

# DELTALINK ELECTRONICS.

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

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## Understanding the Performance

# Throughput:

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

$$802.11g/a \rightarrow 0.6 \times 20 \text{ MHz} \times 1(\text{BPSK}) \times \frac{1}{2} = 6 \text{ Mbps}$$

$$802.11g/a \rightarrow 0.6 \times 20 \text{ MHz} \times 1(\text{BPSK}) \times \frac{3}{4} = 9 \text{ Mbps}$$

$$802.11g/a \rightarrow 0.6 \times 20 \text{ MHz} \times 6(64\text{QAM}) \times \frac{3}{4} = 54 \text{ Mbps}$$

$$802.11(\text{Turbo}) \rightarrow 0.6 \times 40 \text{ MHz} \times 6(64\text{QAM}) \times \frac{3}{4} = 108 \text{ Mbps}$$

$$802.11N \rightarrow 0.75 \times 40 \text{ MHz} \times 6(64\text{QAM}) \times \frac{3}{4} = 135 \text{ Mbps}$$

$$802.11N \rightarrow 0.75 \times 40 \text{ MHz} \times 6(64\text{QAM}) \times \frac{5}{6} = 150 \text{ Mbps}$$

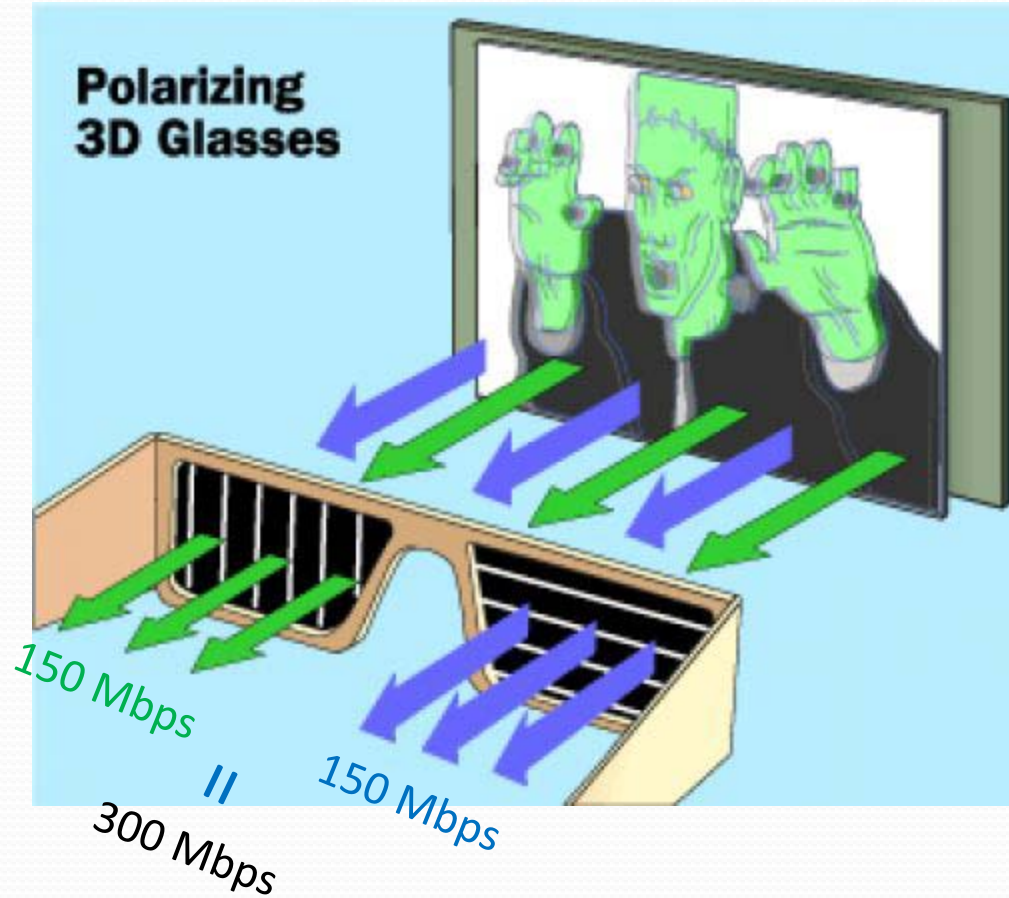
# We Know :

$$0.75 \times 40 \text{ MHz} \times 6(64\text{QAM}) \times 5/6 = 150 \text{ Mbps}$$

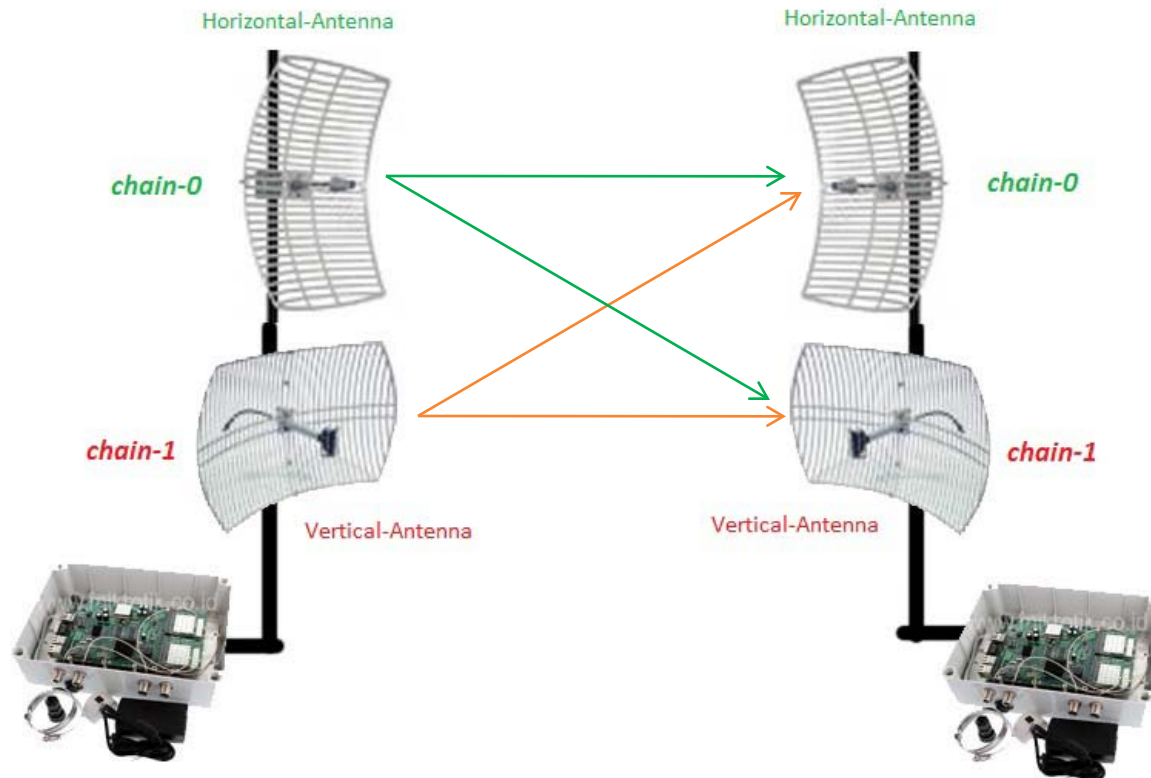
Efficiency      Carrier Width      Modulation      FEC      Data rate

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?

The word 'NO' is rendered in large, bold, 3D red letters. The letters are thick and have a slight shadow on the white surface below them, giving them a three-dimensional appearance. The 'N' and 'O' are connected at the top.

Why **NOT** !!!????

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



# CHAPTER 2:

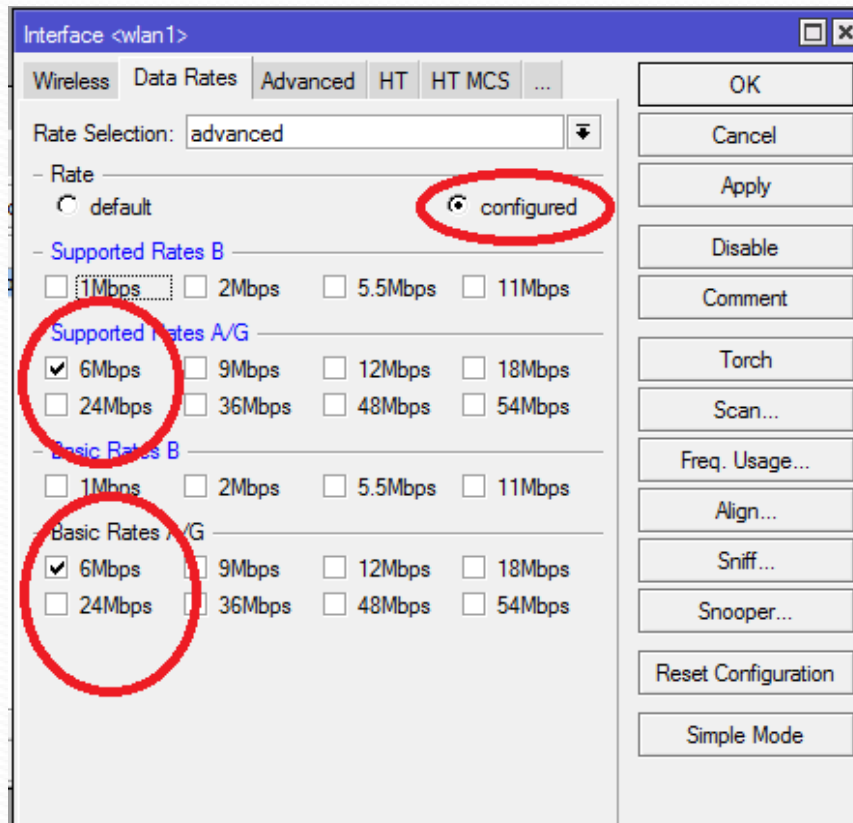
## Tips for Special Wireless Configurations on your Mikrotik wireless Router

- 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	<u>BPSK</u>	1/2	6.50	7.20	13.50	15.00
1	1	<u>QPSK</u>	1/2	13.00	14.40	27.00	30.00
2	1	<u>QPSK</u>	3/4	19.50	21.70	40.50	45.00
3	1	16- <u>QAM</u>	1/2	26.00	28.90	54.00	60.00
4	1	16- <u>QAM</u>	3/4	39.00	43.30	81.00	90.00
5	1	64- <u>QAM</u>	2/3	52.00	57.80	108.00	120.00
6	1	64- <u>QAM</u>	3/4	58.50	65.00	121.50	135.00
7	1	64- <u>QAM</u>	5/6	65.00	72.20	135.00	150.00
8	2	<u>BPSK</u>	1/2	13.00	14.40	27.00	30.00
9	2	<u>QPSK</u>	1/2	26.00	28.90	54.00	60.00
10	2	<u>QPSK</u>	3/4	39.00	43.30	81.00	90.00
11	2	16- <u>QAM</u>	1/2	52.00	57.80	108.00	120.00
12	2	16- <u>QAM</u>	3/4	78.00	86.70	162.00	180.00
13	2	64- <u>QAM</u>	2/3	104.00	115.60	216.00	240.00
14	2	64- <u>QAM</u>	3/4	117.00	130.00	243.00	270.00
15	2	64- <u>QAM</u>	5/6	130.00	144.40	270.00	300.00

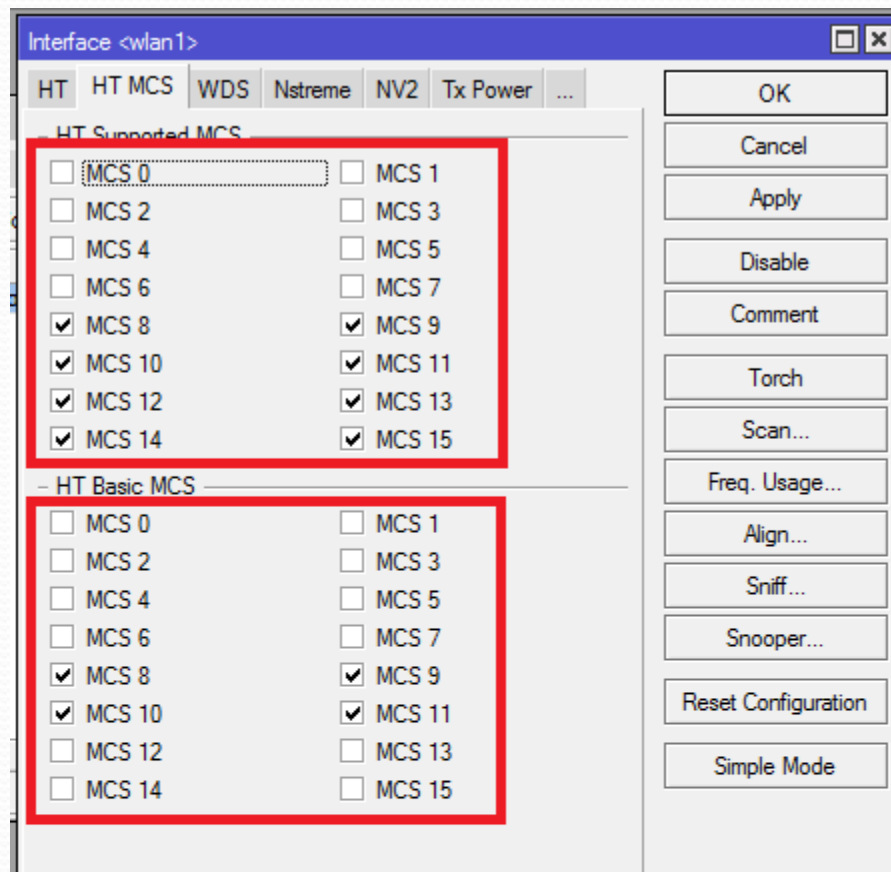
# Wireless Interface Important settings

- 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.



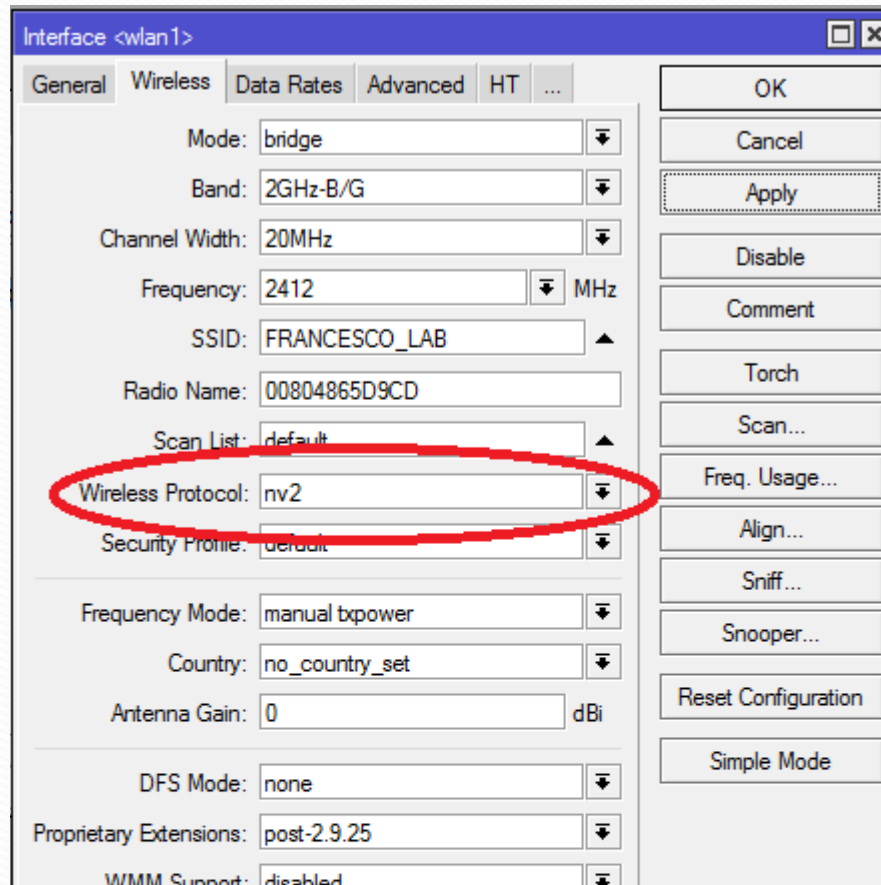
# Wireless Interface Important settings

- 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**



The screenshot shows the configuration window for the wireless interface 'wlan1'. The 'Wireless' tab is selected, and the 'Wireless Protocol' dropdown menu is highlighted with a red circle. The 'Wireless Protocol' is set to 'nv2'. Other settings include Mode: bridge, Band: 2GHz-B/G, Channel Width: 20MHz, Frequency: 2412 MHz, SSID: FRANCESCO\_LAB, Radio Name: 00804865D9CD, Scan List: default, Security Profile: default, Frequency Mode: manual txpower, Country: no\_country\_set, Antenna Gain: 0 dBi, DFS Mode: none, and Proprietary Extensions: post-2.9.25.

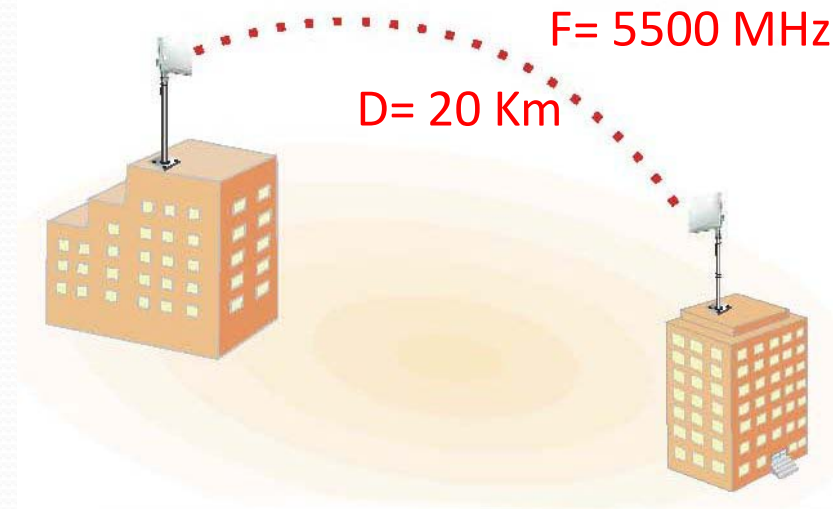
Setting	Value
Mode	bridge
Band	2GHz-B/G
Channel Width	20MHz
Frequency	2412 MHz
SSID	FRANCESCO_LAB
Radio Name	00804865D9CD
Scan List	default
Wireless Protocol	nv2
Security Profile	default
Frequency Mode	manual txpower
Country	no_country_set
Antenna Gain	0 dBi
DFS Mode	none
Proprietary Extensions	post-2.9.25
WMM Support	disabled

# 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 :

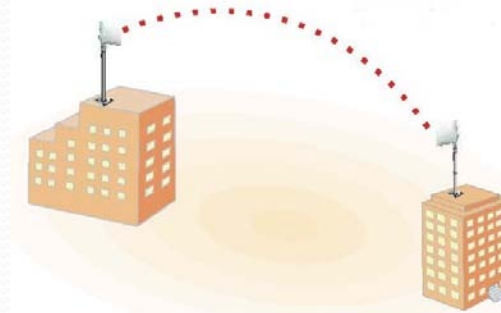


Path Loss(LOS) =  $20 \log (\text{distance in mile}) + 20 \log (\text{ frequency in MHz}) + 36.6$

Path Loss(20 Km) =  $20 \log (20 \text{ km} / 1.61 = \text{Mile}) + 20 \log (5500) + 36.6$

Path Loss(20 Km) =  $21.9 + 74.8 + 36.6 \rightarrow 133.3 \text{ dB}$

- 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

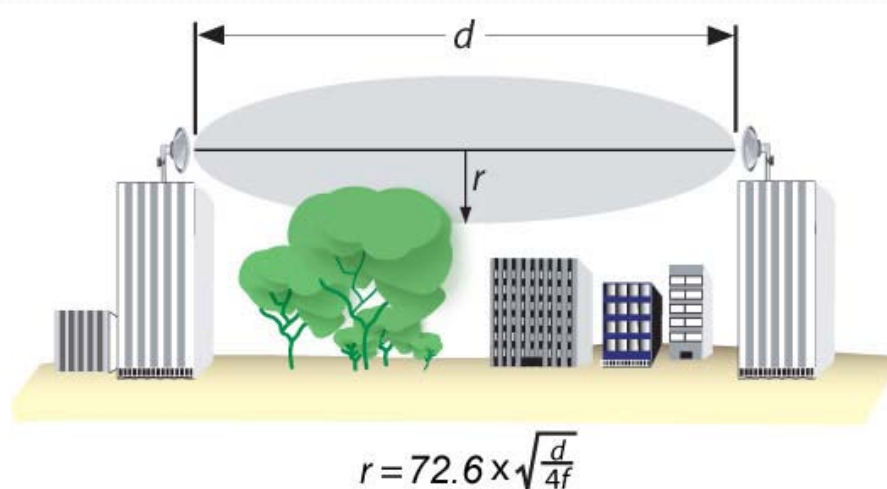
$$-65 = +19 - (\text{Jumper} + \text{Pigtail loss}) 2 + \text{Antenna gain} - 133.3 + \text{Antenna gain} - 2$$

$$-2(\text{Antenna gain}) = 65 + 19 - 2 - 133.3 - 2$$

Antenna gain =  $53.3 / 2 \rightarrow 26.6$  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**



- **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

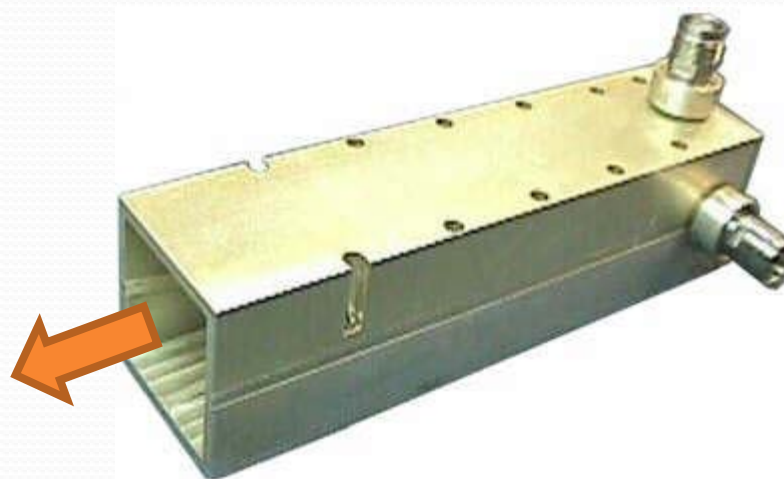
Transmitted Signal – Returned Signal = Antenna Return Loss

$$16 \text{ dBm} - 6 \text{ dBm} = \text{Antenna Return Loss}$$

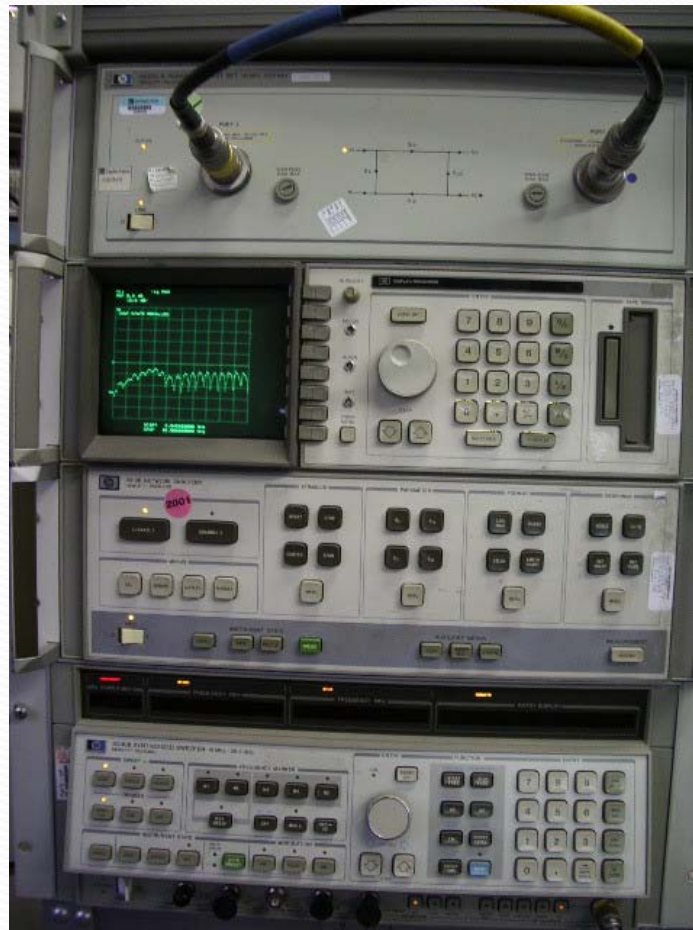
16 dBm 6dBm



$$16 \text{ dBm} + 12 \text{ dBi} = 28 \text{ dB EIRP}$$



- 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:

$$\text{Return Loss} = 20 \log\left(\frac{\text{VSWR}+1}{\text{VSWR}-1}\right)$$

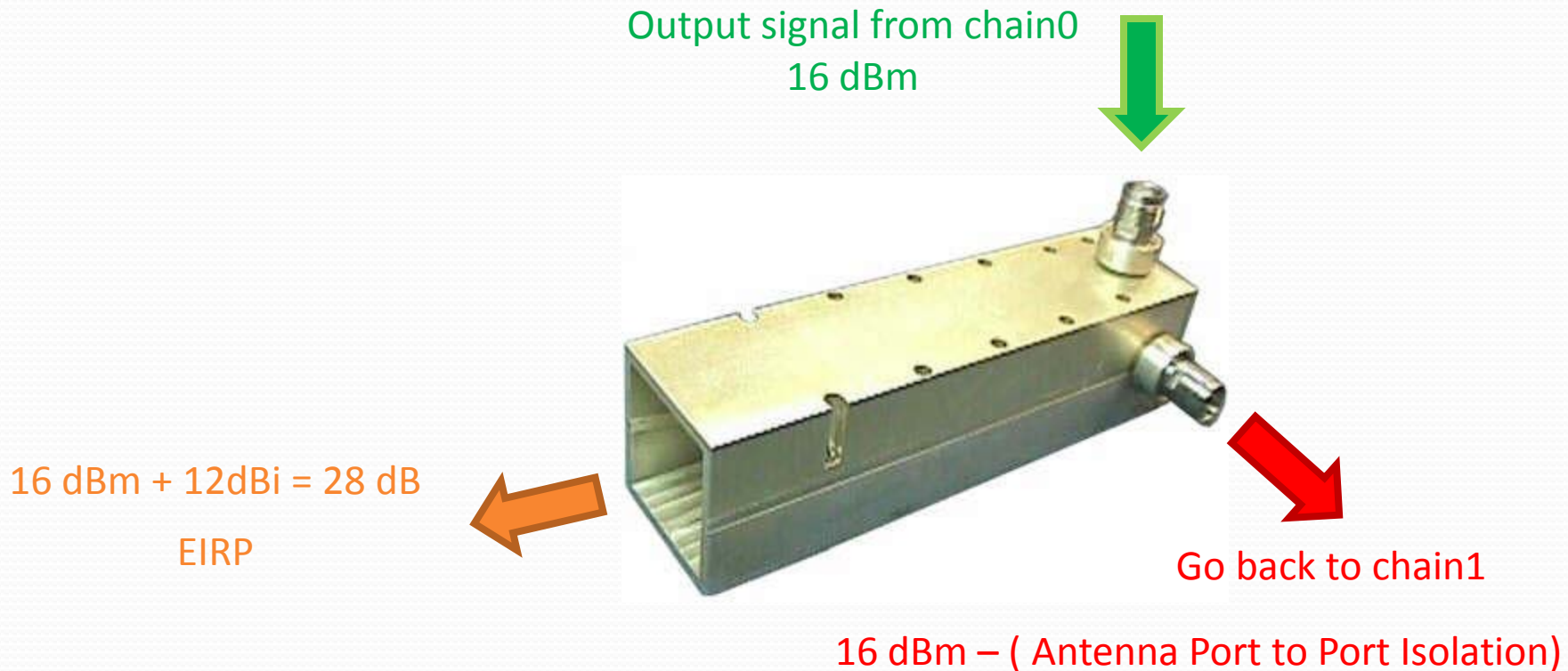
$$\text{VSWR } 2:1 \rightarrow \text{RL: } -9.54$$

$$\text{VSWR } 1.01:1 \rightarrow \text{RL: } -46$$

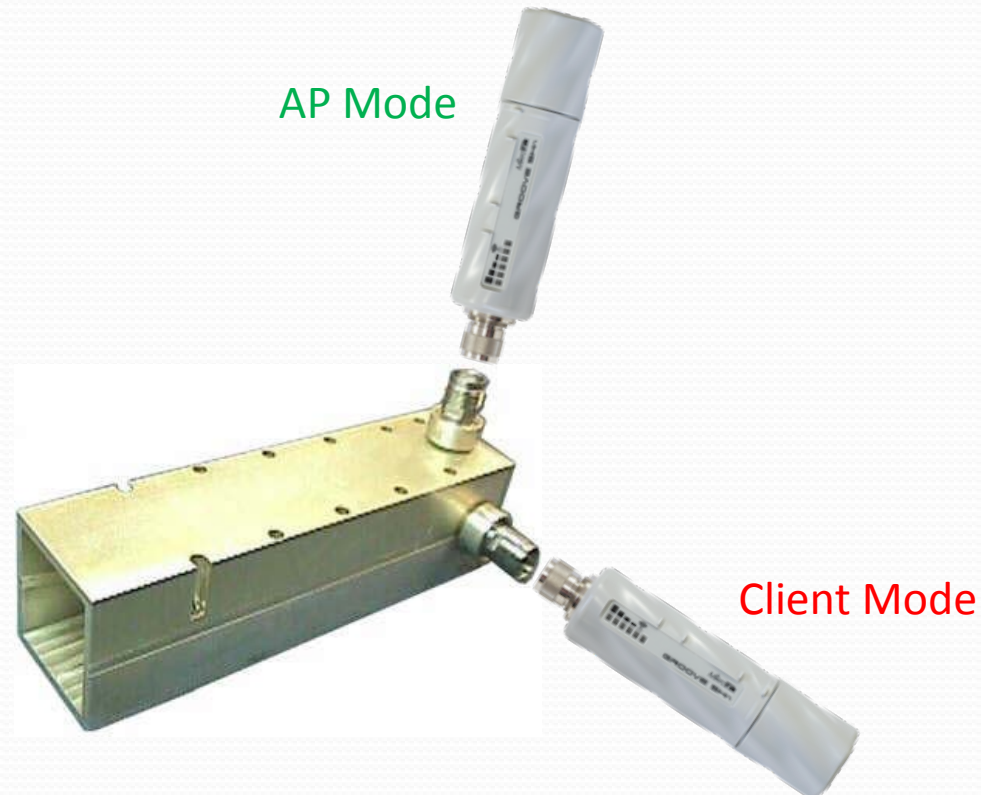
- Tip4 : Just like the Gain the VSWR or Return Loss is not a Fix Parameter and it depends on the frequency so become sure the antenna that you want to use is has a VSWR better than 2:1 on the frequency that you want to use it.
- Tip5 : If you Established a link and after 1 week the RX signal is fall 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 travel to the other chain and it could effect on performance and even cause damage.

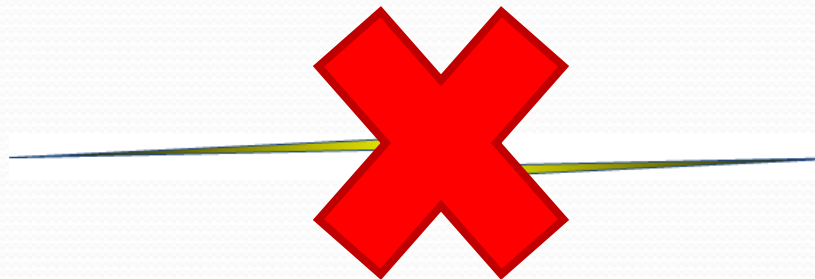


- Most of Wireless manufacture offer to use the antennas with a port to port Isolation better than -25
- you can measure your antenna port to port Isolation by link two radio over the ports of your antenna, minimizing the output power and check the receiving signal(it is not very accurate but at least you can understand the meaning of P-to-P Isolation)



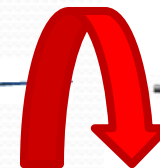
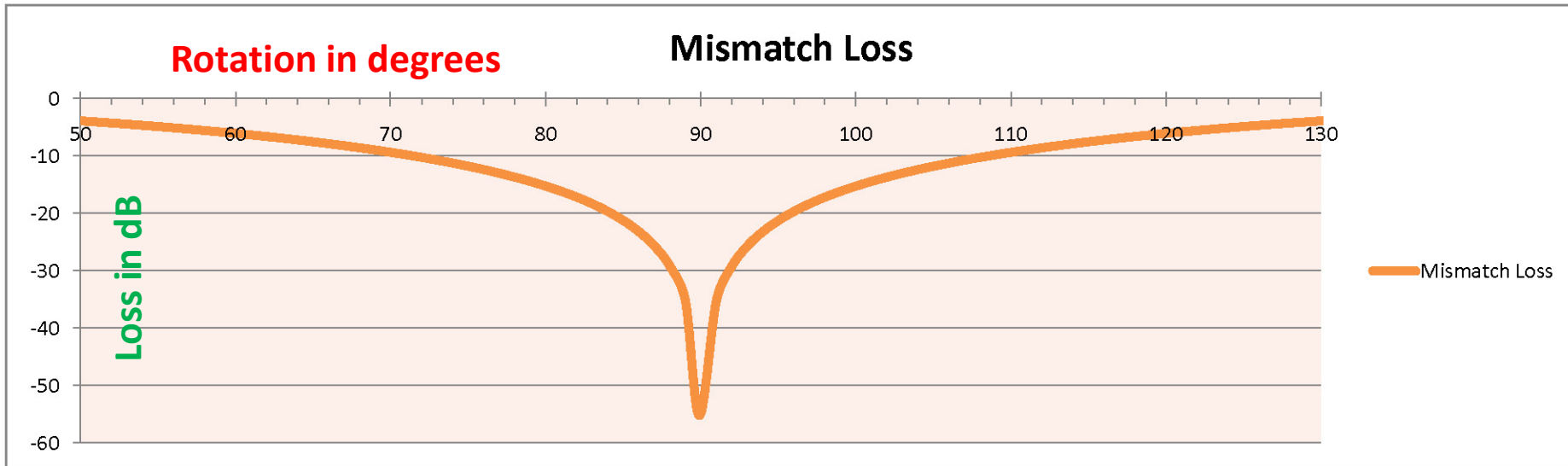
# 4- Cross Polarization

- When you are Using two antennas with Linear polarization linked together if you rotate one side 90 degrees you have to lose your link theoretically :



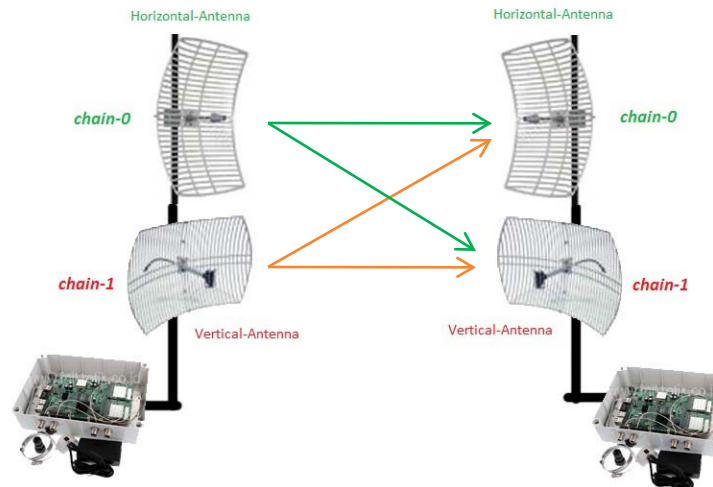
- While we are rotating the far end site antenna we will have the below graf if we monitor loss / rotation degree :

$$\text{Polarization Mismatch Loss (dB)} = 20 \log (\cos \theta)$$





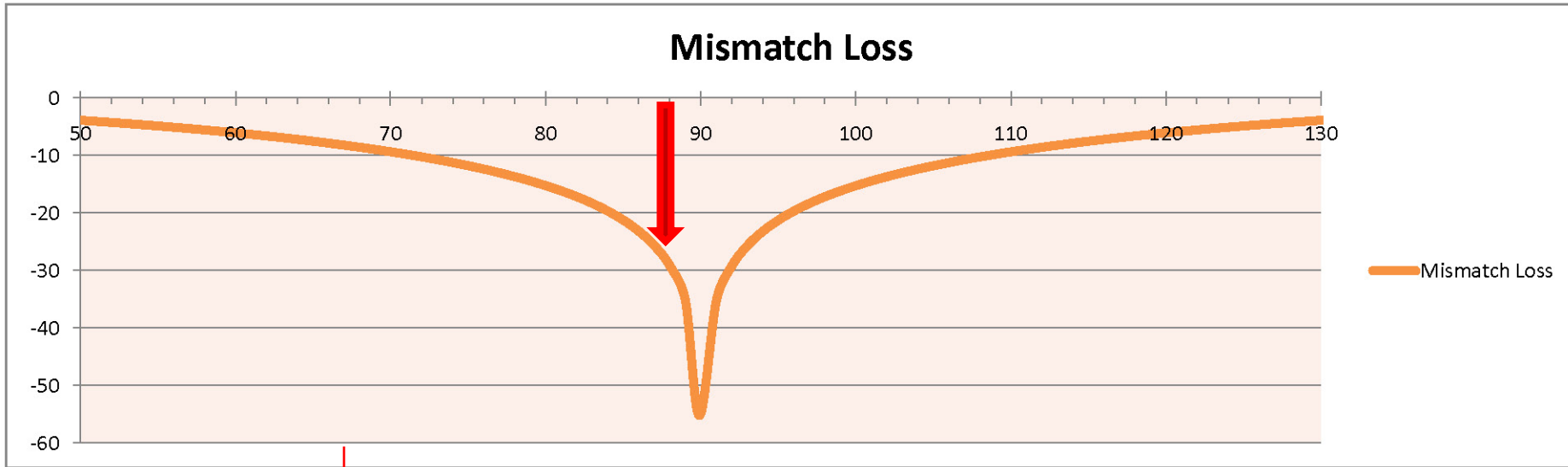
- Cross polarization is used by MIMO MCS-8 to MCS-15 to double the throughput and the radio can use the carrier twice by using this mismatch loss of the other chain.
- The opposite chains signal is like noise and interfered each other. Better cross polarization gives you more throughputs.



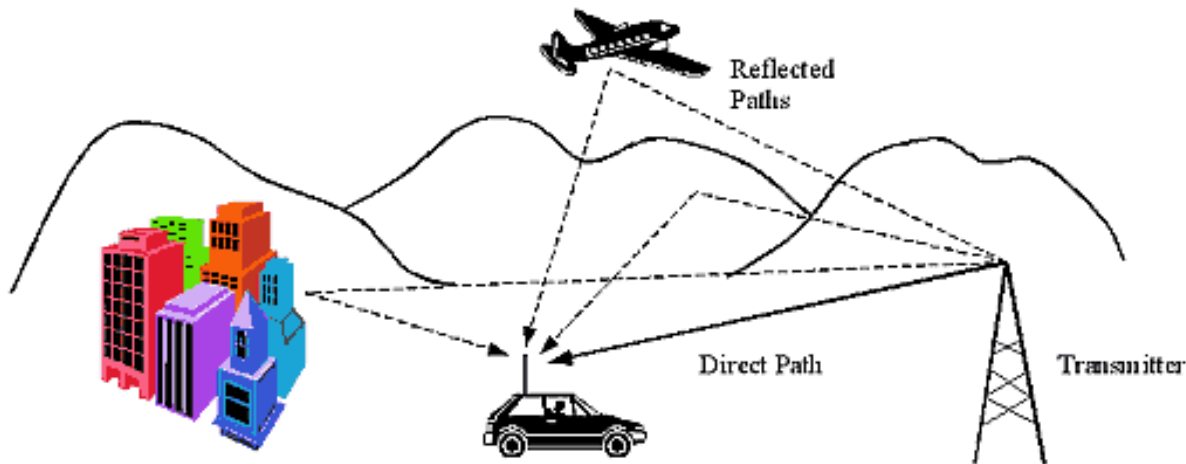
RX chain1(TX chain1) = -45dBm

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



- **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 Pigtaills 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**

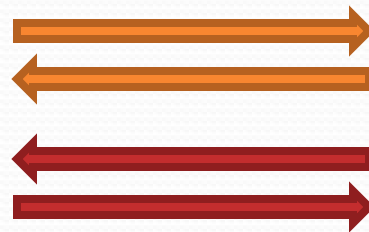




Now It's a good time to go and use this Tips to improve your performance and enjoy the real meaning of MIMO.

Vertical

*MikroTik*



*MikroTik*

Horizontal

200 Mbps

200 Mbps

For more information please contact me at:

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