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- 2006-EDCwifi国际业务员
- 2009年4月-Mikrotik中国代理商

  http://www.mikrotik.com/1howtobuy.html
- 2009年11月-Mikrotik中国培训合作伙伴

  http://www.mikrotik.com/training/php
- 2010年04月-EDCwifi第一次MTCNA培训

MikroTik RouterOS Wireless Concepts

by:
Andrew Zheng
EDCwifi – 深圳捷联讯通科技有限公司

www.edcwifi.com

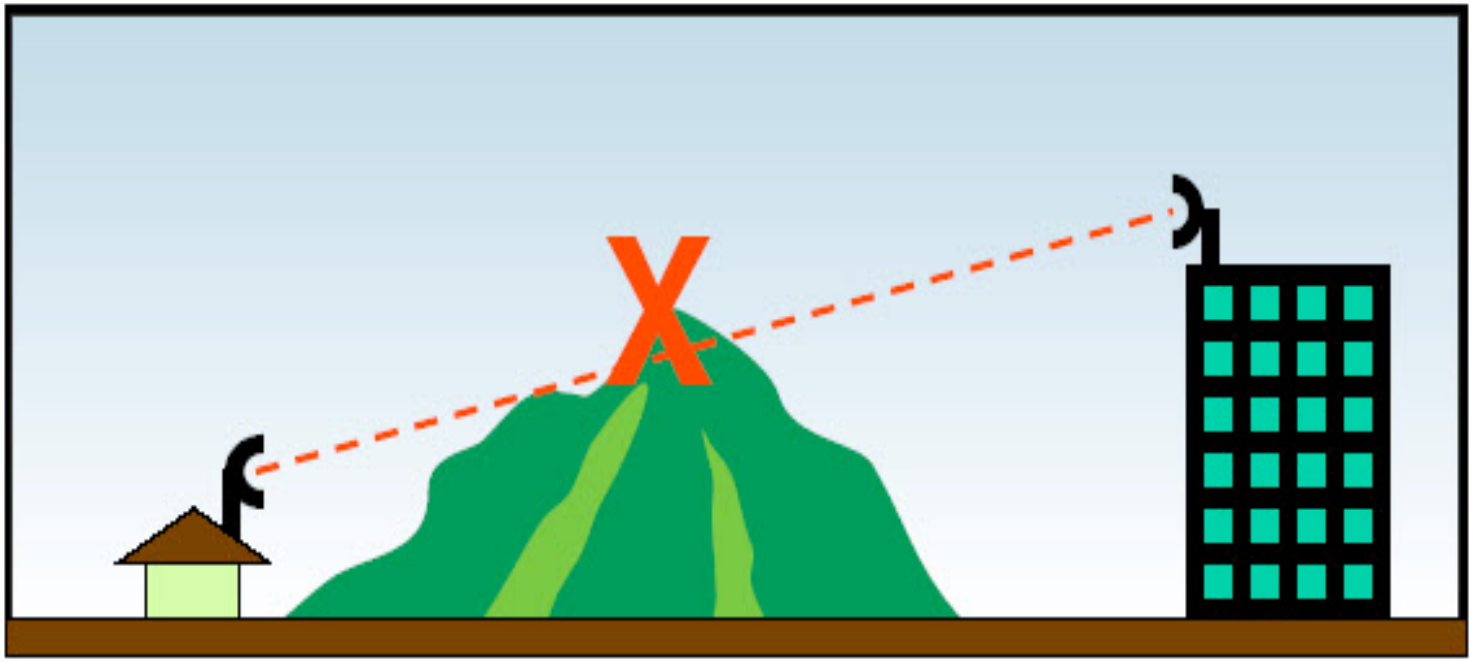
China-GuangZhou, 10 April 2010

第一个问题

为什么只有500米到800米的距离做不了无线天桥？

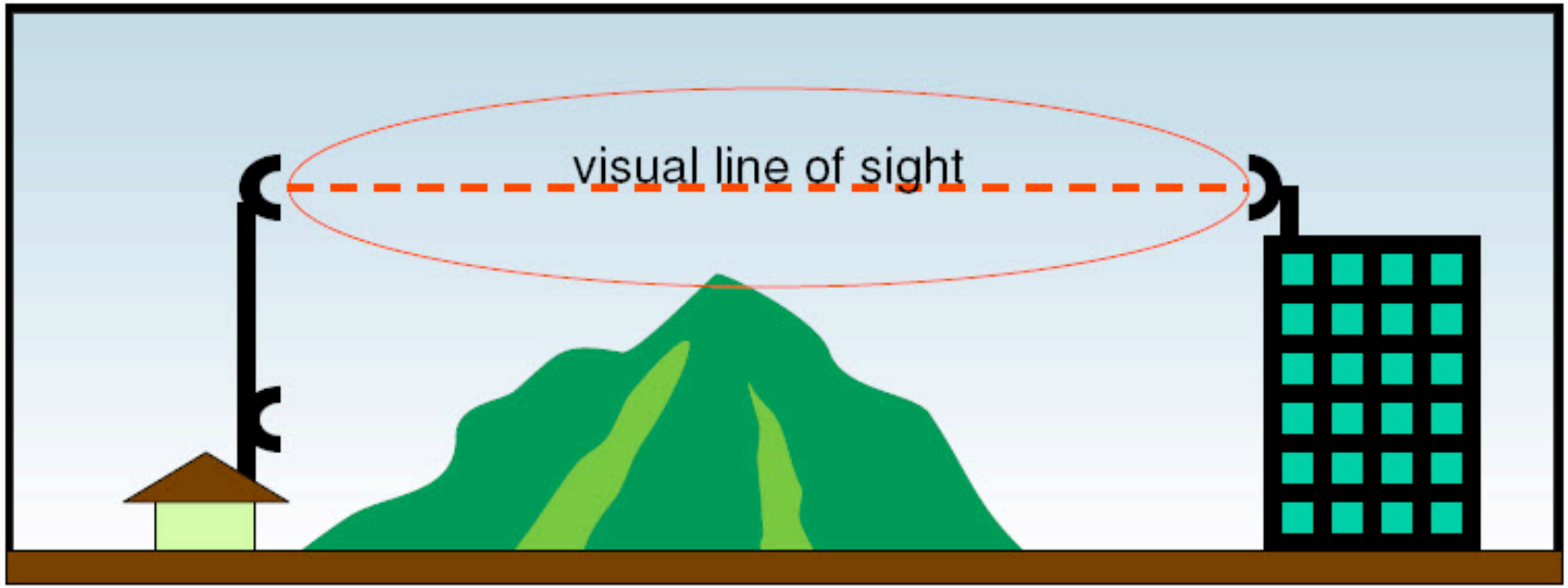
Line of Sight (LOS)

户外无线必须遵循的主要视线



Line of Sight (LOS)

设备高度必须和视线位置是一致的

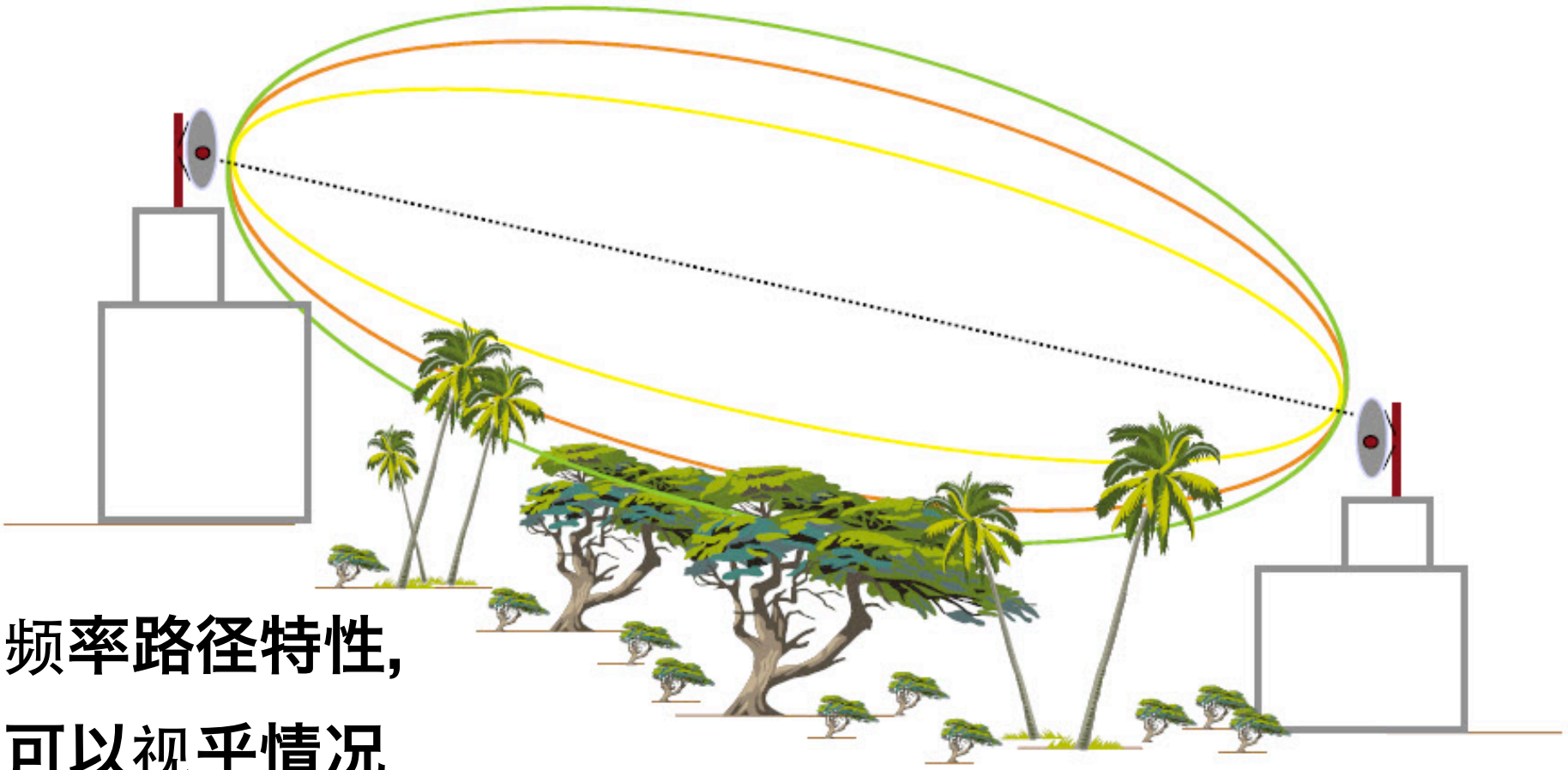


第二个问题

为什么在可视范围内，但是连接的质量还不好？

1. FRESNEL ZONE (菲涅尔区)

Fresnel Zone (菲涅尔区)



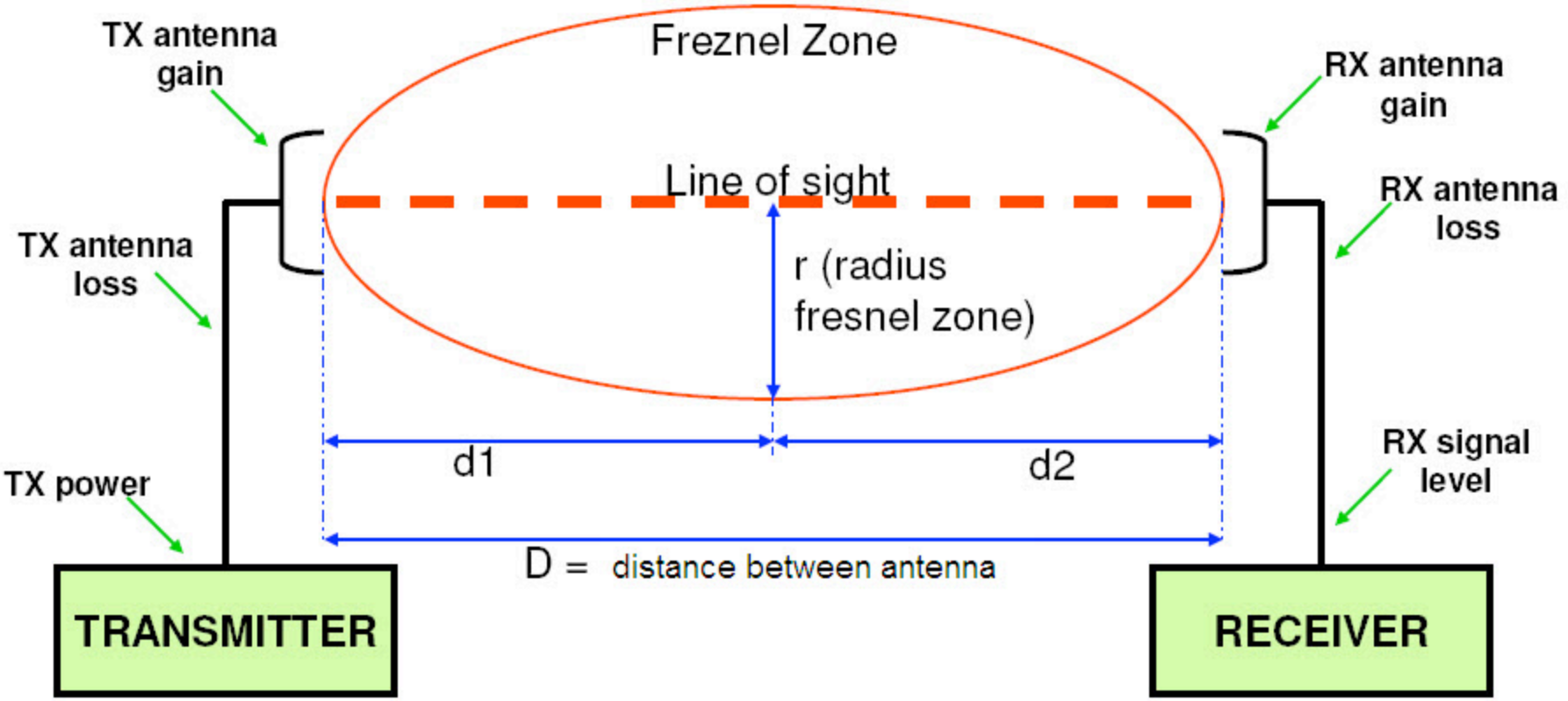
频率路径特性,

可以视乎情况

而定随时改变.

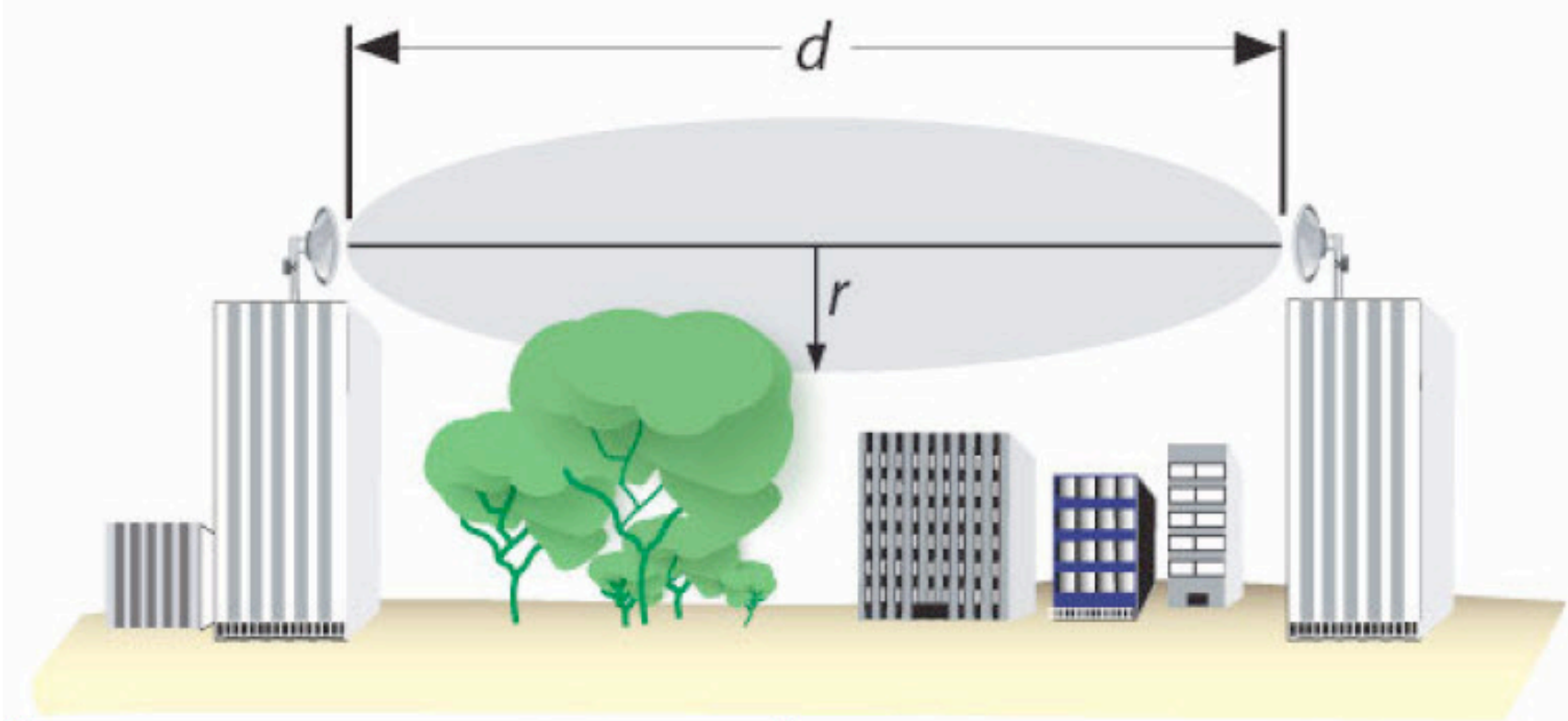
Fresnel Zone (菲涅尔区)

室外无线不仅要考虑到视线,但还必须考虑菲涅耳区规则.



菲涅尔区方程

菲涅尔区算法是假设地球是平的.



$$r_{(\text{in mts})} = 17.32 \times \sqrt{\frac{d}{4f}}\ \begin{matrix}(\text{in Km}) \\ (\text{in GHz})\end{matrix}$$

$$r_{(\text{in ft})} = 72.05 \times \sqrt{\frac{d}{4f}}\ \begin{matrix}(\text{in miles}) \\ (\text{in GHz})\end{matrix}$$

菲涅尔区计算

频率:2.4GHz

距离:10公里

$$r\,(\text{meter}) = 17.32 * \sqrt{\frac{d\,(\text{km})}{4\,f\,(\text{GHz})}}$$

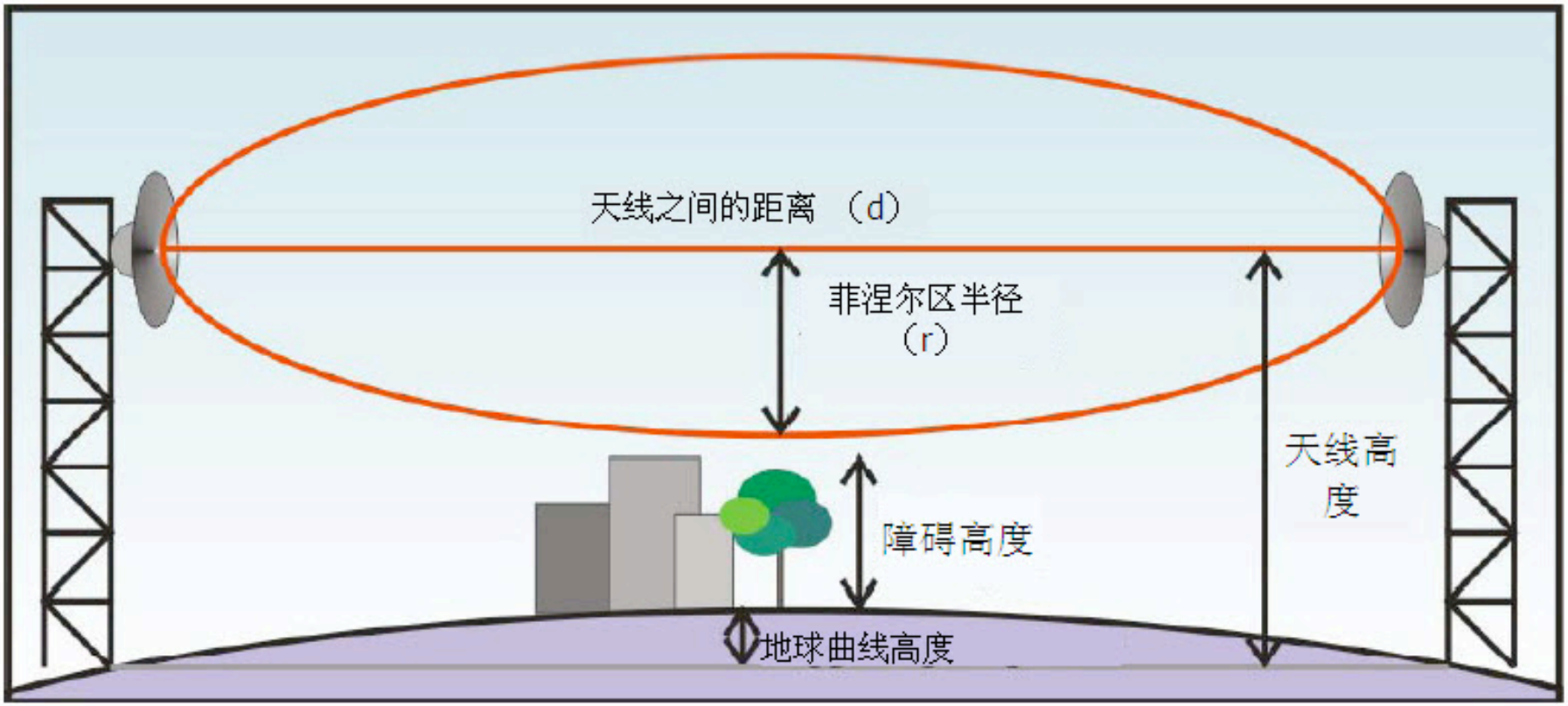
$$= 17.32 * \sqrt{\frac{10\,(\text{km})}{4 * 2.4\,(\text{GHz})}}$$

$$= 17.32 * \sqrt{1.042} = 17.68 \text{ meter}$$

2. EARTH CURVATURE (地球弯曲)

地球弯曲

对于更大的距离,信号塔高度必须慎重考虑,也必须考虑地球的曲线高度



地球弯曲

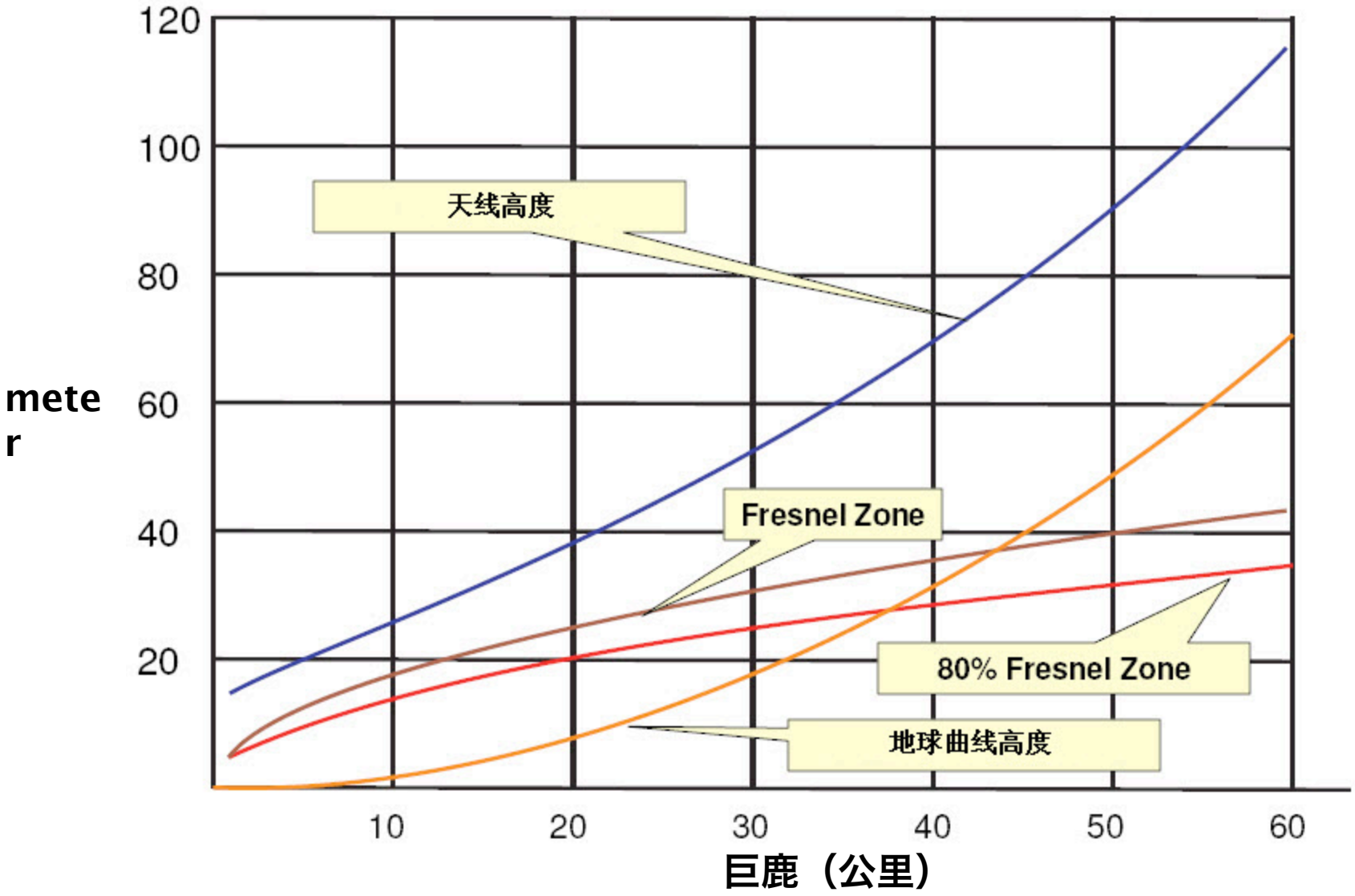
地球曲率计算

$$E = (\text{距离})^2/(51024)$$

$$= 0.00195\text{km}$$

$$= 1.95\text{m}$$

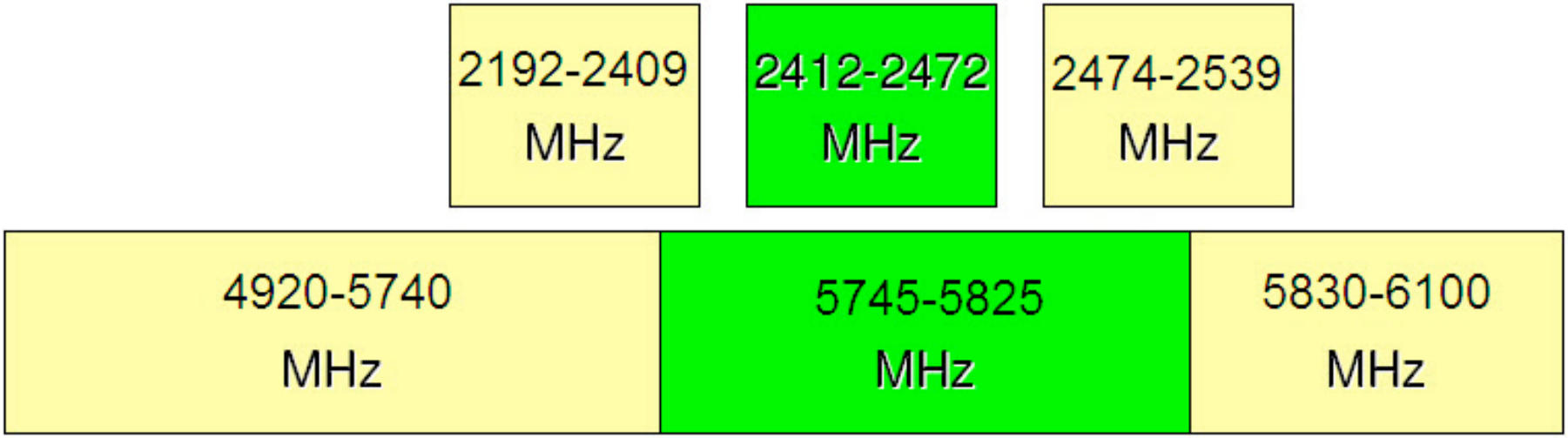
天线高度


120
100
80
60
40
20
meter
天线高度
Fresnel Zone
80% Fresnel Zone
地球曲线高度
10
20
30
40
50
60
巨鹿（公里）

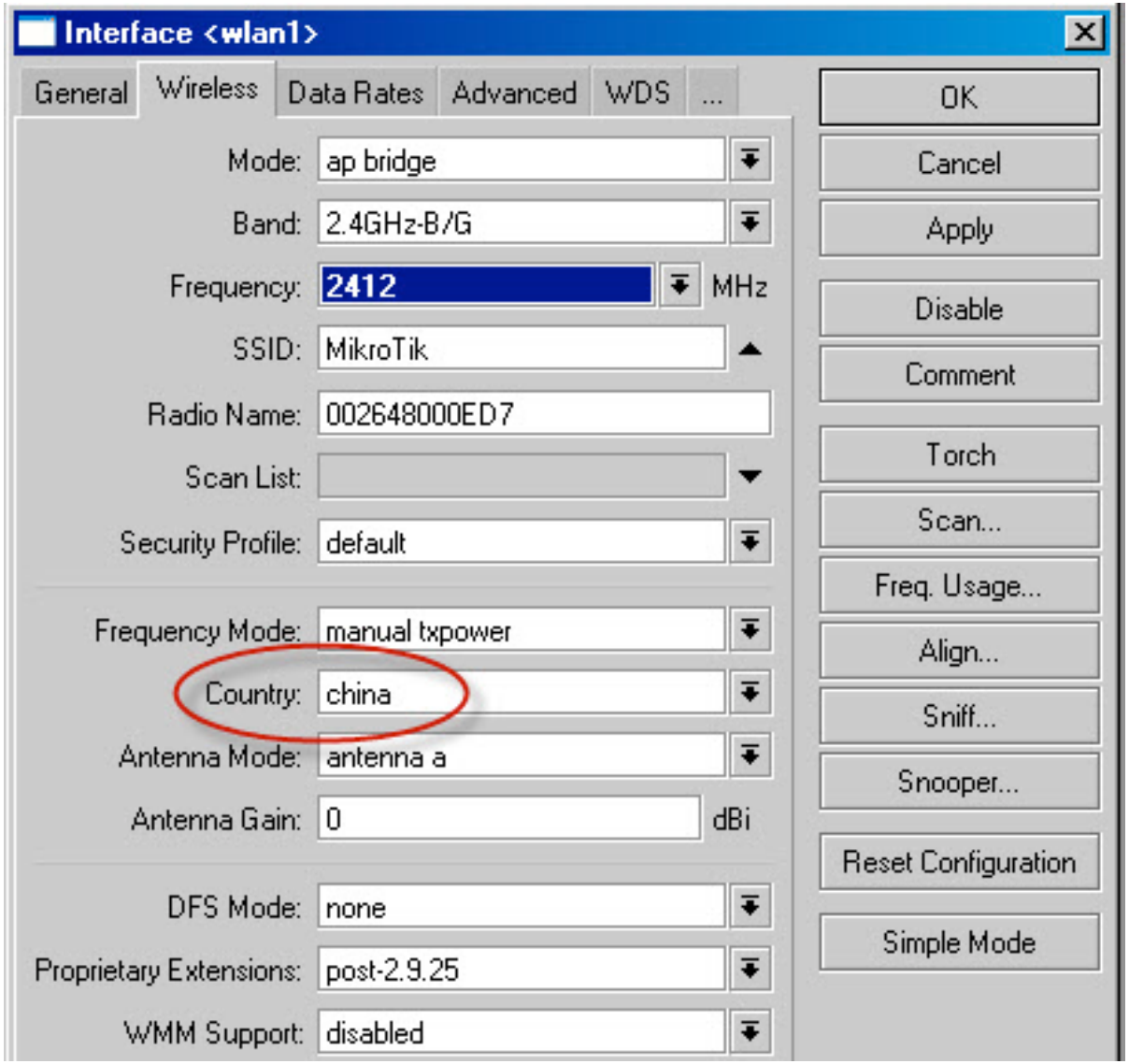
3. INTERFERENCE (干扰)

平率(Frequency)

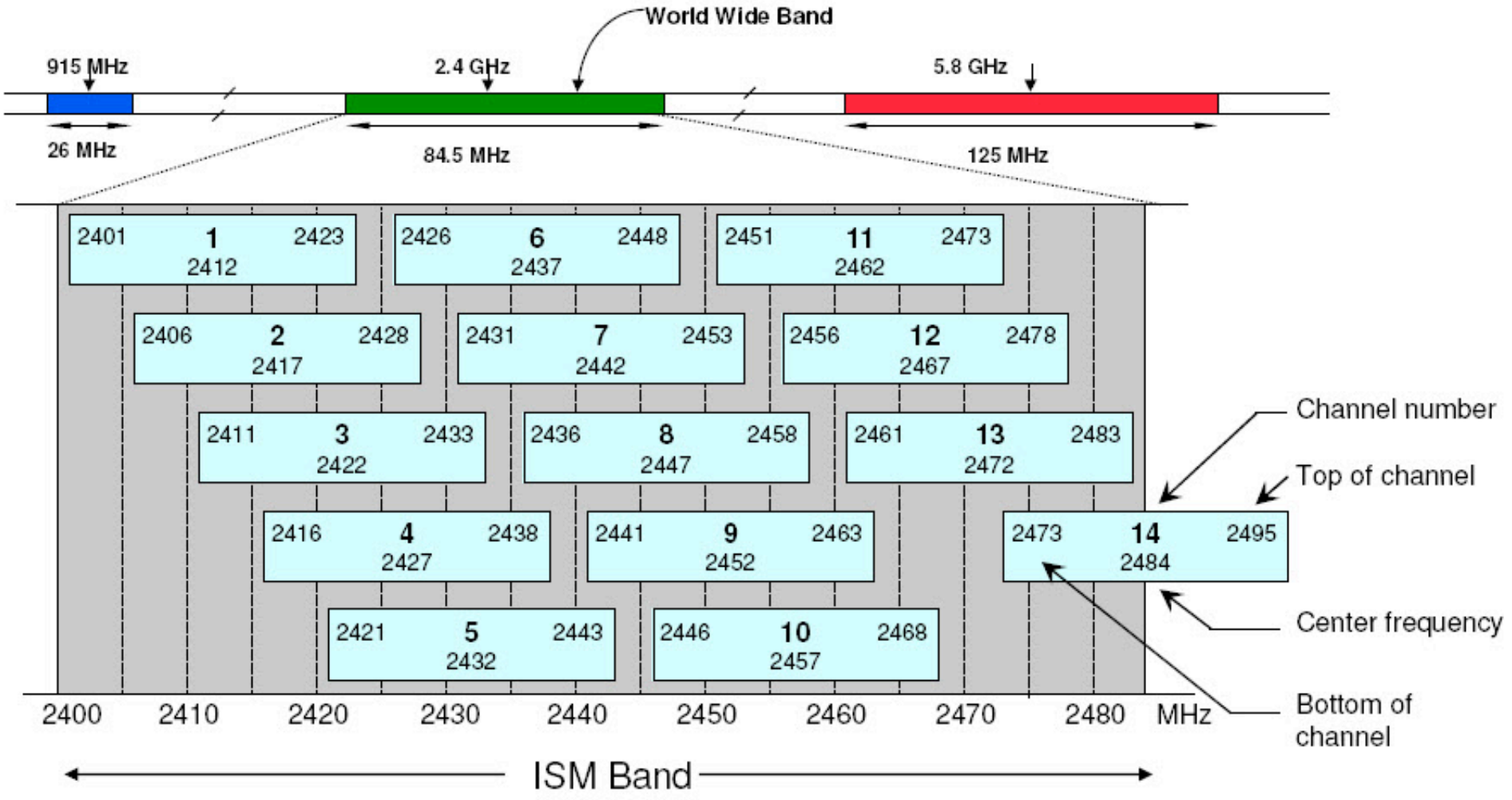
Mikrotik RouterOS支持Atheros卡的频率



平率(Frequency)

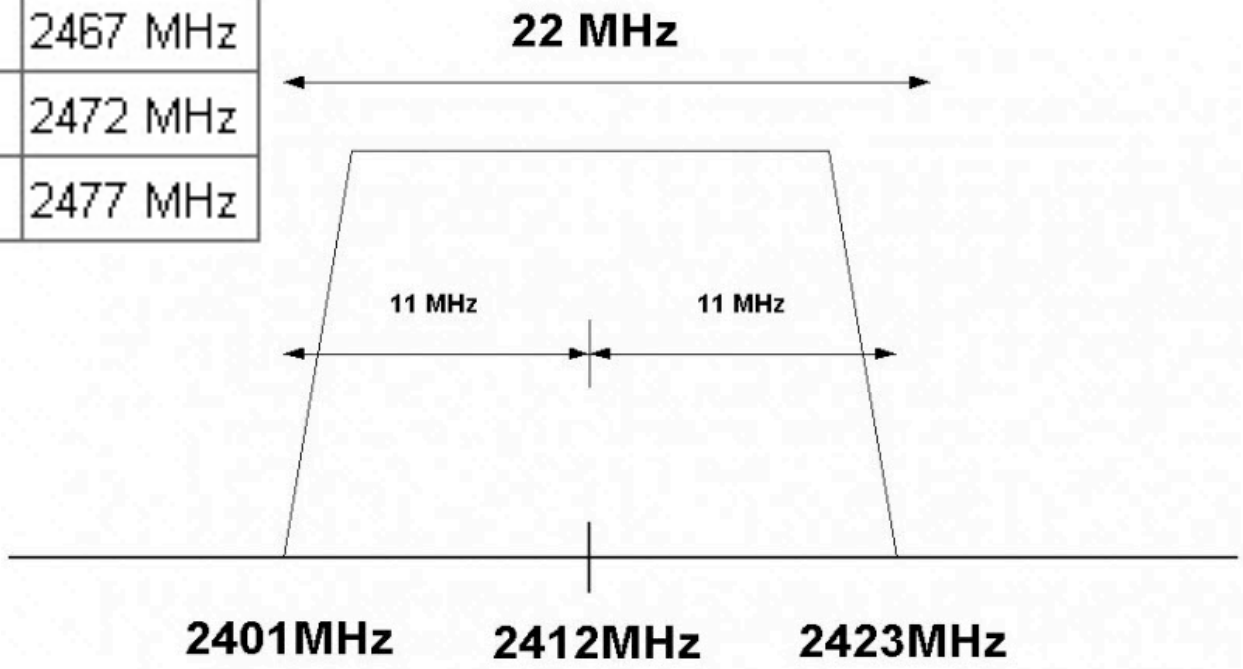


802.11b

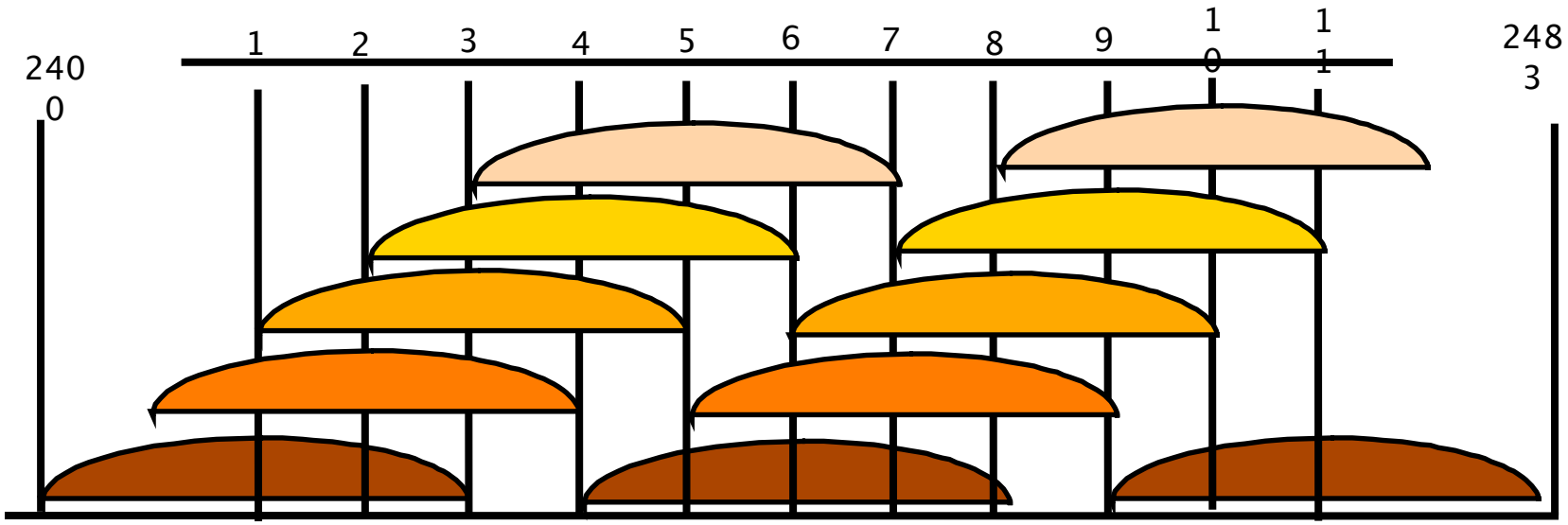

World Wide Band
915 MHz
2.4 GHz
5.8 GHz
26 MHz
84.5 MHz
125 MHz
2401 1 2423
2412
2426 6 2448
2437
2451 11 2473
2462
2406 2 2428
2417
2431 7 2453
2442
2456 12 2478
2467
2411 3 2433
2422
2436 8 2458
2447
2461 13 2483
2472
2416 4 2438
2427
2441 9 2463
2452
2473 14 2495
2484
2421 5 2443
2432
2446 10 2468
2457
Channel number
Top of channel
Center frequency
Bottom of channel
2400 2410 2420 2430 2440 2450 2460 2470 2480 MHz
ISM Band

802.11b/g

Channel	Frekuensi	Channel	Frekuensi
1	2412 MHz	8	2447 MHz
2	2417 MHz	9	2452 MHz
3	2422 MHz	10	2457 MHz
4	2427 MHz	11	2462 MHz
5	2432 MHz	12	2467 MHz
6	2437 MHz	13	2472 MHz
7	2442 MHz	14	2477 MHz

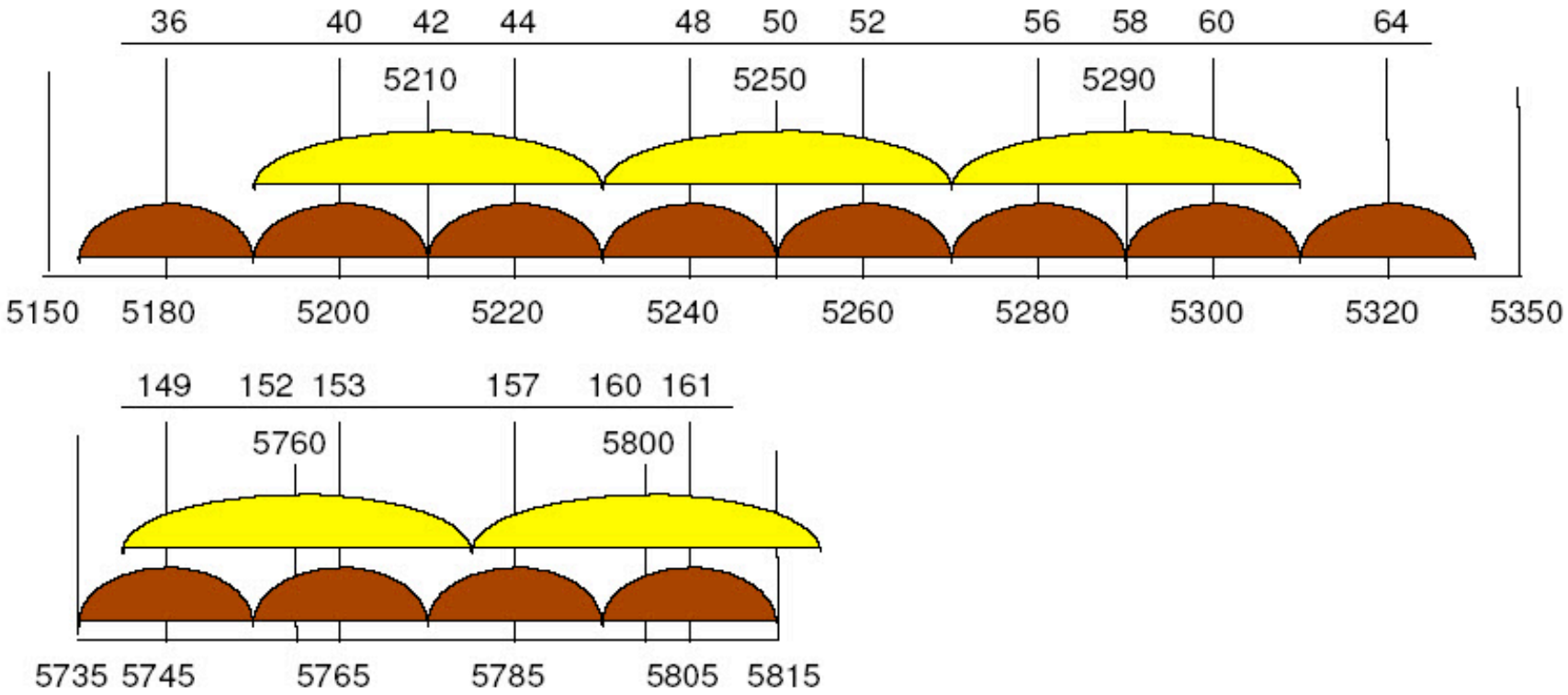


802.11b/g



- Frequency wide 22MHz
- 3 non-overlapping channels
- 3 Access Points can occupy same area without interfering

802.11a的频段



- (12) 20 MHz wide channels
- (5) 40MHz wide turbo channels

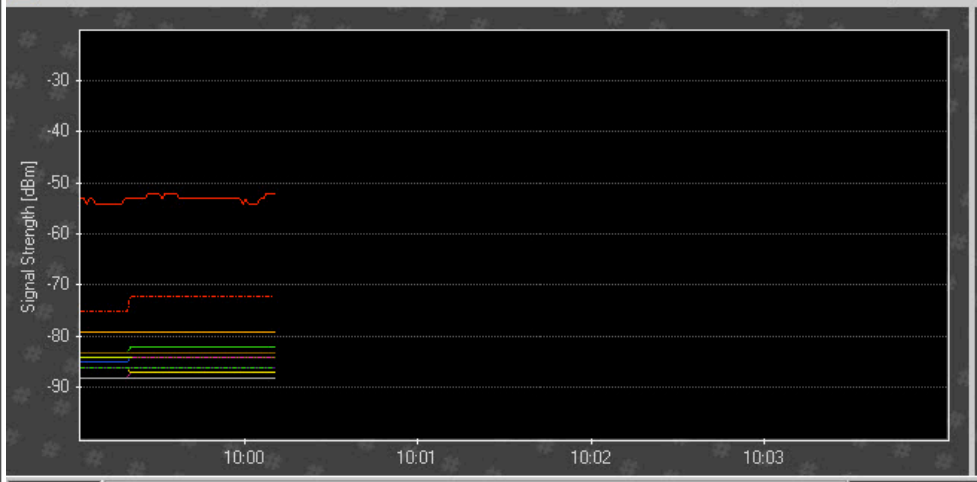
干扰

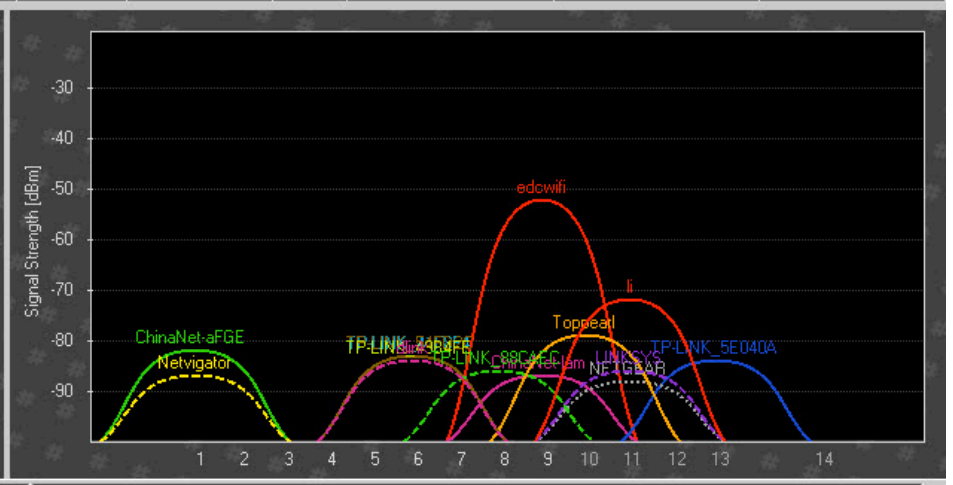
inSSIDer

File View Help

Stop Scanning | Intel(R) Wireless WiFi Link 5100 - Packet Scheduler Miniport | Channel Graph: 2.4 GHz 5 GHz

MAC Address	SSID	Channel	RSSI	Security	Network Type	Speed	First Seen	Last Seen	Location
00:07:13:7c:07:d4	edcwifi	9	-52	WPA2-CCMP	Access Point	18	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:25:68:19:75:69	ChinaNet-aFGE	1	-82	WPA	Access Point	54	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:25:12:3a:21:0e	ChinaNet-lam	9	-87	WPA	Access Point	11	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:22:cf:08:11:a8	Netvigator	1	-87	WEP	Access Point	54	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:27:19:5e:04:0a	TP-LINK_5E040A	13	-84	WPA-TKIP	Access Point	36	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:1b:2f:4e:e7:62	NETGEAR	11	-88	None	Access Point	36	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:1f:5b:87:7f:f3	Toppearl	10	-100	WPA-TKIP	Access Point	18	9:59:02 PM	9:59:19 PM	0.00000 , 0.00000
00:25:86:41:f8:f4	TP-LINK_41F8F4	6	-83	WPA-TKIP	Access Point	36	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:23:cd:54:fd:2e	TP-LINK_54FD2C	6	-83	WPA-TKIP	Access Point	18	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:25:86:49:b4:fe	TP-LINK_49B4FE	6	-84	WEP	Access Point	36	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:1a:70:46:8c:10	LINKSYS	11	-86	WEP	Access Point	36	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:0f:b5:78:50:12	li	11	-72	WPA	Access Point	11	9:59:02 PM	10:00:10 PM	0.00000 , 0.00000
00:23:cd:88:ca:ec	TP-LINK_88CAEC	8	-100	WEP	Access Point	36	9:59:02 PM	9:59:19 PM	0.00000 , 0.00000
1c:af:f7:26:d6:0e	dlink	6	-84	WEP	Access Point	54	9:59:20 PM	10:00:10 PM	0.00000 , 0.00000
00:ee:ee:9e:2a:43	ALPHA-WLAN	11	-256	WEP	Access Point	18	9:59:20 PM	10:00:10 PM	0.00000 , 0.00000

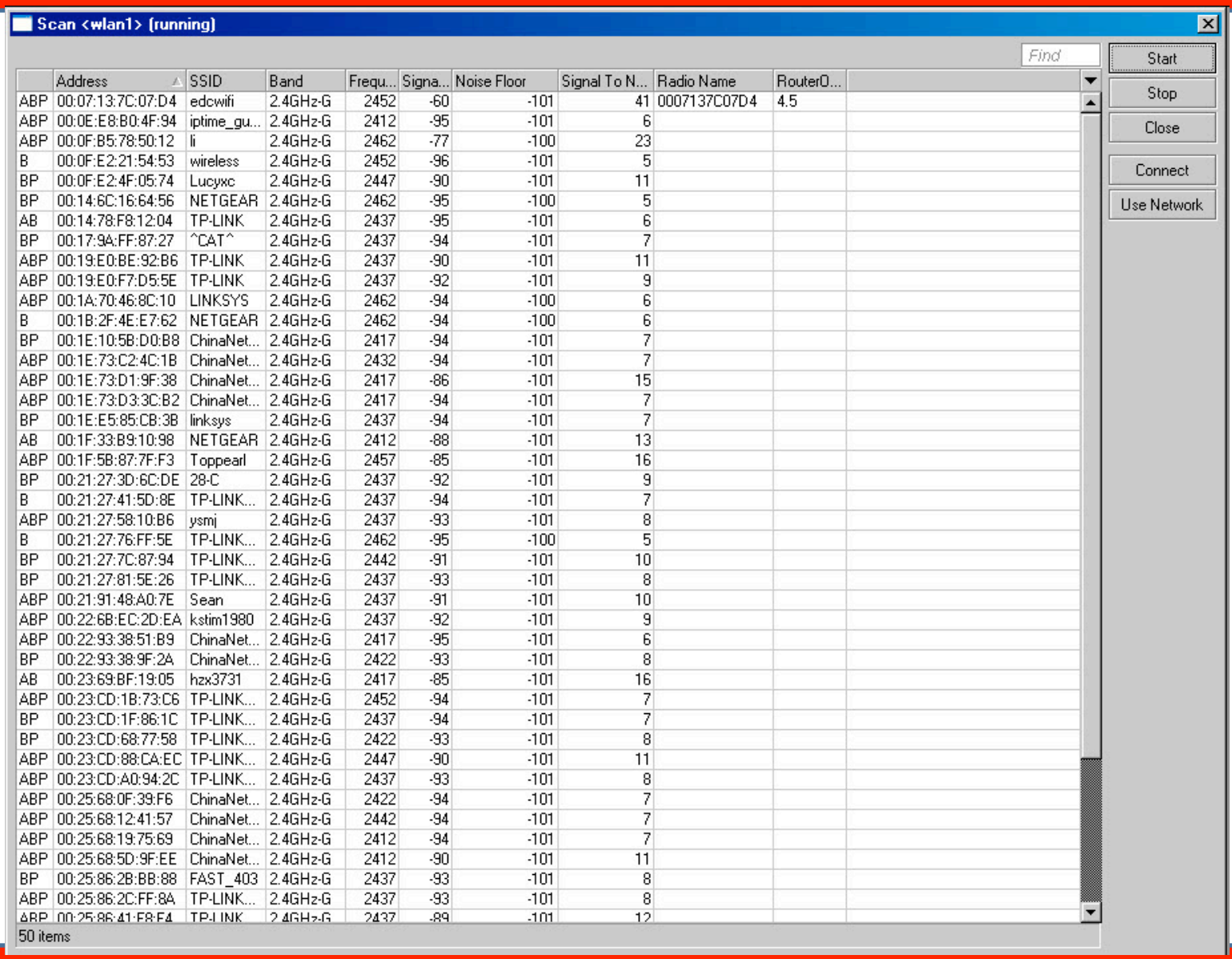




inSSIDer | 15 AP(s) | GPS: Disabled

10:00 PM

干扰



	Address	SSID	Band	Frequ...	Signa...	Noise Floor	Signal To N...	Radio Name	RouterO...
ABP	00:07:13:7C:07:D4	edcwifi	2.4GHz-G	2452	-60	-101	41	0007137C07D4	4.5
ABP	00:0E:E8:B0:4F:94	iptime_gu...	2.4GHz-G	2412	-95	-101	6		
ABP	00:0F:B5:78:50:12	li	2.4GHz-G	2462	-77	-100	23		
B	00:0F:E2:21:54:53	wireless	2.4GHz-G	2452	-96	-101	5		
BP	00:0F:E2:4F:05:74	Lucyxc	2.4GHz-G	2447	-90	-101	11		
BP	00:14:6C:16:64:56	NETGEAR	2.4GHz-G	2462	-95	-100	5		
AB	00:14:78:F8:12:04	TP-LINK	2.4GHz-G	2437	-95	-101	6		
BP	00:17:9A:FF:87:27	^CAT^	2.4GHz-G	2437	-94	-101	7		
ABP	00:19:E0:BE:92:B6	TP-LINK	2.4GHz-G	2437	-90	-101	11		
ABP	00:19:E0:F7:D5:5E	TP-LINK	2.4GHz-G	2437	-92	-101	9		
ABP	00:1A:70:46:8C:10	LINKSYS	2.4GHz-G	2462	-94	-100	6		
B	00:1B:2F:4E:E7:62	NETGEAR	2.4GHz-G	2462	-94	-100	6		
BP	00:1E:10:5B:D0:B8	ChinaNet...	2.4GHz-G	2417	-94	-101	7		
ABP	00:1E:73:C2:4C:1B	ChinaNet...	2.4GHz-G	2432	-94	-101	7		
ABP	00:1E:73:D1:9F:38	ChinaNet...	2.4GHz-G	2417	-86	-101	15		
ABP	00:1E:73:D3:3C:B2	ChinaNet...	2.4GHz-G	2417	-94	-101	7		
BP	00:1E:E5:85:CB:3B	linksys	2.4GHz-G	2437	-94	-101	7		
AB	00:1F:33:B9:10:98	NETGEAR	2.4GHz-G	2412	-88	-101	13		
ABP	00:1F:5B:87:7F:F3	Toppearl	2.4GHz-G	2457	-85	-101	16		
BP	00:21:27:3D:6C:DE	28-C	2.4GHz-G	2437	-92	-101	9		
B	00:21:27:41:5D:8E	TP-LINK...	2.4GHz-G	2437	-94	-101	7		
ABP	00:21:27:58:10:B6	ysmj	2.4GHz-G	2437	-93	-101	8		
B	00:21:27:76:FF:5E	TP-LINK...	2.4GHz-G	2462	-95	-100	5		
BP	00:21:27:7C:87:94	TP-LINK...	2.4GHz-G	2442	-91	-101	10		
BP	00:21:27:81:5E:26	TP-LINK...	2.4GHz-G	2437	-93	-101	8		
ABP	00:21:91:48:A0:7E	Sean	2.4GHz-G	2437	-91	-101	10		
ABP	00:22:6B:EC:2D:EA	kstim1980	2.4GHz-G	2437	-92	-101	9		
ABP	00:22:93:38:51:B9	ChinaNet...	2.4GHz-G	2417	-95	-101	6		
BP	00:22:93:38:9F:2A	ChinaNet...	2.4GHz-G	2422	-93	-101	8		
AB	00:23:69:BF:19:05	hzx3731	2.4GHz-G	2417	-85	-101	16		
ABP	00:23:CD:1B:73:C6	TP-LINK...	2.4GHz-G	2452	-94	-101	7		
BP	00:23:CD:1F:86:1C	TP-LINK...	2.4GHz-G	2437	-94	-101	7		
BP	00:23:CD:68:77:58	TP-LINK...	2.4GHz-G	2422	-93	-101	8		
ABP	00:23:CD:88:CA:EC	TP-LINK...	2.4GHz-G	2447	-90	-101	11		
ABP	00:23:CD:A0:94:2C	TP-LINK...	2.4GHz-G	2437	-93	-101	8		
ABP	00:25:68:0F:39:F6	ChinaNet...	2.4GHz-G	2422	-94	-101	7		
ABP	00:25:68:12:41:57	ChinaNet...	2.4GHz-G	2442	-94	-101	7		
ABP	00:25:68:19:75:69	ChinaNet...	2.4GHz-G	2412	-94	-101	7		
ABP	00:25:68:5D:9F:EE	ChinaNet...	2.4GHz-G	2412	-90	-101	11		
BP	00:25:86:2B:BB:88	FAST_403	2.4GHz-G	2437	-93	-101	8		
ABP	00:25:86:2C:FF:8A	TP-LINK...	2.4GHz-G	2437	-93	-101	8		
ABP	00:25:86:41:F8:F4	TP-LINK...	2.4GHz-G	2437	-89	-101	12		

第三个问题

视线ok！，干扰没有问题！，菲涅尔区算算好了！还有其他的吗？

为什么应该用室外外壳浪费钱？

电缆损耗

频率2.4GHz在每百英尺(30米)电缆功率损耗:

耗:

- RG8 :10
- LMR400 :6.8
- LMR600 :5.4
- Heliax 3/8“ :5.36
- Heliax ½“ :3.74
- Heliax 5/8“ :2.15

比如说

参数：

- AP power 100mW
- 无放大器
- LMR400 线 30feet
- 天线 24dBi
- 频率 2.4GHz
- 距离10km

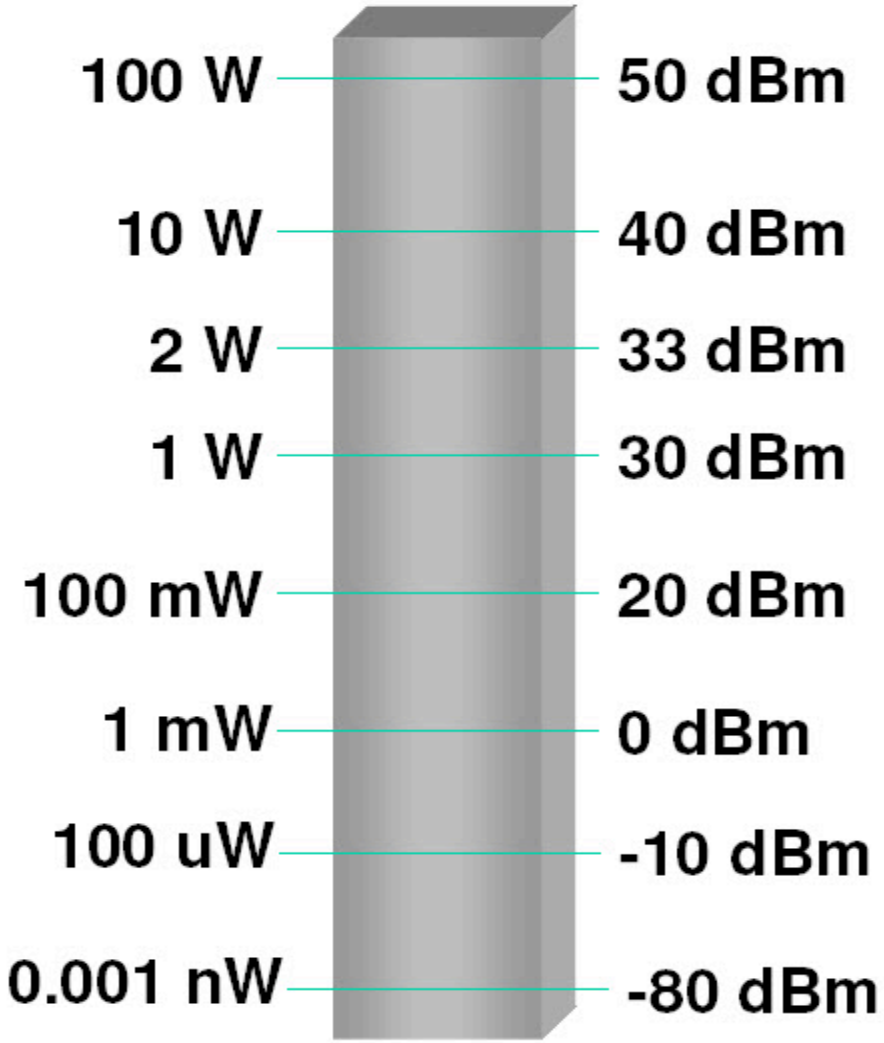
无线局域网参数

- Frequency (频率) →2.4GHz
- Tx Power (功率) →100mW = ? dbm
- Rx Sensitivity→ ?
- Looses→6.8
- EIRP→?
- Free Space Loss (FSL)→?
- Line of sight →搞定
- Fresnel Zone(菲涅耳区) →搞定

Tx Power

$$10 \log \frac{(mW)}{} = x \text{ dBm}$$

Watts to dBm


100 W
50 dBm
10 W
40 dBm
2 W
33 dBm
1 W
30 dBm
100 mW
20 dBm
1 mW
0 dBm
100 uW
-10 dBm
0.001 nW
-80 dBm

Rx Sensitivity

Output Power / Receive Sensitivity*:

IEEE 802.11a:	24dBm / -90dBm @ 6Mbps
	19dBm / -70dBm @ 54Mbps
IEEE 802.11b:	25dBm / -92dBm @ 1Mbps
	25dBm / -87dBm @ 11Mbps
IEEE 802.11g:	25dBm / -90dBm @ 6Mbps
	20dBm / -70dBm @ 54Mbps

Rx的计算

必须大于接收器接口的RX-sensitivity

参考FSL

发射机 TX -power+天线 -损失

接收天线- 损失

Effective Isotropic Radiated Power (EIRP)
有效全向辐射功率

- 可发射功率的无线设备包括天线规格和其他干扰.
- EIRP= dBm设备+ DBI天线 – 损耗
- 损耗是由连接器,电缆等造成.

(FSL) Free Space Loss

频率在空气中损耗计算方法:

FSL(dB) = 32.45 + 20 Log (F-MHz) + 20 Log (D-km)

2.4GHz频率10公里损耗:

FSL(dB) = 32.45 + 20 Log (2400) + 20 Log (10)

= 32.45 + 67.6 + 20

= 120.05 dB

FSL (db)

距离	2.4 GHz	5.2 GHz	5.8 GHz
1 km	100.026	106.742	107.69
3 km	109.568	116.284	117.233
5 km	114.005	120.721	121.670
10 km	120.026	126.742	127.690
15 km	123.548	130.264	131.212
20 km	126.047	132.762	133.711
30 km	129.568	136.284	137.233
40 km	132.067	138.783	139.732

Rx的计算

设备			db
Transmitter (EIRP)			
	Access Point 100 mWatt	20 dbm	
	线 30 meter	-6.8 db	37.2 db
	天线 24 db	24 dbi	**(EIRP)**
FSL / Path Loss 2,4 GHz 10 km			-120.026 db
Receiver (Receiver Power)			
	线 30 meter	-6.8 db	17.2 db
	天线 24 db	24 dbi	
RX-Rate / Signal Strength			**-65.626 db**

Link Possibility Calculator

Parametrs	SITE 1	SITE 2
Wireless cards		
Power	65 mW	65 mW
RX Sensitivity	-90 dBm	-90 dBm
Antennas		
Gain	24 dBi	24 dBi
Cables		
Length	3 m	3 m
Type:	LMR400	LMR400
Link		
Distance	10 km	
Frequency	2400 MHz	

Calculate

Link theoretical status	**reliable**
Theoretical signal level at site 1	-56/required -90
Theoretical signal level at site 2	-56/required -90

第四个问题

为什么晚上能连接很好，白天速度很慢，有时候连接不上？

晚上对白天

注意在什么地方？

- 办公地方白天的时候干扰比较多
- 住的地方晚上的时候

安装设备

设备可以帮忙安装

Power Meter (功率计算器)

能检查MINIPCI的Tx-Power

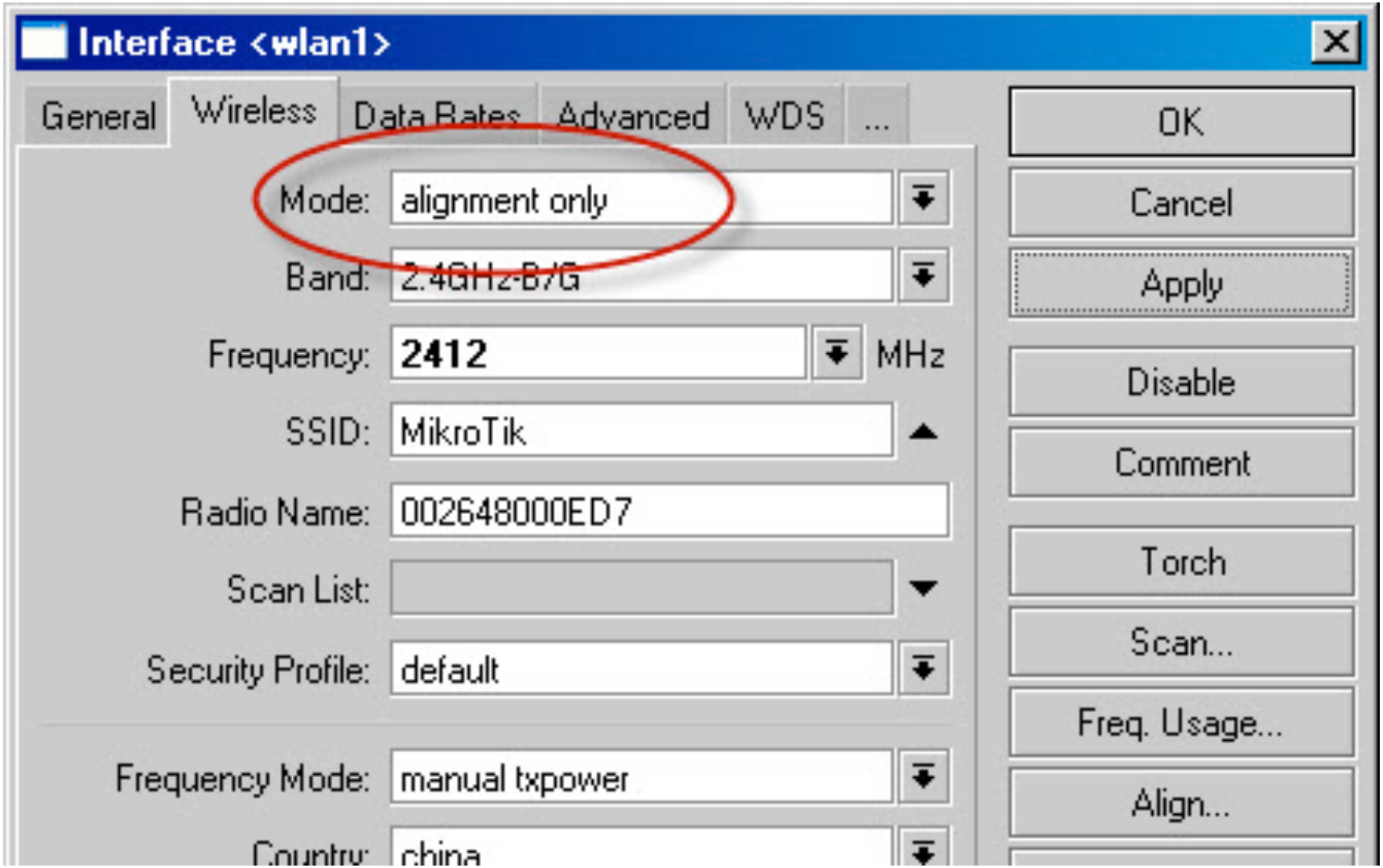
- 多少功率
- 稳定或不稳定

*Mikrotik MiniPCI功率好，也非常稳定

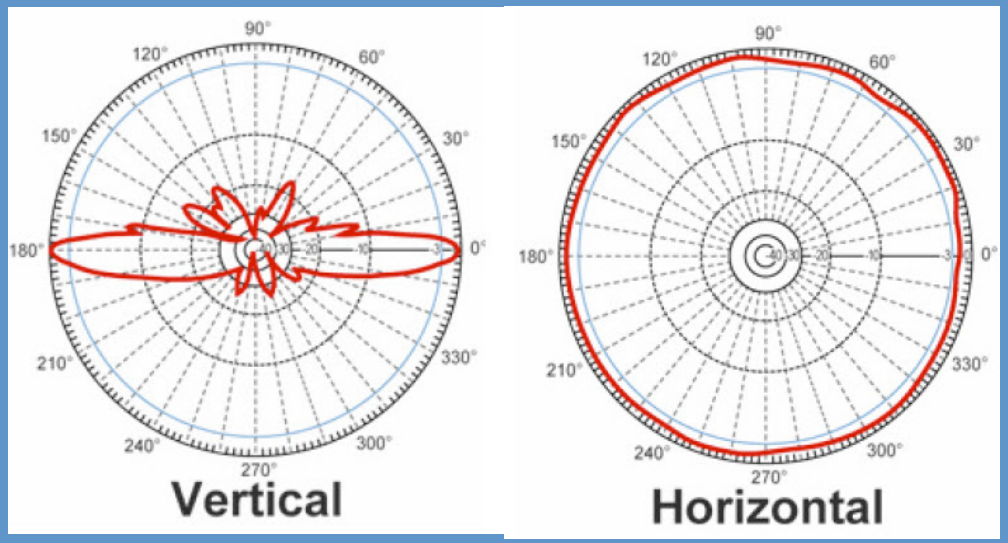
GPS (Global Positioning System)

对于知道高度和两个无线点位置,更好地利用GPS(全球定位系统)

Alignment 模式

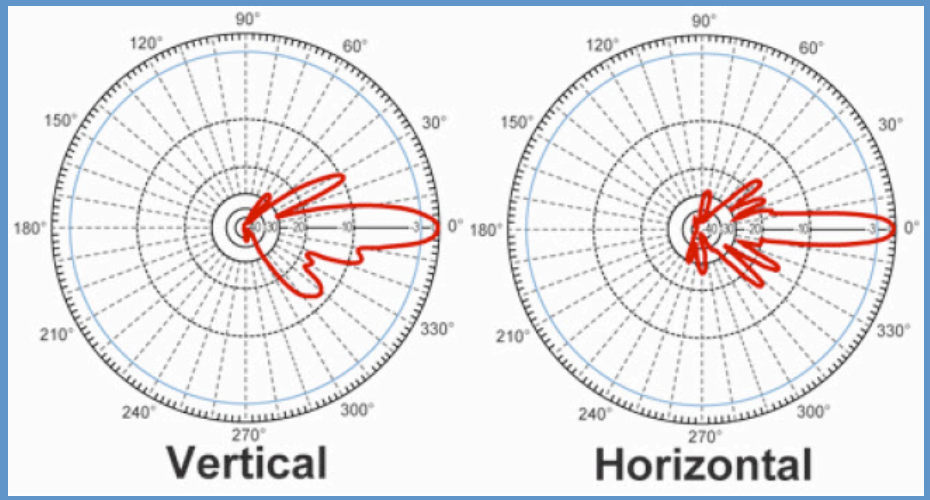


天线型号



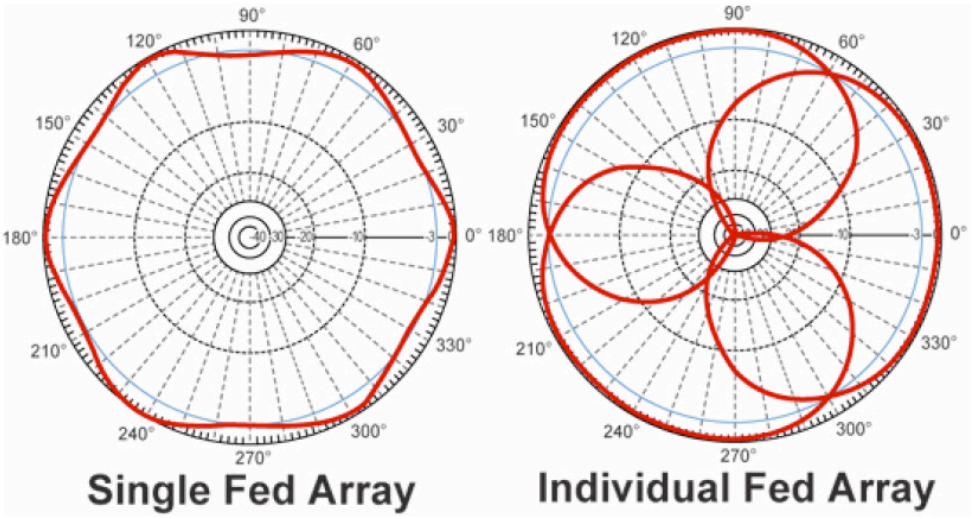
全向天线

定向天线



扇区天线阵列


©HyperLink


90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
Single Fed Array
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
Individual Fed Array

扇区天线安装图片

天气防护

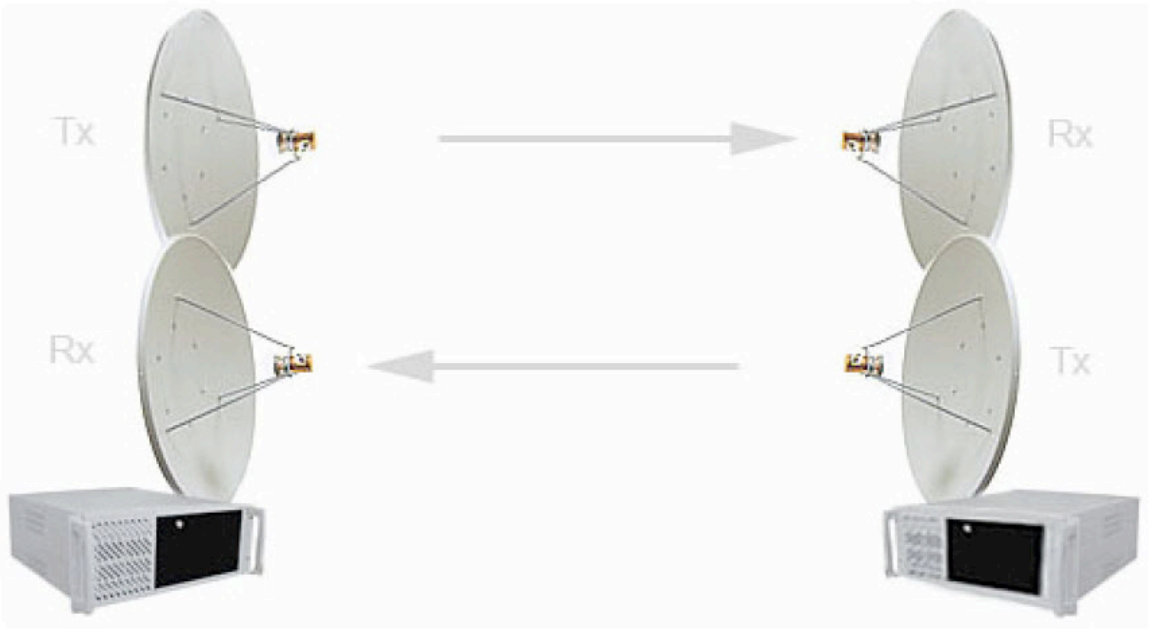
天气对无线网络系统影响十分明显.
因此,我们必须注意:

- 连接器必须密封，以保护他们免受腐蚀

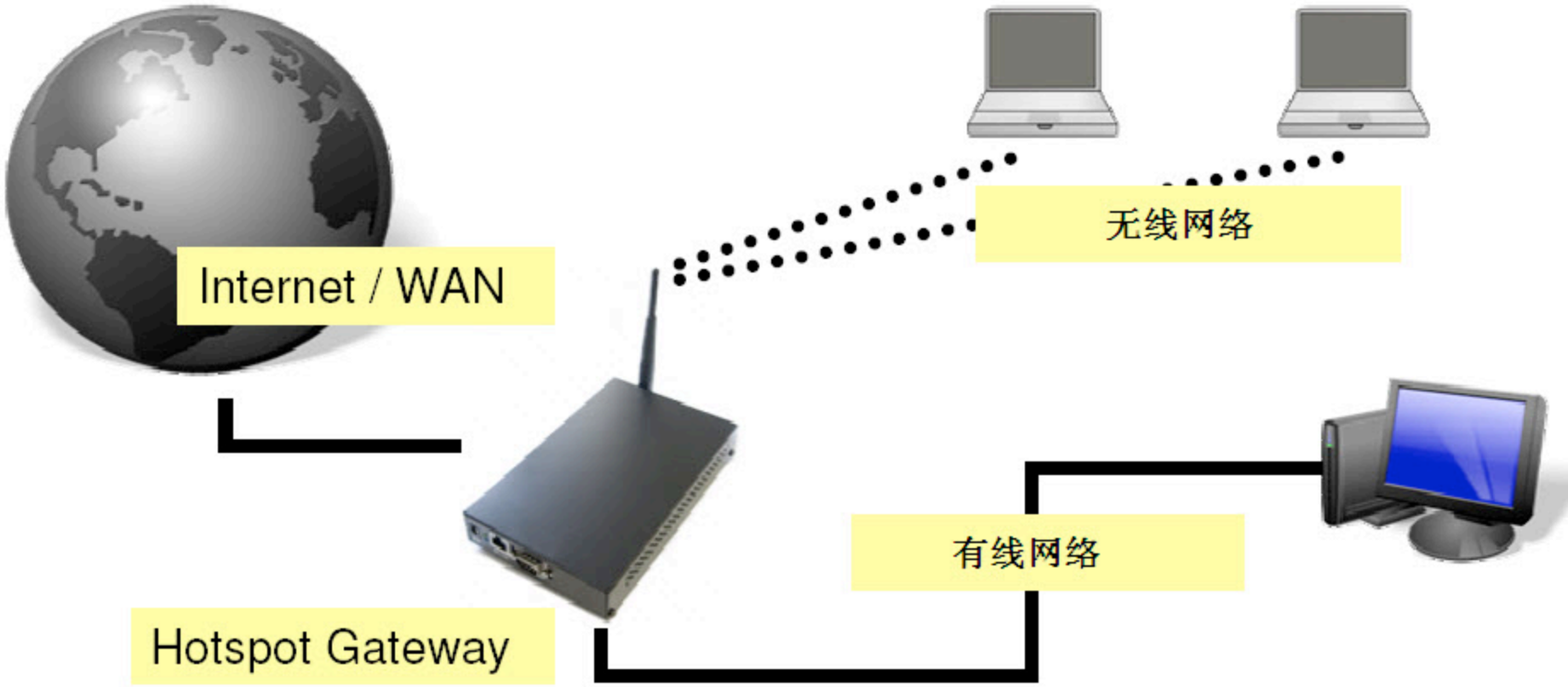
天气防护(确保您的设备安全)

点对点(Dual Nstream)

1. 每个接收站使用2单元天线和2单位miniPCI线网卡
2. 一个传输连接,一个接收连接.
3. Mikrc



示例Hotspot网络



Hotspot系统可以用于有线或无线网络,或者同时应用于无线和有线网络

Hotspot网络使用网桥拓扑