DELTALINK ELECTRONICS.

- Why our link performance is not Good ?
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CHAPTER 1:

Understanding the Performance

Throughput:

Carrier efficiency x channel width x bit/symbols x FEC = Throughput

802.11g/a ➔ 0.6   x   20 MHz   x 1(BPSK)   x 1/2 =   6 Mbps
802.11g/a ➔ 0.6   x   20 MHz   x   1(BPSK) x ¾ =   9 Mbps
802.11g/a ➔ 0.6   x   20 MHz   x 6(64QAM) x ¾   =   54 Mbps
802.11(Turbo) ➔ 0.6 x 40 MHz x 6(64QAM) x ¾   =   108 Mbps
802.11N ➔   0.75 x   40 MHz   x 6(64QAM) x ¾   =   135 Mbps

802.11N ➔   0.75 x   40 MHz   x 6(64QAM) x 5/6 =   150 Mbps

We Know :

0.75   x   40 MHz   x   6(64QAM)   x   5/6   =   150 Mbps

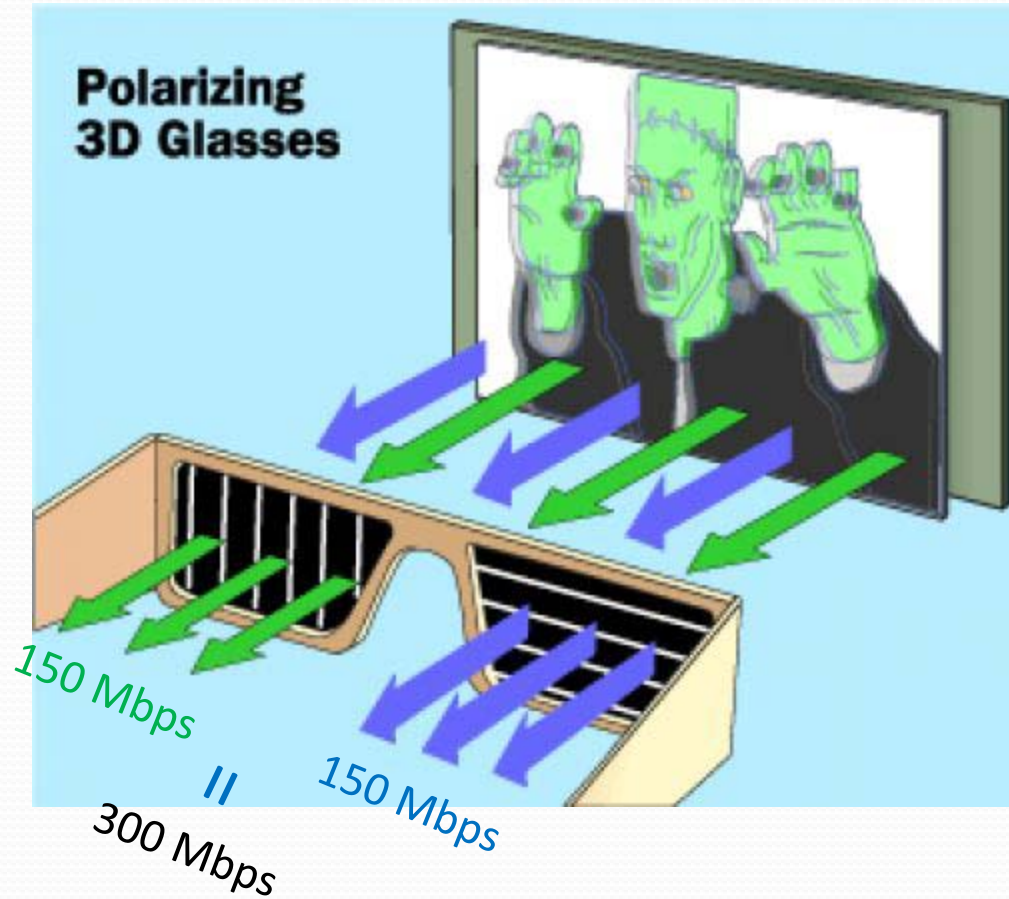Efficiency   Carrier Width   Modulation   FEC   Data rate
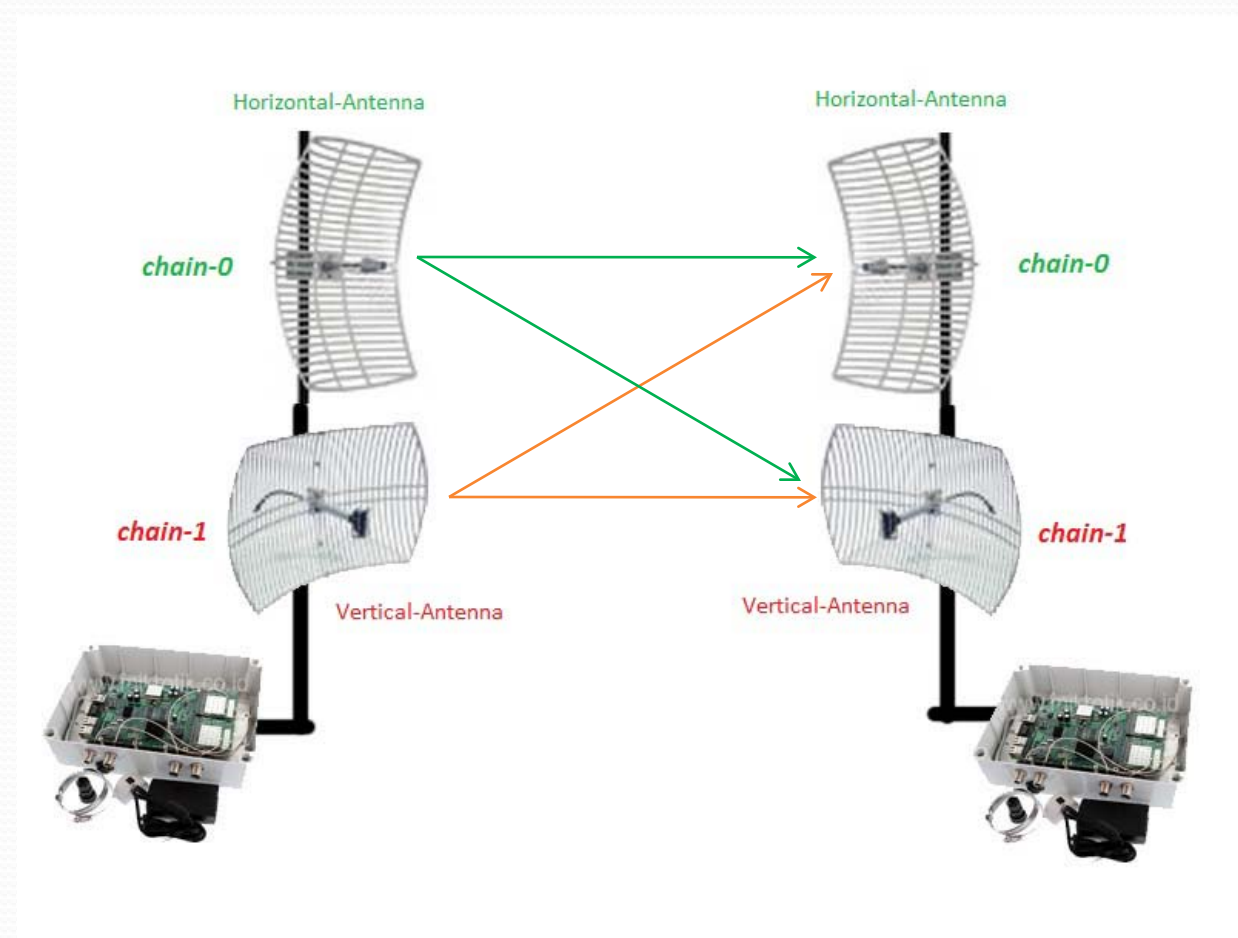
The question is how we can make it double to reach 300 Mbps?

- 3D Movies is the KEY !!???

- By using two antennas in different polarity or by using one dual polarity antenna in one side our MIMO radio can double the aggregate speed and we can reach 300 Mbps in Theory

• Is it this much Simple and any one can do it?

Why NOT !!!???

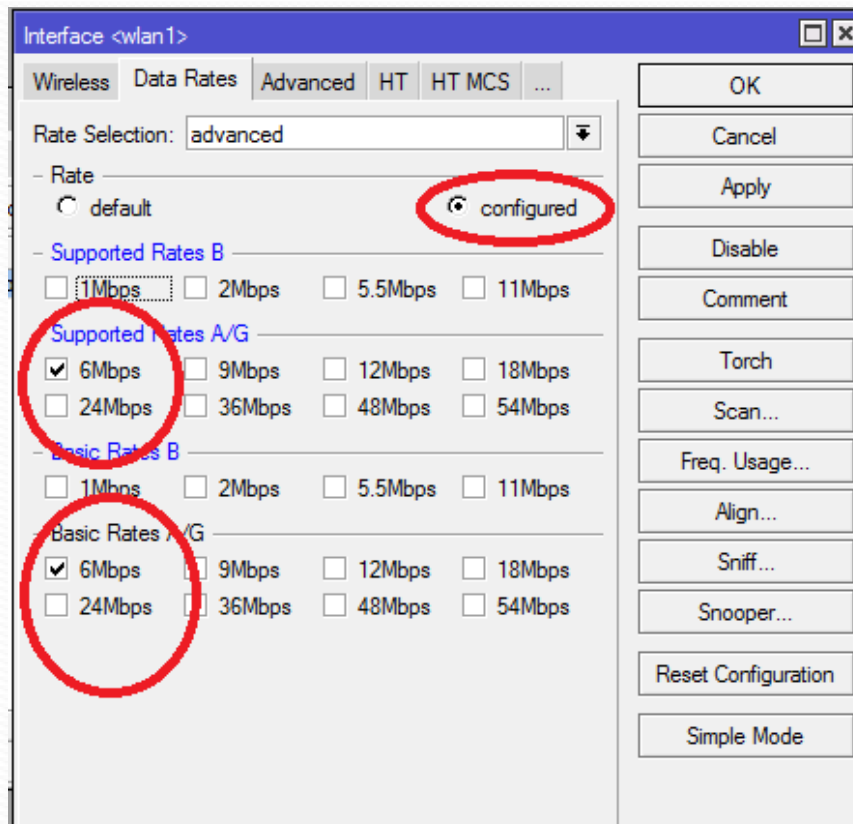That's what we will Talk about in this presentation ……

CHAPTER 2:

Tips for Special Wireless Configurations on your Mikrotik wireless Router

- MIMO Data rates :

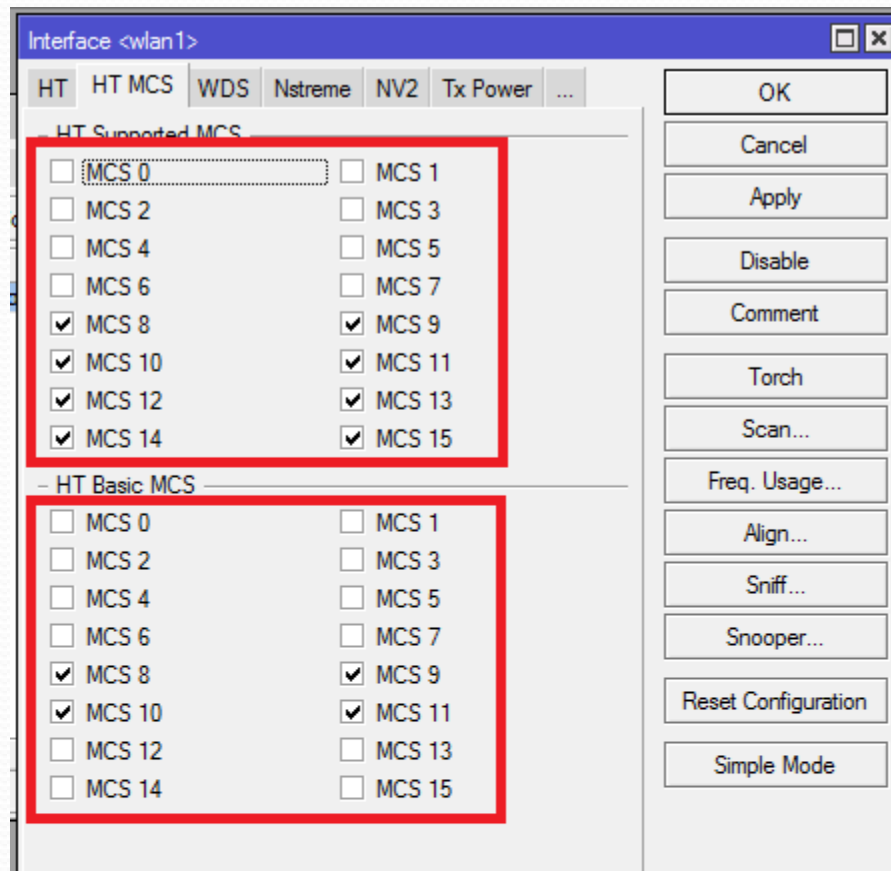| MCS Index	Spatial Streams	Modulation Type	Coding Rate	Data Rate Mbit/s			
				20 MHz channel		40 MHz channel	
				800ns GI	400ns GI	800ns GI	400ns GI
0	1	BPSK	1/2	6.50	7.20	13.50	15.00
1	1	QPSK	1/2	13.00	14.40	27.00	30.00
2	1	QPSK	3/4	19.50	21.70	40.50	45.00
3	1	16-QAM	1/2	26.00	28.90	54.00	60.00
4	1	16-QAM	3/4	39.00	43.30	81.00	90.00
5	1	64-QAM	2/3	52.00	57.80	108.00	120.00
6	1	64-QAM	3/4	58.50	65.00	121.50	135.00
7	1	64-QAM	5/6	65.00	72.20	135.00	150.00
8	2	BPSK	1/2	13.00	14.40	27.00	30.00
9	2	QPSK	1/2	26.00	28.90	54.00	60.00
10	2	QPSK	3/4	39.00	43.30	81.00	90.00
11	2	16-QAM	1/2	52.00	57.80	108.00	120.00
12	2	16-QAM	3/4	78.00	86.70	162.00	180.00
13	2	64-QAM	2/3	104.00	115.60	216.00	240.00
14	2	64-QAM	3/4	117.00	130.00	243.00	270.00
15	2	64-QAM	5/6	130.00	144.40	270.00	300.00

Wireless Interface Important settings

● After Basic Configurations and after established your link you should force your router to use dual Stream MCS to double our throughput if you are using dual polarity Antenna first change the data rate mode to manual.
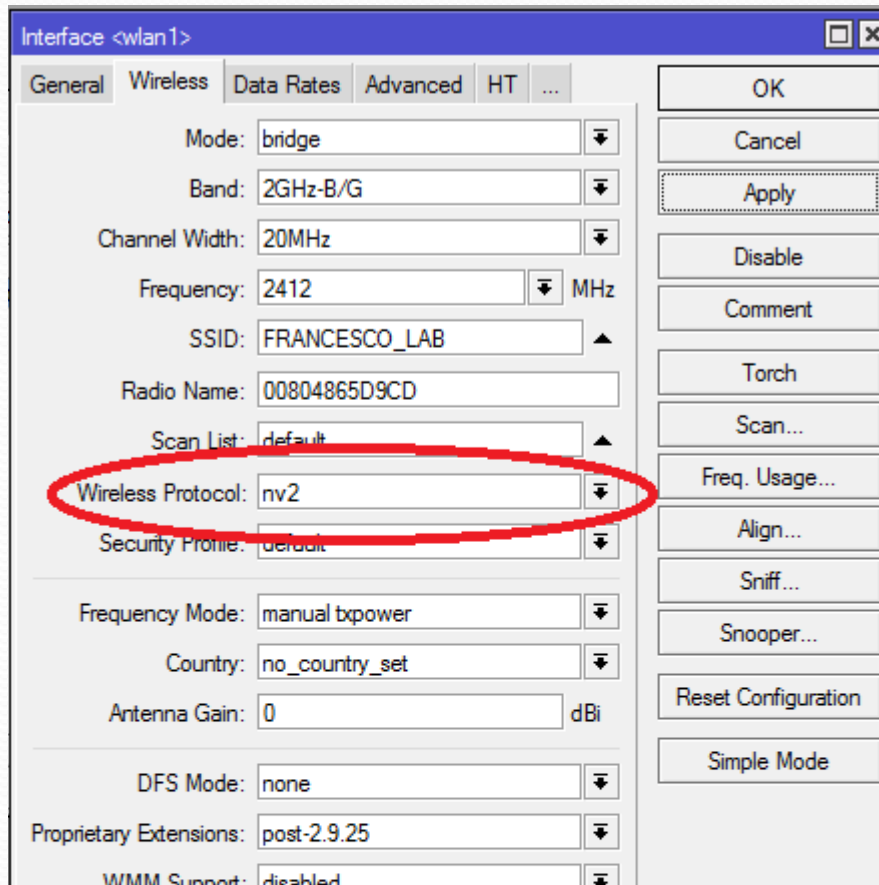
Wireless Interface Important settings

- Then uncheck the MCS 0 – 7 both in the basic and Supported rates and check the MCS 8 to 15 only in basic and Supported rates.

Wireless Interface Important settings

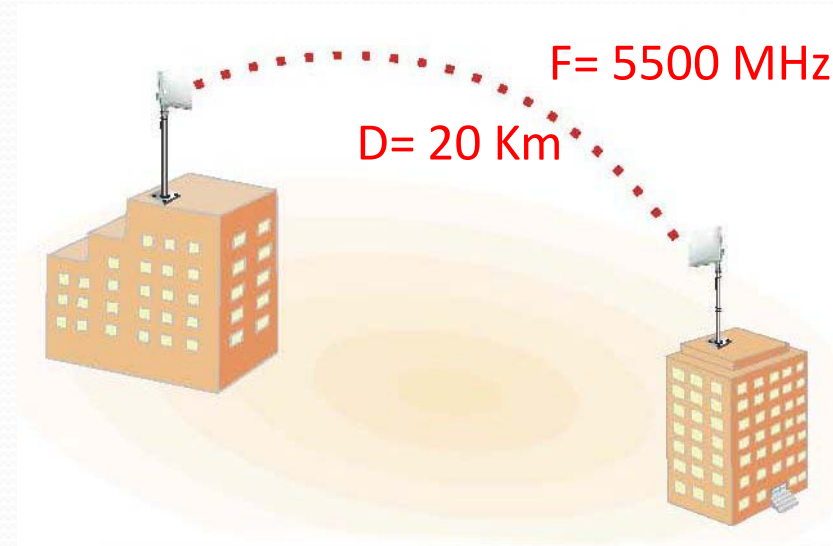- Do not forget to use NV2 as your wireless protocol and set your wireless mode to Station Bridge

CHAPTER 3:

Tips for choosing a right Antenna for your MIMO radio link

1- Calculating The Antenna Gain

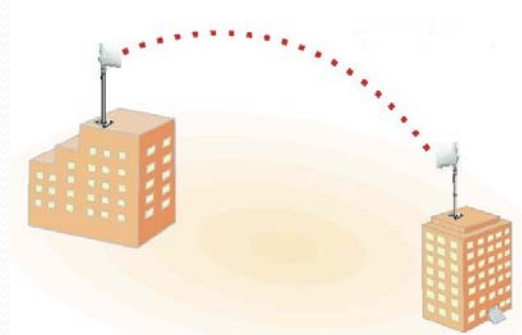- First you have to Calculate the path loss :

F= 5500 MHz

D= 20 Km

Path Loss(LOS) = 20 log (distance in mile) + 20 log (frequency in MHz) + 36.6

Path Loss(20 Km) = 20log(20km/1.61 = Mile) + 20 log (5500) + 36.6

Path Loss(20 Km) = 21.9 + 74.8 + 36.6 ➜ 133.3 dB

- Second based on your desire RX level Calculate the Antenna Gain that you have to use:

Path loss =133.3 dB

RX Signal = TX power – Cable loss + TX Antenna gain – Path loss + RX Antenna gain – Cable Loss

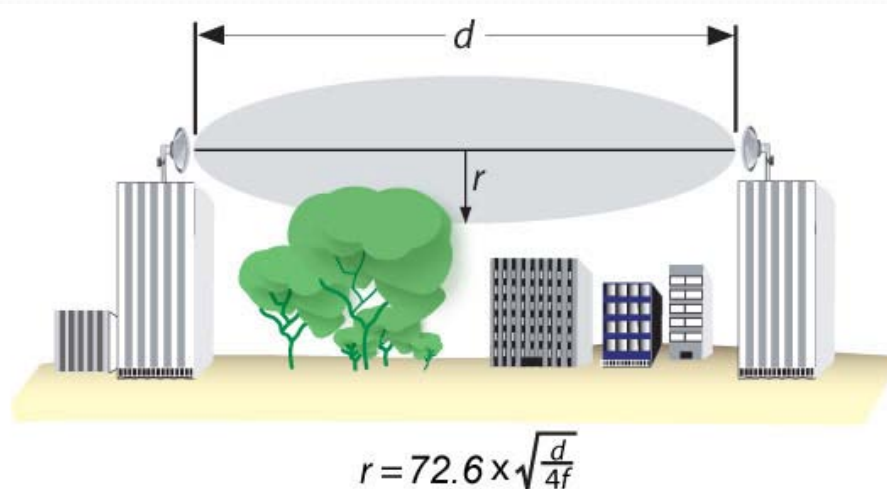Check Your MiniPCI wireless adapter RX level @ MCS7 or MCS 15

Check Your MiniPCI wireless adapter maximum TX power @ MCS7 or MCS 15

-65 = +19 – (Jumper + Pigtail loss) 2 + Antenna gain – 133.3 + Antenna gain – 2

-2(Antenna gain) = 65 +19 – 2 – 133.3 – 2

Antenna gain = 53.3 / 2 ➔ 26.6 dBi (Minimum Antenna that you need to reach -65 RX)

● **Tip1 : Obstacles or Ground in the First Fresnel Zone can Kill your signal before saying bad words to me please check your link for line of sight**

$$r = 72.6 \times \sqrt{\frac{d}{4f}}$$

● **Tip2 : The Antenna Gain is not a Fix Parameter and it depends on the frequency and it could be weaker or stronger in your desire frequency**

● **Tip3 : The output power of your Wireless Adapter Could be variable in different frequencies and data rates if this is your job and you want to be a professional buy a Power meter**

2- VSWR and Return loss

● If you measure the returned signal (because of the Impedance Mismatching) from your antenna then you can calculate your antenna return loss
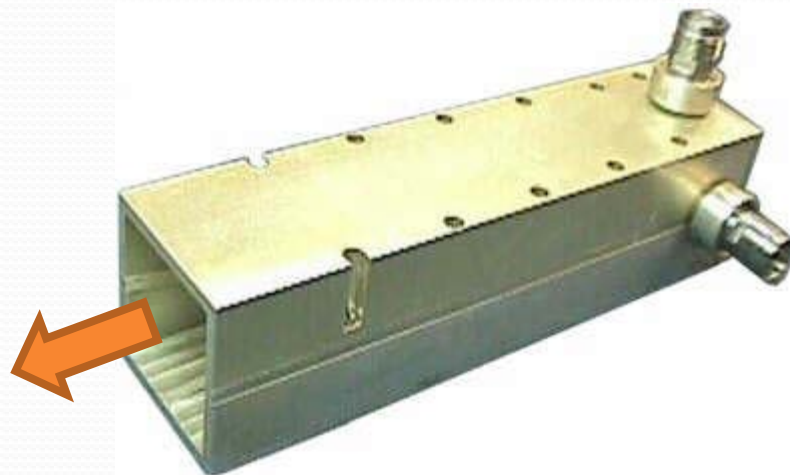
Transmitted Signal – Returned Signal = Antenna Return Loss
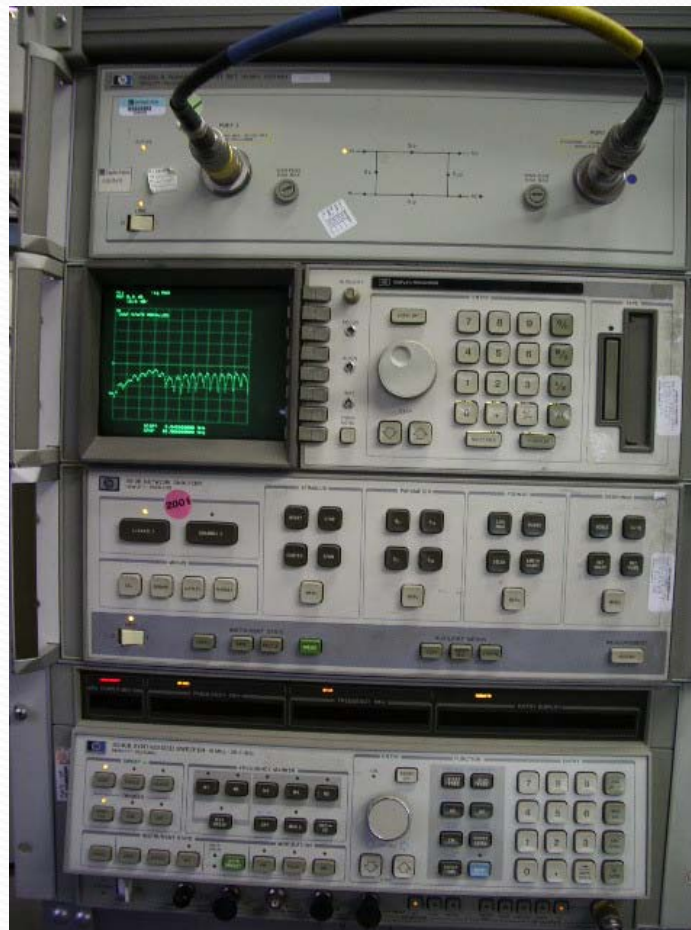
16 dBm – 6 dBm = Antenna Return Loss

16 dBm   6dBm

16 dBm + 12dBi = 28 dB
EIRP

• Most of Wireless Radios can handle the Return loss up to -9.5 or better(The Best Measurable Return loss is -100 and you can measure it by a RF Network Analyzer)

- **You can Convert the VSWR to Return Loss by using this Formula:**

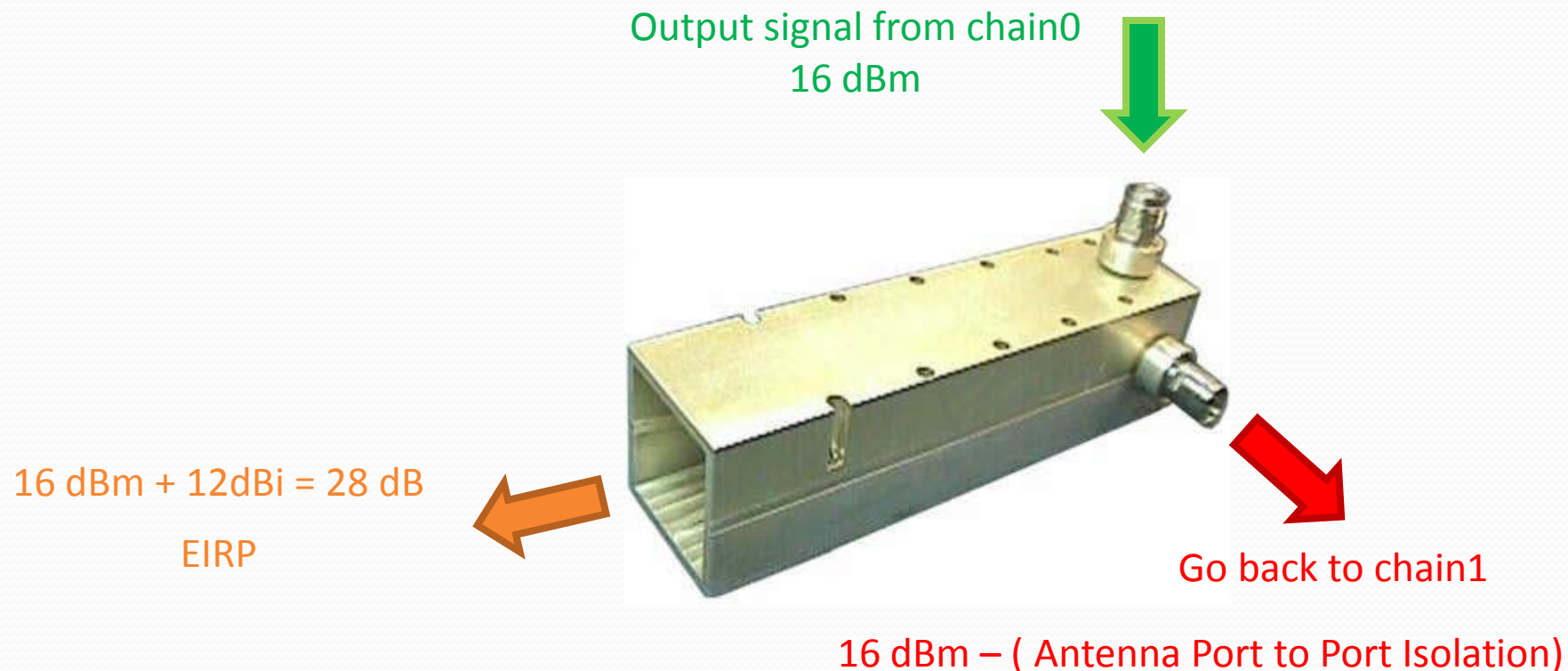$$\text{Return Loss} = 20 \log((\text{VSWR}+1) / (\text{VSWR}-1))$$
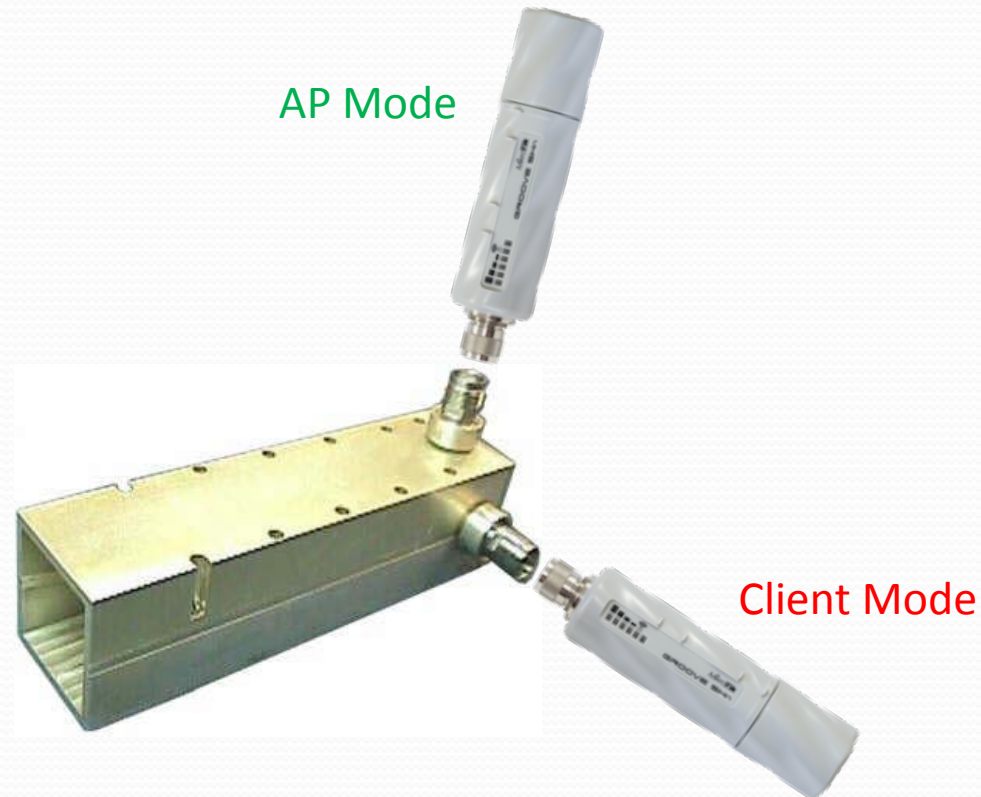
VSWR 2:1 → RL: -9.54

VSWR 1.01:1 → RL: -46

- **Tip4 : Just like the Gain the VSWR or Return Loss is not a Fix Parameter and it depends on the frequency so become sure the antenna that you want to use is has a VSWR better than 2:1 on the frequency that you want to use it.**

- **Tip5 : If you Established a link and after 1 week the RX signal is fall down for 10 or 20 dB it means your system VSWR is more than 2:1**

3- Port to Port Isolation:

• The signal generated by one chain can travels to the other chain and it could effect on performance and even cause damage.

Output signal from chain0
16 dBm

16 dBm + 12dBi = 28 dB

EIRP

Go back to chain1

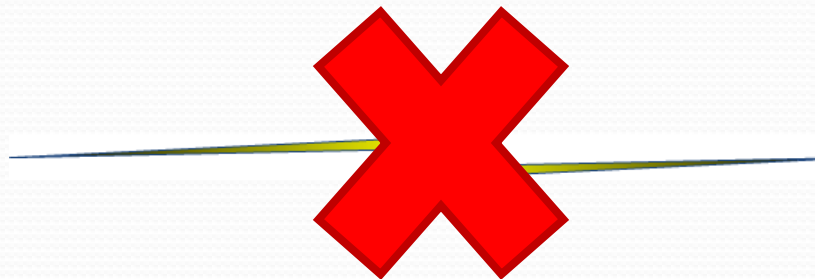16 dBm – (Antenna Port to Port Isolation)

- Most of Wireless manufacture offer to use the antennas with a port to port Isolation better than -25

- you can measure your antenna port to port Isolation by link two radio over the ports of your antenna, minimizing the output power and check the receiving signal(it is not very accurate but at least you can understand the meaning of P-to-P Isolation)
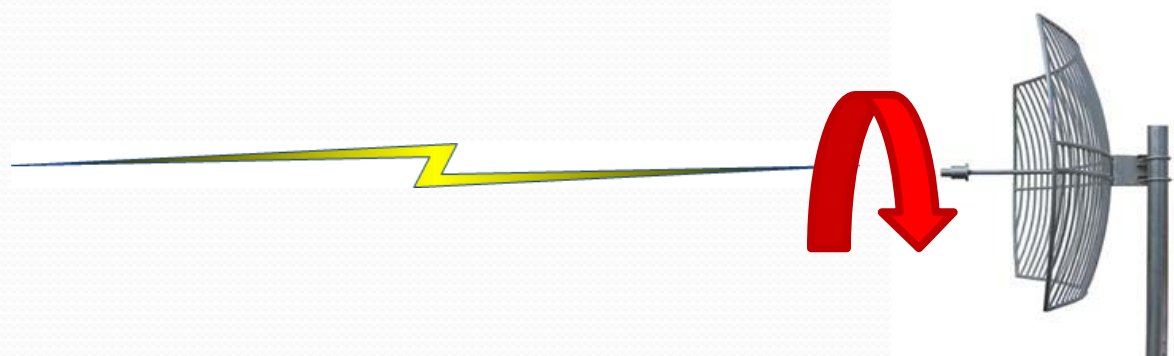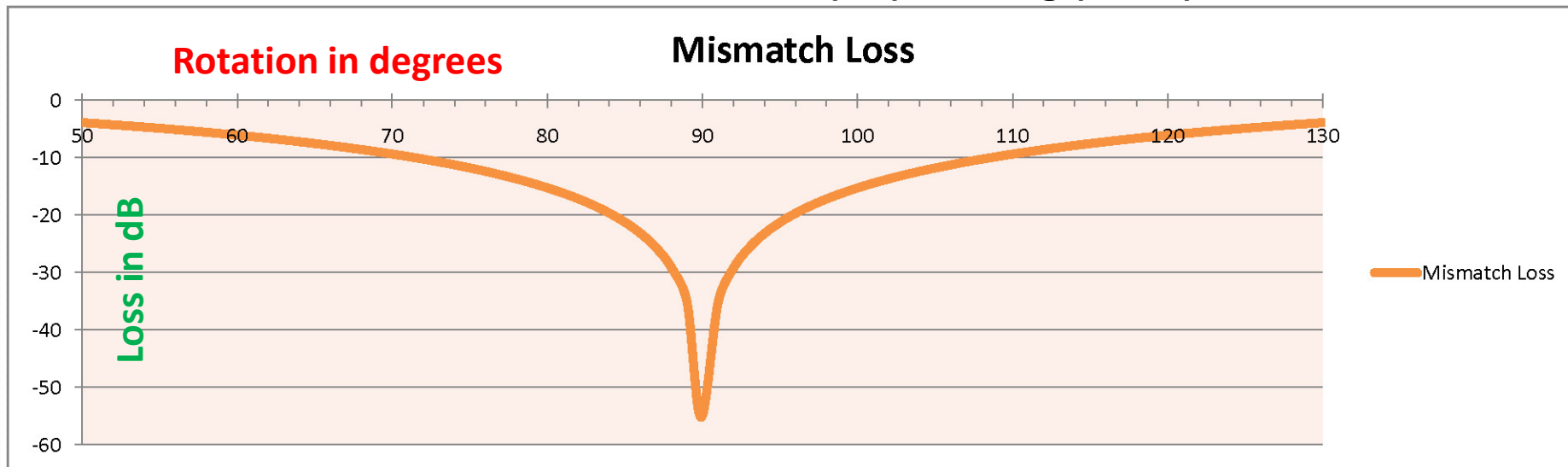
AP Mode

Client Mode

4- Cross Polarization

- When you are Using two antennas with Liner polarization linked together if you rotate one side 90 digress you have to lose your link theoretically :
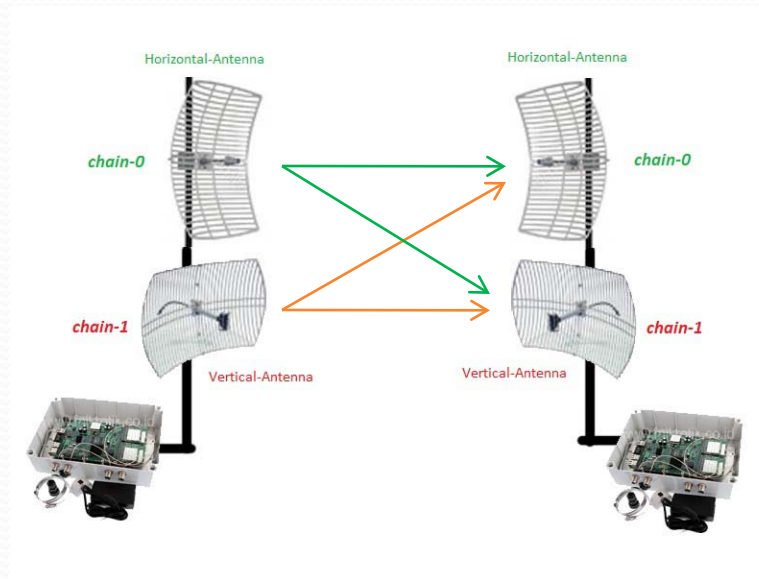
• While we are rotating the far end site antenna we will have the below graf if we monitor loss / rotation degree :
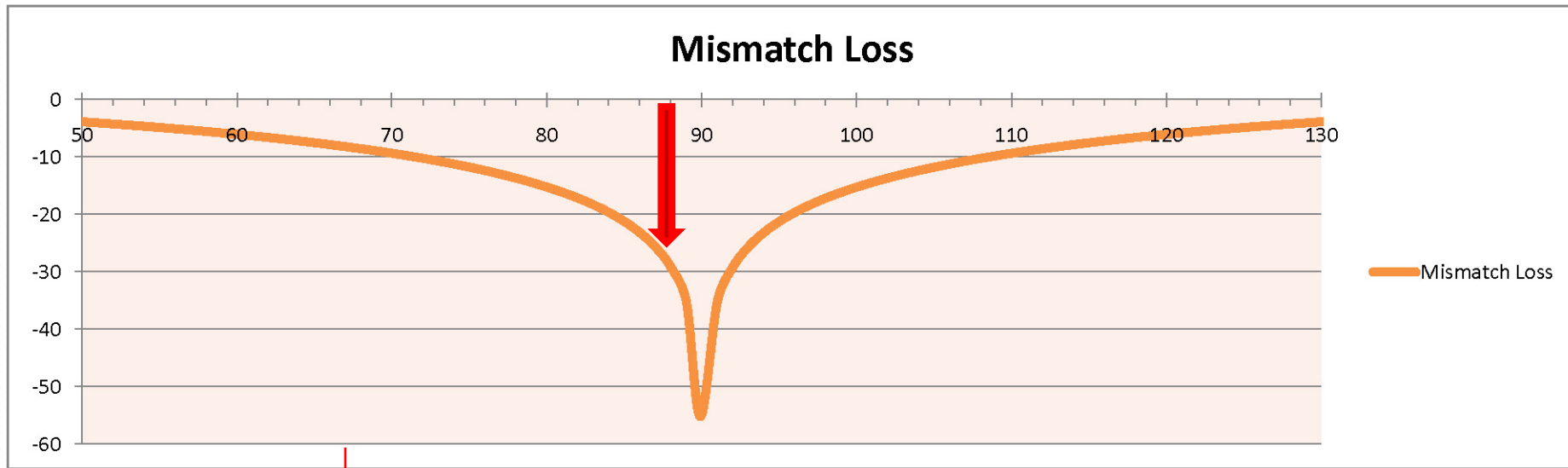
Polarization Mismatch Loss (dB) = 20 log (cos θ)

• Cross polarization is used by MIMO MCS-8 to MCS-15 to double the throughput and the radio can use the carrier twice by using this mismatch loss of the other chain.

• The opposite chains signal is like noise and interfered each other. Better cross polarization gives you more throughputs.

RX chain1(TX chain1) = -45dBm
RX chain1(TX chain0) = -45dBm – 25dBi(RX Antenna Cross Pol.) = -70 dBm

- **Tip6: In a dual polarity outdoor link always become sure that your antenna are well leveled only 1 degree mismatch in each side can drop your Cross pol. for more than 20dB**

Mismatch Loss

- **Tip7: In the real world situation every antenna shows different reactions for different frequencies in cross polarization. For better performance if you have any option to chose the frequency, select the channel that your antenna cross polarization are better on it.**

- **Tip8: In long range links the multipath signals will have small(1-5 Degrees) mismatch caused by reflections. Adjusting the level of your antenna some times will improve your performance but it only suggested to advanced installers and wireless experts.**

CHAPTER 4:

Tips for choosing a right Pigtail and Jumper for your Link

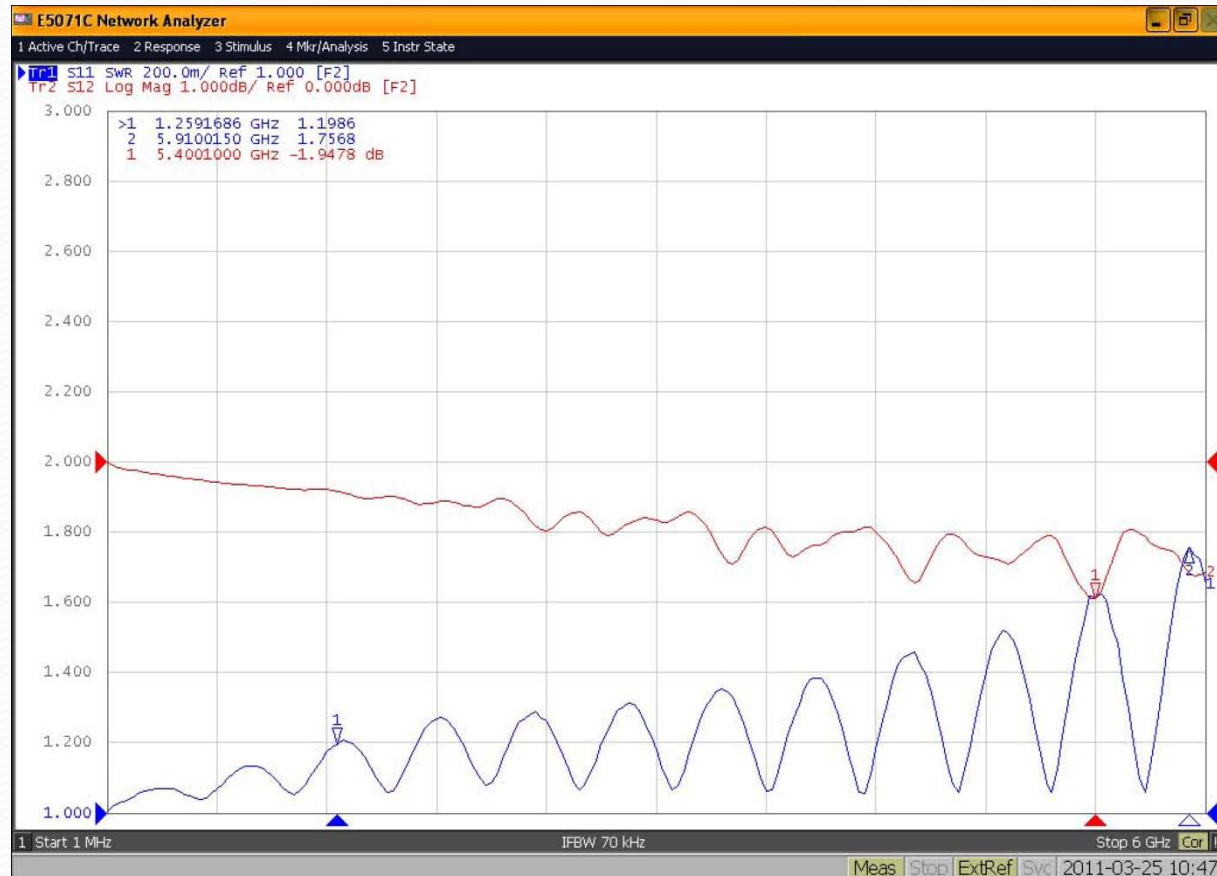# Pigtails an Jumpers

- We are using the pigtails and jumpers to connect our radio to the antenna and we only care about the loss

• Please remember the Jumpers and Pigtails is a important part of your radio system and just like the antennas they have there own Return Loss(or VSWR).

• Cable loss and VSWR are depends to the frequency and most of the RF cables cannot gives you a good VSWR in High frequencies(5 GHz specially)

Cable:1.13
Loss(red)
VSWR(blue)

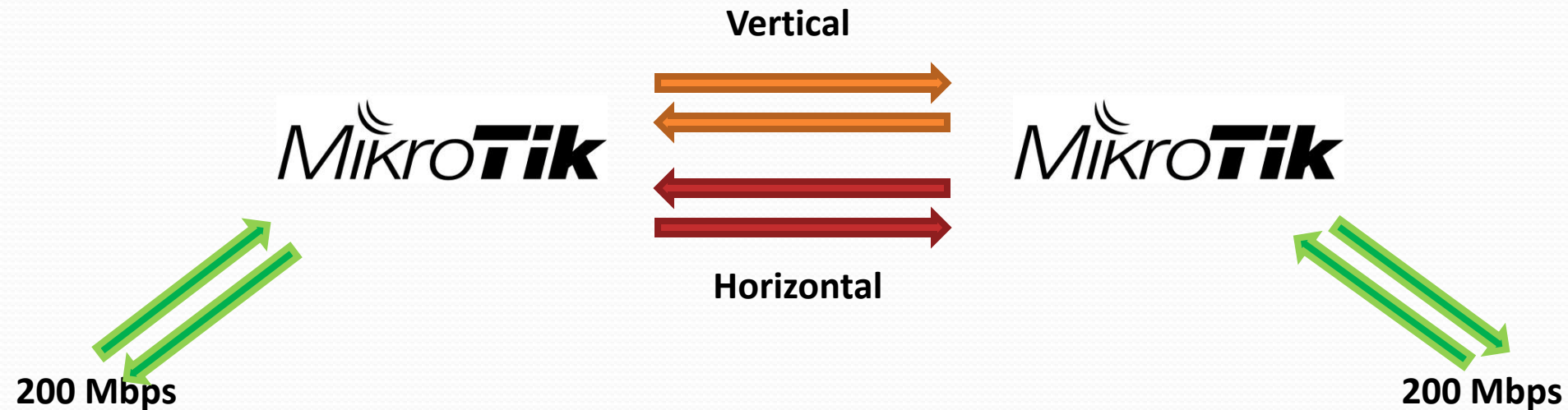- Here is a compare between 1.13 cable and RG-178

Cable:1.13   Cable:RG-178

• **Tip9: it is highly recommended to test the jumpers and pigtail cables that you will commonly use for VSWR even once.**

• **Tip10: Using Thick jumpers dose not improve your link performance or even make it worse because of the flexibility issues you have to use longer cable and have more loss.**

• **Tip11: It is necessary to seal and water proof your outdoor connector, the water or dust can increase the System VSWR and you will lose you link after maximum One year**

Now It's a good time to go and use this Tips to improve your performance and enjoy the real meaning of MIMO.

Vertical

MikroTik

MikroTik

Horizontal

200 Mbps

200 Mbps

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