5815 5825 5835 5845 5855 5865 5875 5885 5895 5905 5915 5925 5935 5945MHz
Connected to 192.168.28.226 (ePMP 2000)
00:01:18
Stop Scan


Cambium Spectrum Analyser 3.3
File
Range
View
Average
average
peak
current
min
dBm
-25
-50
-75
-100
-125
5155 5165 5175 5185 5195 5205 5215 5225 5235 5245 5255 5265 5275 5285 5295 5305 5315 5325 5335 5345MHz
Statistics
0 25 50 75 100 #
dBm
-25
-50
-75
-100
-125
5155 5165 5175 5185 5195 5205 5215 5225 5235 5245 5255 5265 5275 5285 5295 5305 5315 5325 5335 5345MHz
Spectrogram
-125 -100 -75 -50 -25 dBm
min:s
5155 5165 5175 5185 5195 5205 5215 5225 5235 5245 5255 5265 5275 5285 5295 5305 5315 5325 5335 5345MHz
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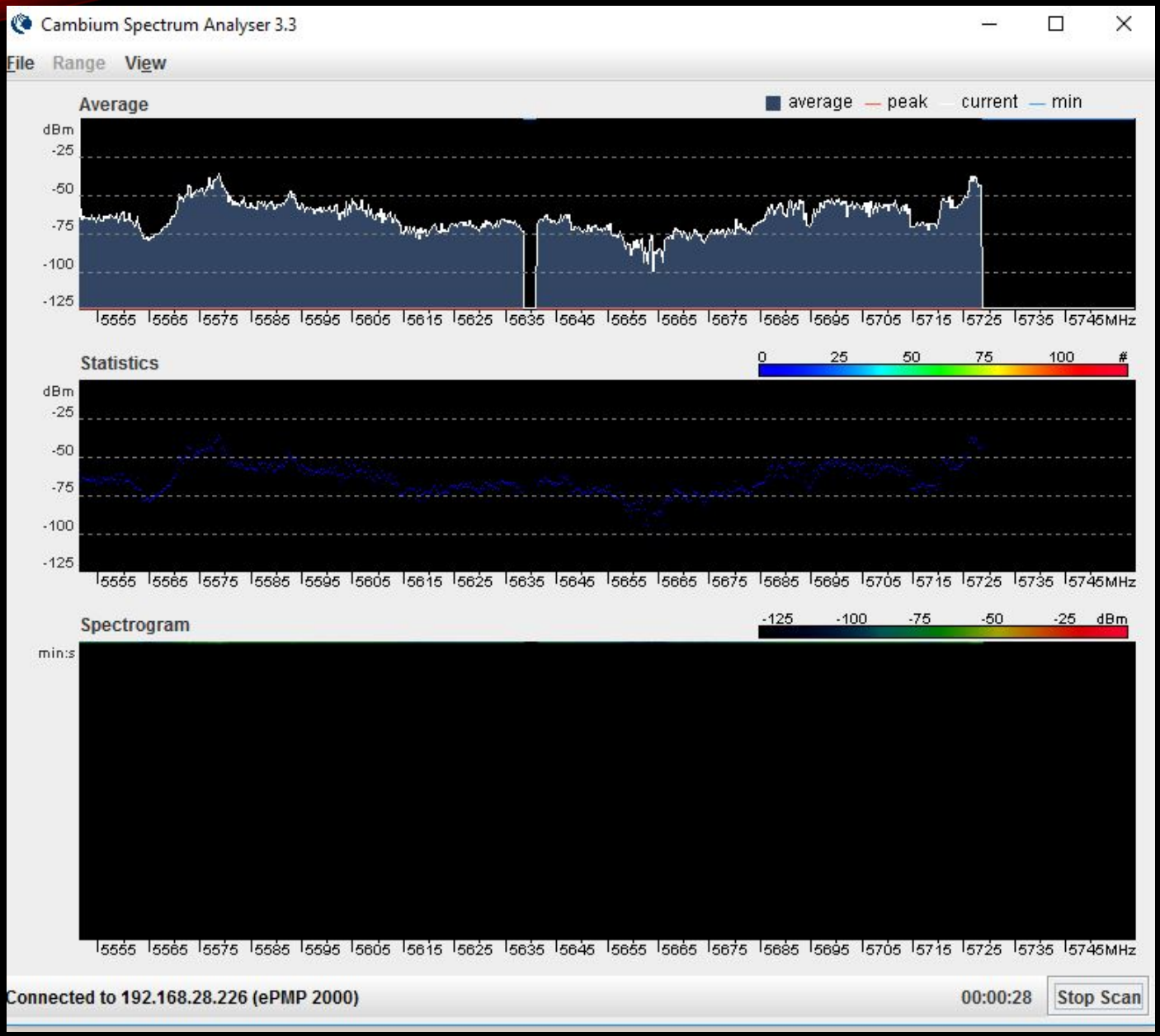
Cambium Spectrum Analyser 3.3
File
Range
View
Average
average
peak
current
min
dBm
-25
-50
-75
-100
-125
5555 5565 5575 5585 5595 5605 5615 5625 5635 5645 5655 5665 5675 5685 5695 5705 5715 5725 5735 5745MHz
Statistics
0 25 50 75 100 #
dBm
-25
-50
-75
-100
-125
5555 5565 5575 5585 5595 5605 5615 5625 5635 5645 5655 5665 5675 5685 5695 5705 5715 5725 5735 5745MHz
Spectrogram
-125 -100 -75 -50 -25 dBm
min:s
5555 5565 5575 5585 5595 5605 5615 5625 5635 5645 5655 5665 5675 5685 5695 5705 5715 5725 5735 5745MHz
Connected to 192.168.28.226 (ePMP 2000)
00:00:28
Stop Scan

ANY
questions?

CONTACT DETAILS

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raissdana.mani@gmail.com

www.mits-co.com

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Mani Raissdana

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GOOD LUCK
&
ENJOY MUM