

Altai Certification Training WiFi Network Optimization

Professional Services
Altai Technologies Limited



Urban Network



Rural Network



Enterprise Network

- Problem
- Coverage
- Channel Usage and Capacity
- Noise and interference

Customer complain item

- No coverage
- Cannot connect
- Low Throughput
- Easily to lose the connection

- Coverage issue
- Channel Usage and Capacity
- Noise or interference

Coverage

How to find out

- Coverage mapping (drive test)
- Customer complain
- AP MCS statistic

Solution

- Adjust antenna direction, tilt or height to focus on weak coverage location
- Adding new sites
- Adding C1n-C1n back to back pair

AP MCS Statistic (Good)

Data Rate Usage Distribution Statistics

Data Rate Usage Distribution [clear all to zeros](#)

Refresh

Rate	#Tx	TxBytes	TxBytes%	#Rx	RxBytes	RxBytes%
1M	0	0	0%	0	0	0%
2M	0	0	0%	0	0	0%
5.5M	0	0	0%	0	0	0%
11M	0	0	0%	0	0	0%
6M	2446354	250521876	32%	218506	27542370	0%
9M	0	0	0%	0	0	0%
12M	0	0	0%	298	36226	0%
18M	0	0	0%	97	11882	0%
24M	0	0	0%	0	0	0%
36M	0	0	0%	0	0	0%
48M	0	0	0%	0	0	0%
54M	0	0	0%	0	0	0%
MCS0	438	97252	0%	0	0	0%
MCS1	228	246526	0%	0	0	0%
MCS2	715	968516	0%	0	0	0%
MCS3	3072	4538939	0%	0	0	0%
MCS4	29196	44250370	5%	0	0	0%
MCS5	27682	41260929	5%	0	0	0%
MCS6	2645	3066422	0%	0	0	0%
MCS7	0	0	0%	0	0	0%
MCS8	0	0	0%	0	0	0%
MCS9	0	0	0%	0	0	0%
MCS10	0	0	0%	0	0	0%
MCS11	0	0	0%	0	0	0%
MCS12	15409	19328218	2%	20	2785	0%
MCS13	122558	108240758	13%	83	23848	0%
MCS14	794440	202722251	20%	48764	64893746	2%
MCS15	540343	99966437	12%	2868400	2691932743	98%
MCS16	0	0	0%	0	0	0%
MCS17	0	0	0%	0	0	0%
MCS18	0	0	0%	0	0	0%
MCS19	0	0	0%	0	0	0%
MCS20	0	0	0%	0	0	0%
MCS21	0	0	0%	0	0	0%
MCS22	0	0	0%	0	0	0%
MCS23	0	0	0%	0	0	0%
Total	3983080	775208494	-	3136168	2784443600	-

Close

MCS Throughput Table

20 MHz speeds (long guard interval)

Modulation and coding	1 SS	2 SS	3 SS
BPSK, R=1/2	6.5 (MCS 0)	13.0 (MCS 8)	19.5 (MCS 16)
QPSK, R=1/2	13.0 (MCS 1)	26.0 (MCS 9)	39.0 (MCS 17)
QPSK, R=3/4	19.5 (MCS 2)	39.0 (MCS 10)	58.5 (MCS 18)
16-QAM, R=1/2	26.0 (MCS 3)	52.0 (MCS 11)	78.0 (MCS 19)
16-QAM, R=3/4	39.0 (MCS 4)	78.0 (MCS 12)	117.0 (MCS 20)
64-QAM, R=1/2	52.0 (MCS 5)	104.0 (MCS 13)	156.0 (MCS 21)
64-QAM, R=3/4	58.5 (MCS 6)	117.0 (MCS 14)	175.5 (MCS 22)
64-QAM, R=5/6	65.0 (MCS 7)	135.0 (MCS 15)	195.0 (MCS 23)

AP MCS Statistic (Bad)

Data Rate Usage Distribution Statistics

Data Rate Usage Distribution [clear all to zeros](#)

Rate	#Tx	TxBytes	TxBytes%	#Rx	RxBytes	RxBytes%
1M	2149239	503592475	89%	28930640	6168663236	88%
2M	0	0	0%	45537	2639734	0%
5.5M	0	0	0%	20053	1618401	0%
11M	0	0	0%	336	20611	0%
6M	0	0	0%	2705	375961	0%
9M	0	0	0%	920	175133	0%
12M	1	364	0%	375	41409	0%
18M	0	0	0%	70	2997	0%
24M	2	728	0%	87	4344	0%
36M	0	0	0%	8	224	0%
48M	0	0	0%	0	0	0%
54M	0	0	0%	1	68	0%
MCS0	0	0	0%	22584	6519461	0%
MCS1	9024	6738634	1%	22751	13330576	0%
MCS2	7411	7691009	1%	17492	17159860	0%
MCS3	9273	9842951	1%	18795	20377219	0%
MCS4	9613	8782754	1%	14140	14808090	0%
MCS5	6700	5405154	0%	3511	3236395	0%
MCS6	8694	6091576	1%	303	261230	0%
MCS7	20506	8836905	1%	18	2084	0%
MCS8	0	0	0%	427	66973	0%
MCS9	0	0	0%	44	5556	0%
MCS10	0	0	0%	0	0	0%
MCS11	4819	6051441	1%	0	0	0%
MCS12	1511	1658180	0%	0	0	0%
MCS13	73	46578	0%	0	0	0%
MCS14	1	96	0%	0	0	0%
MCS15	0	0	0%	0	0	0%
MCS16	0	0	0%	0	0	0%
MCS17	0	0	0%	0	0	0%
MCS18	0	0	0%	0	0	0%
MCS19	0	0	0%	0	0	0%
MCS20	0	0	0%	0	0	0%
MCS21	0	0	0%	0	0	0%
MCS22	0	0	0%	0	0	0%
MCS23	0	0	0%	0	0	0%
Total	2226867	564738845	-	29100797	6249309562	-

How to find out

- Coverage mapping (drive test)
- Customer complain
- AP MCS statistic

Solution

- Adjust antenna direction, tilt or height to focus on weak coverage location
- Adding new sites
- Adding C1n-C1n back to back pair

Adjust antenna tilt

- Increase antenna down tilt to focus on the nearby region and coverage.

- Scenario 1 ($h = 500\text{m}$)

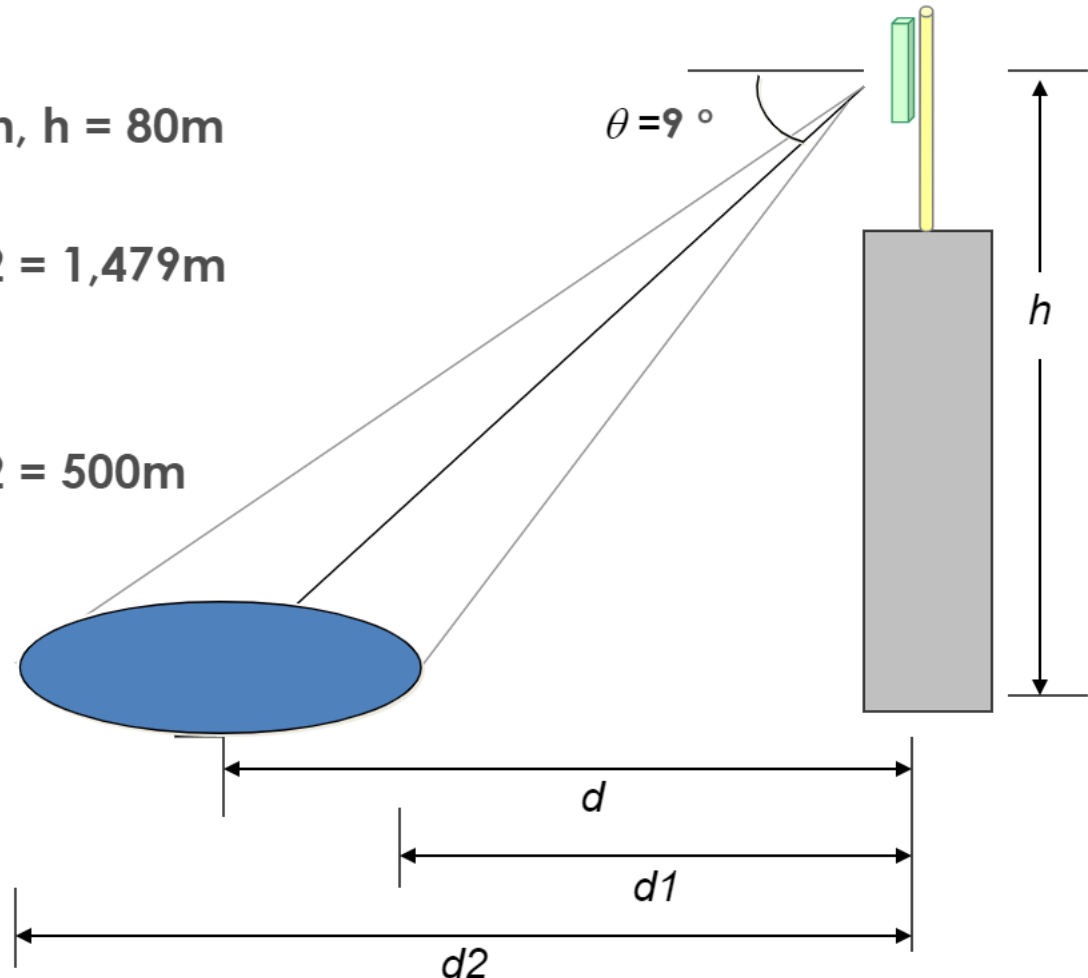
Original down tilt = 500m , $h = 80\text{m}$

$$\theta = 9^\circ$$

$$d = 500\text{m}, d1 = 290\text{m}, d2 = 1,479\text{m}$$

Increase down tilt to 15°

$$d = 298\text{m}, d1 = 198\text{m}, d2 = 500\text{m}$$



Adjust antenna tilt

- Increase antenna down tilt to focus on the nearby region and coverage.

- Scenario 1 ($h = 500\text{m}$)

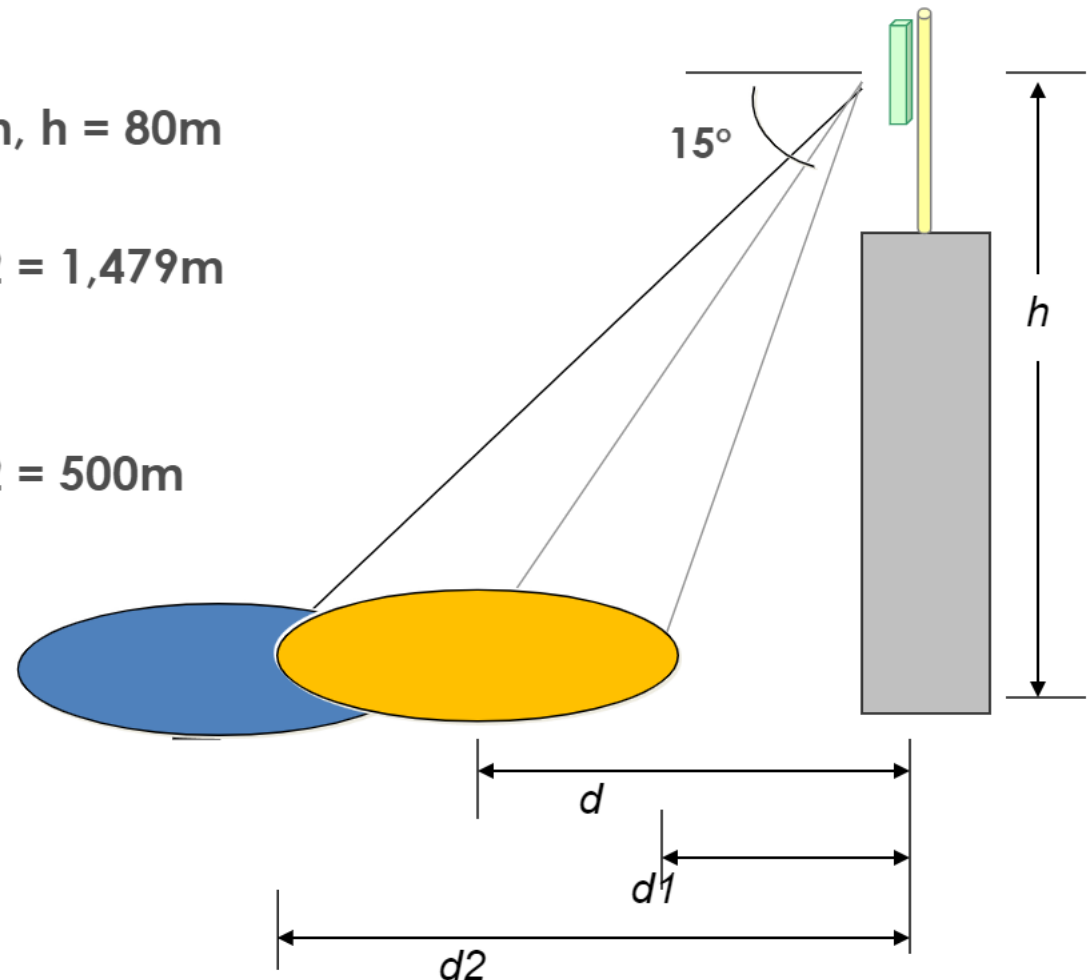
Original down tile = 500m , $h = 80\text{m}$

$$\theta = 9^\circ$$

$$d = 500\text{m}, d1 = 290\text{m}, d2 = 1,479\text{m}$$

Increase down tilt to 15°

$$d = 298\text{m}, d1 = 198\text{m}, d2 = 500\text{m}$$

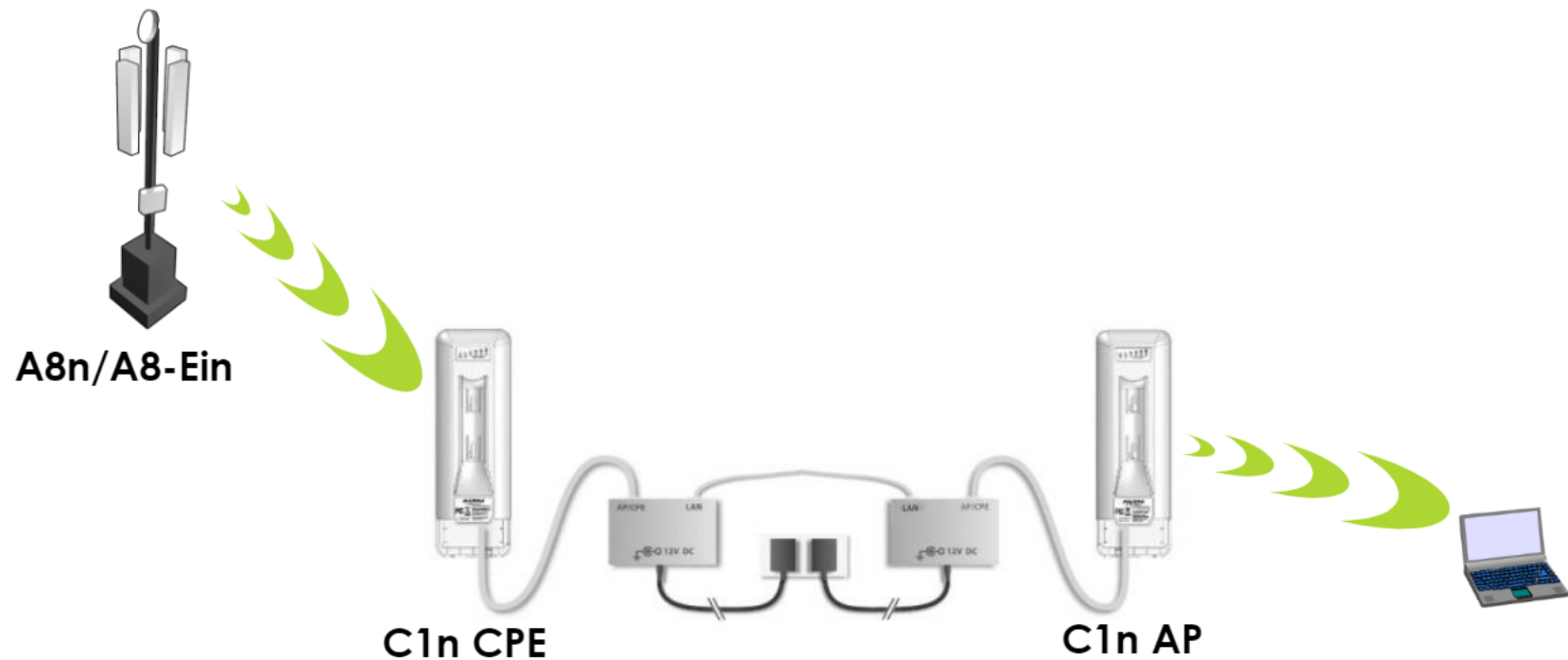


Coverage mapping result

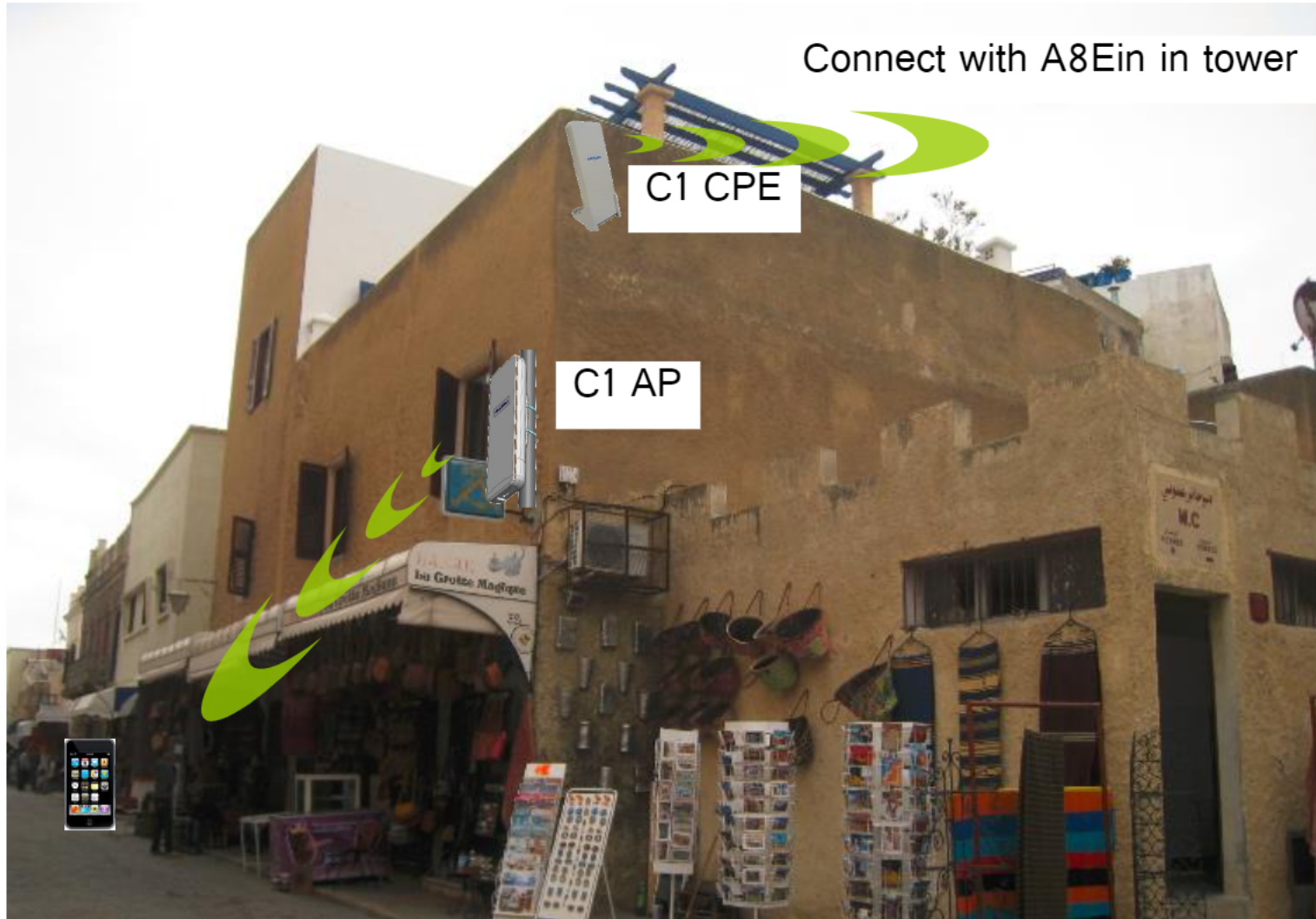


C1n back to back diagram

C1n back to back is that one C1n work as CPE (station) mode to connect to the A8n/A8-Ein which maybe far away, then other C1n which will work as AP connect to the C1n CPE via Ethernet cable and PoE adaptor provide the WiFi for the area where the A8n/A8-Ein can not cover.



C1n-C1n corner shop Enhance coverage



New A8Ein vs C1n CPE-C1n AP Altai Super WiFi

New site configuration	Adding new A8Ein	C1n CPE -C1n AP
Coverage	Large	Medium (Street level)
Increase total network capacity	Yes	No
Remote AWMS management	Yes	Yes
Site requirement	High (Rooftop or tower)	Low (Corner shop or lamp post)
Backhaul	Yes	No
Power requirement	Yes	Yes
Hardware cost	Normal	Low
Installation cost	Normal	Low

Channel Usage and Capacity

Channel Usage from A8Ein



Status Configuration Administration Tools Statistics About

System Interface Log

[Radio0\(2.4G\)](#) - [Radio1\(5G\)](#) - [Ethernet](#)

Status Statistic **Channel Usage** WLAN Association List

Data Rate Usage Distribution: [View](#)

Channel Usage List

Sector	State	Tx% (Avg)	Rx% (Avg)	Busy% (Avg)	Noise Floor (dBm)	CTL0	CTL1	EXT0	EXT1
0	ON	0%(0%)	16%(12%)	17%(13%)	-85	-85	-80	0	0
1	ON	5%(3%)	5%(3%)	15%(11%)	-83	-85	-83	0	0
2	ON	0%(0%)	21%(16%)	25%(19%)	-85	-84	-85	0	0
3	ON	0%(0%)	10%(8%)	11%(8%)	-85	-97	-84	0	0

$Tx + Rx < Busy \%$

The other AP and client occupy part of radio air time

How to find out

- From A8Ein Channel Usage Statistic

Continuous high channel usage (>90%) leads to low user throughput, high latency.

The channel usage is by AP itself or other AP.

- AP itself -> capacity issue
- Other AP -> channel usage issue

Solution

- Change the frequency
- Adjust antenna direction, tilt or height to limit the exposure of antenna from of AP traffic

Frequency Scanning Result

Channel Scan Result

Channel Usage Info

Overall BSS Info

Sector0 BSS Info

Sector1 BSS Info

Sector2 BSS Info

Sector3 BSS Info

Sector0

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-91	-88	-89	-89	-88	-88	-84	-89	-88	-84	-88	-88	-99
Noise Floor (CT0)	-91	-88	-89	-89	-88	-88	-84	-89	-88	-84	-88	-88	-99
Noise Floor (CT1)	-90	-85	-86	-85	-85	-85	-82	-86	-84	-82	-85	-86	-91
Noise Floor (EX0)	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Floor (EX1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Busy %	54	39	18	57	24	60	46	54	42	52	58	42	46
#BSS	7	1	1	1	3	4	0	6	1	0	11	0	2

Sector1

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-88	-91	-92	-87	-85	-85	-85	-85	-85	-84	-87	-84	-90
Noise Floor (CT0)	-88	-91	-92	-87	-85	-85	-85	-85	-85	-84	-87	-84	-90
Noise Floor (CT1)	-90	-88	-89	-87	-85	-84	-84	-85	-86	-83	-86	-84	-88
Noise Floor (EX0)	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Floor (EX1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Busy %	37	24	20	17	47	55	47	82	37	28	62	30	33
#BSS	3	2	0	0	2	6	0	6	4	0	5	0	2

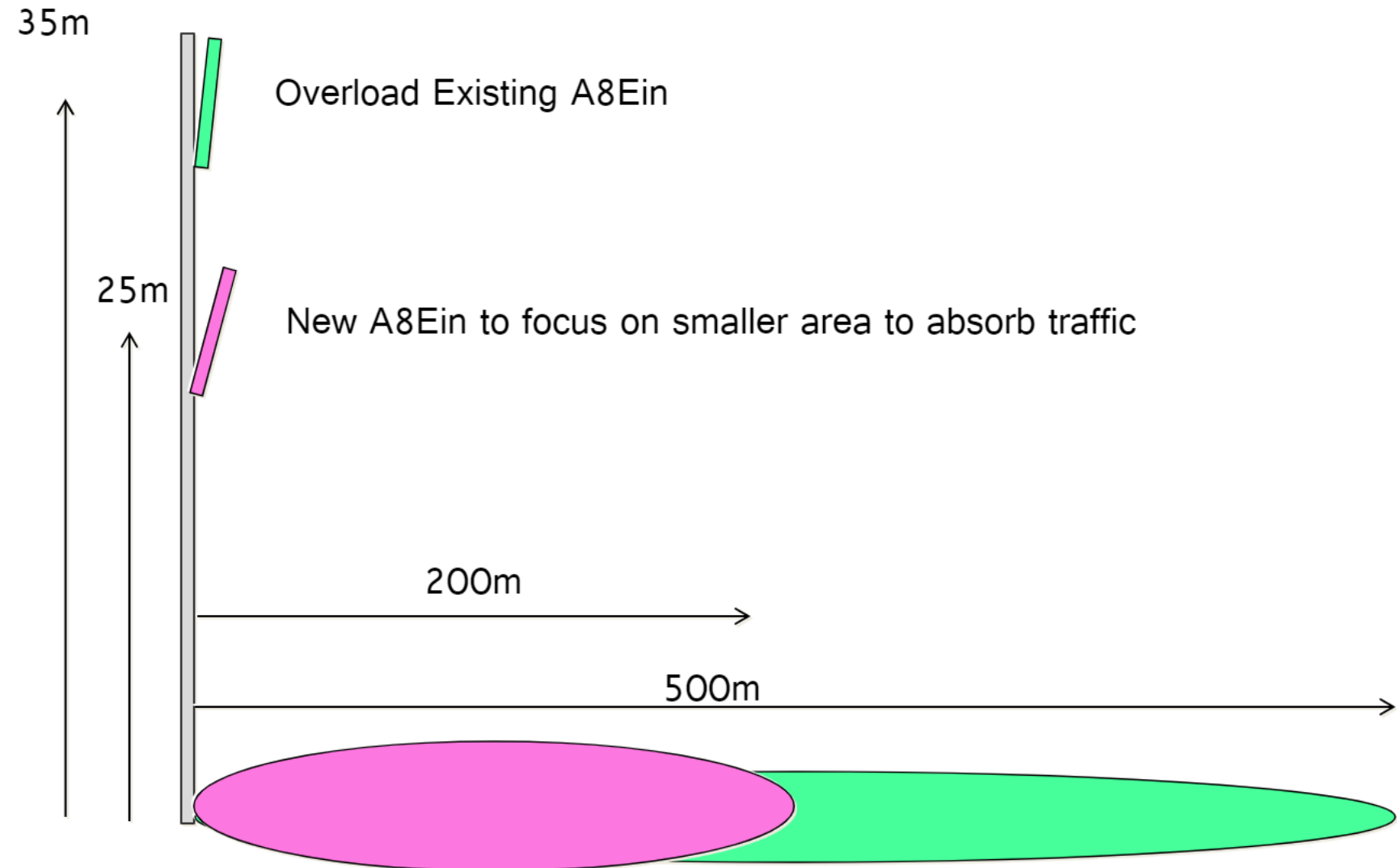
Sector2

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-89	-90	-86	-88	-85	-86	-86	-87	-86	-85	-93	-97	-97
Noise Floor (CT0)	-89	-90	-86	-88	-85	-86	-86	-87	-86	-85	-93	-97	-97
Noise Floor (CT1)	-89	-87	-86	-86	-86	-86	-88	-87	-86	-86	-86	-91	-91

Solution

- Adding new sites
- Adding new A8Ein in the same site
 - With smaller coverage and focus on high user density area
- AirFi
 - It will increase the overall base station throughput but not making every client happy

Adding new A8Ein in same tower



Noise and Interference

2.4GHz is sharing band

Noise level increase as number of WiFi AP and client increase. No particular source.

Interference is coming from particular source, e.g. high power transmitter (non-standard compliance device)

Noise Level

Noise level is available from A8Ein Web GUI or AWMS.

The screenshot displays the Altai Web GUI interface. At the top, there are navigation tabs: Status, Configuration, Administration, Tools, Statistics, and About. Below these, there are sub-tabs: System, Interface, and Log. The main content area shows the configuration for Radio0(2.4G), with links for Radio1(5G) and Ethernet. There are buttons for Status, Statistic, Channel Usage, WLAN, and Association List. The 'Channel Usage' button is selected. Below the buttons, there is a section for 'Data Rate Usage Distribution' with a 'View' link. The main part of the screenshot is a table titled 'Channel Usage List'.

Sector	State	Tx% (Avg)	Rx% (Avg)	Busy% (Avg)	Noise Floor (dBm)	CTL0	CTL1	EXT0	EXT1
0	ON	0%(0%)	16%(12%)	17%(13%)	-85	-85	-80	0	0
1	ON	5%(3%)	5%(3%)	15%(11%)	-83	-85	-83	0	0
2	ON	0%(0%)	21%(16%)	25%(19%)	-85	-84	-85	0	0
3	ON	0%(0%)	10%(8%)	11%(8%)	-85	-97	-84	0	0

Frequency Scan

Channel Scan Result

Channel Usage Info

Overall BSS Info

Sector0 BSS Info

Sector1 BSS Info

Sector2 BSS Info

Sector3 BSS Info

Sector0

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-91	-88	-89	-89	-88	-88	-84	-89	-88	-84	-88	-88	-99
Noise Floor (CT0)	-91	-88	-89	-89	-88	-88	-84	-89	-88	-84	-88	-88	-99
Noise Floor (CT1)	-90	-85	-86	-85	-85	-85	-82	-86	-84	-82	-85	-86	-91
Noise Floor (EX0)	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Floor (EX1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Busy %	54	39	18	57	24	60	46	54	42	52	58	42	46
#BSS	7	1	1	1	3	4	0	6	1	0	11	0	2

Sector1

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-88	-91	-92	-87	-85	-85	-85	-85	-85	-84	-87	-84	-90
Noise Floor (CT0)	-88	-91	-92	-87	-85	-85	-85	-85	-85	-84	-87	-84	-90
Noise Floor (CT1)	-90	-88	-89	-87	-85	-84	-84	-85	-86	-83	-86	-84	-88
Noise Floor (EX0)	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Floor (EX1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Busy %	37	24	20	17	47	55	47	82	37	28	62	30	33
#BSS	3	2	0	0	2	6	0	6	4	0	5	0	2

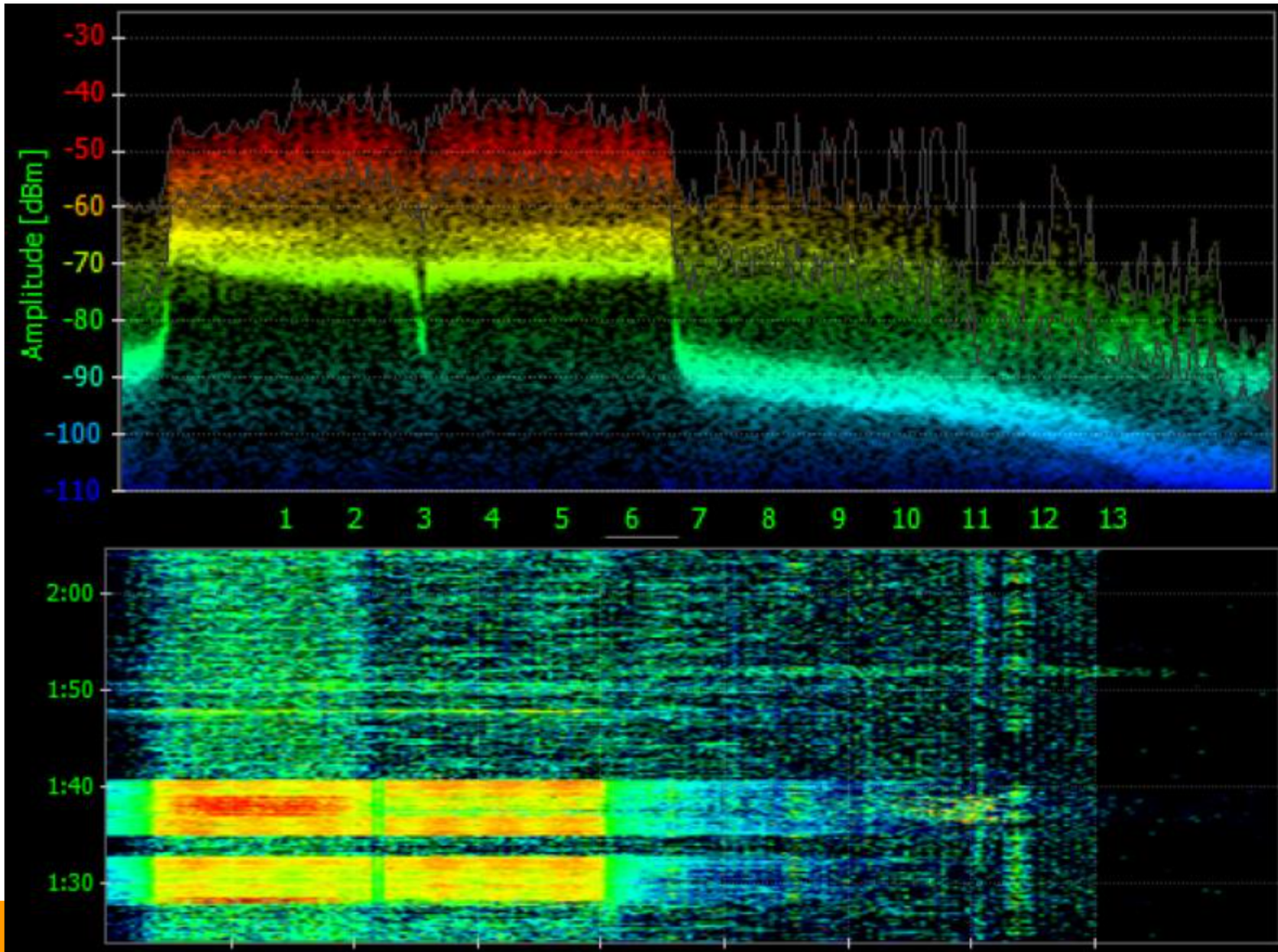
Sector2

CH	1	2	3	4	5	6	7	8	9	10	11	12	13
Noise Floor	-89	-90	-86	-88	-85	-86	-86	-87	-86	-85	-93	-97	-97
Noise Floor (CT0)	-89	-90	-86	-88	-85	-86	-86	-87	-86	-85	-93	-97	-97
Noise Floor (CT1)	-89	-87	-86	-86	-86	-86	-88	-87	-86	-86	-86	-91	-91

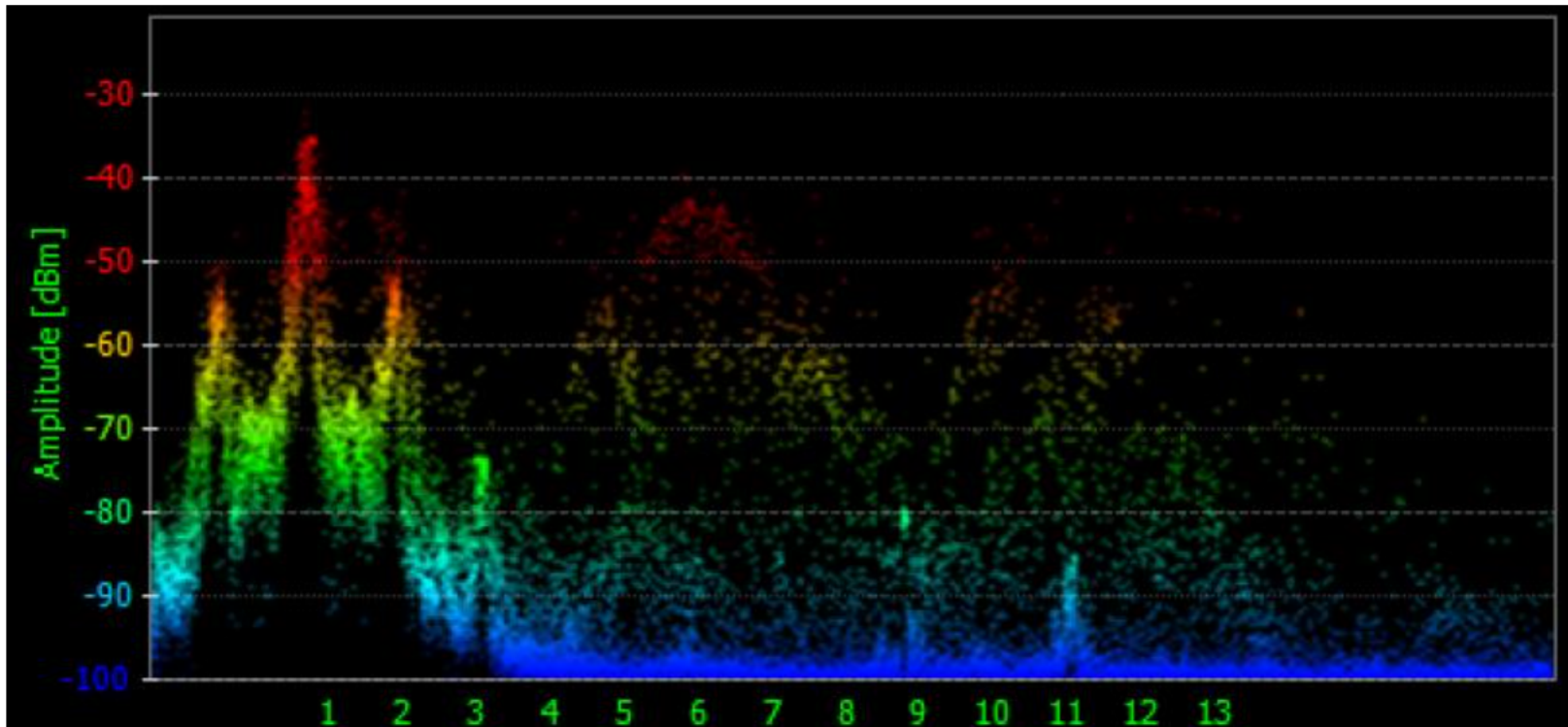
Interference

- Interference is coming from particular source, e.g. high power transmitter (non-standard compliance device)
- Interference is very rare case. Nearly all cases in undeveloped countries that many high power non-standard compliance transmitter existed.
- Need to find out the interference source to eliminate or avoid it.
- Handheld spectrum analyzer to locate the source.

Normal 802.11n spectrum

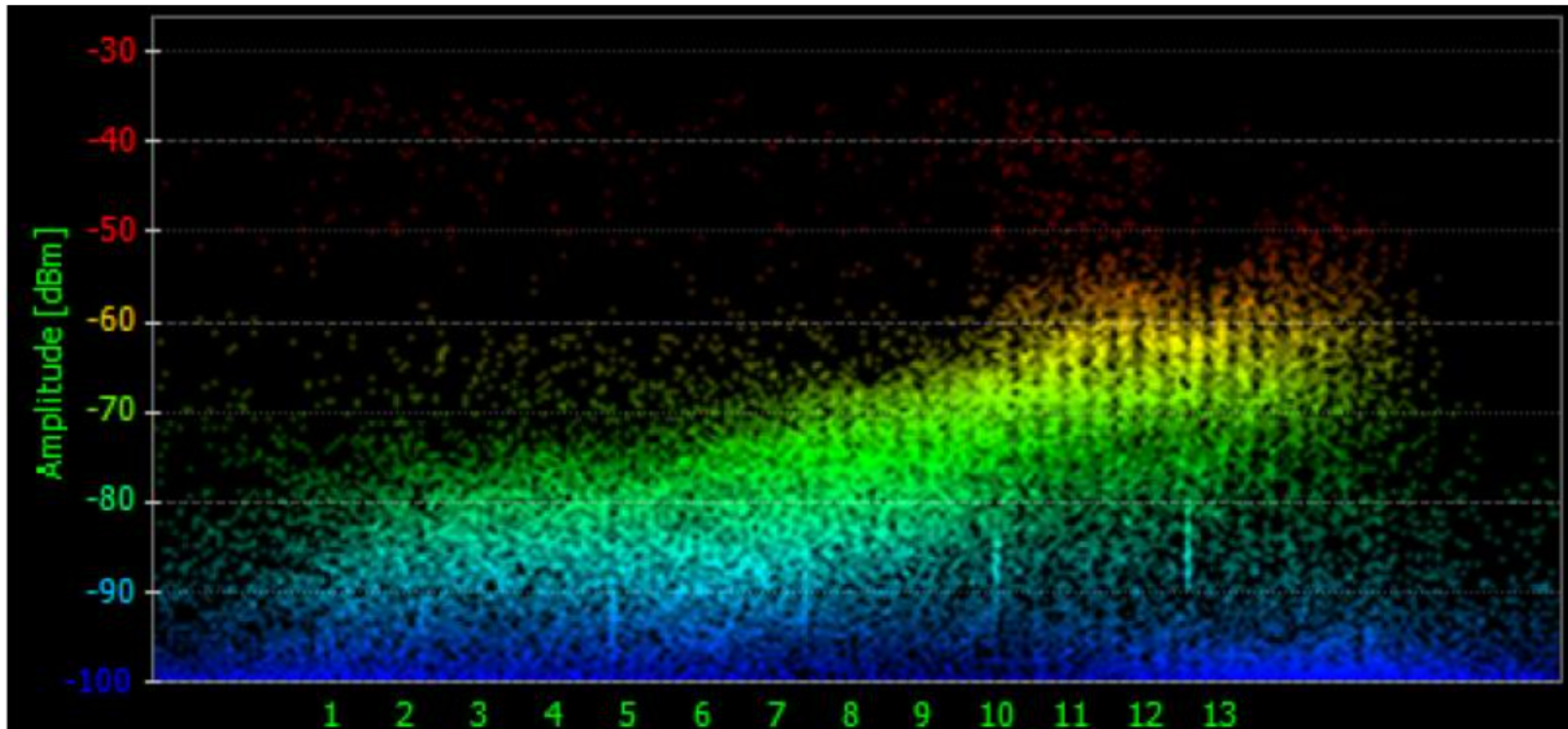


Spectrum for audio video transmitter



3 peaks narrow band signal. Constant transmitting.

Spectrum for microwave oven



Very wide band and mountain shape. Continue for a few minutes.

**Illegal transmitter or malfunction transmitter
- ask the owner to turn it off and fix it**

Interference source cannot be eliminated -> avoid it

- **turn AP antenna direction back to the interference source**
- **metal grid between AP antenna and interference source**
- **Move the antenna sites to other location**

A2 and PTP link optimization

A2 PTP Link Status between JAD-0002 and JAD-MCO

A2 on JAD-0002 with IP address 10.119.4.103

A2 on JAD-MCO with IP address 10.119.4.124



Status > 5G Radio Association Table

Status	ID	MAC Address	RSSI	Status	Bridge
System	STA0	00:19:be:74:53:40	-68	Reachable	0
Clients Statistics					
Rogue AP Detection					
5G radio Associated Bridge					



00:19:be:74:53:40

Association ID: 0

Encryption	Advertised Cipher	Power Save		
open	none	off		
Deauthentication	Disassociation			
0	0			
	Data	Multicast	Management	Control
Receive	3006919	2280354	179	0
Transmit	918465	0	543	0
Received Signal Strength (RSSI)	TX Data Rate (Mbps)			
-68	130.0			
RX Duplicate Frames	RX CRC Errors			
1	0			



Status > 5G Radio Association Table

Status	ID	MAC Address	RSSI	Status	Bridge
System	STA0	00:19:be:74:53:9e	-70	Reachable	0
Clients Statistics					
Rogue AP Detection					
5G radio Associated Bridge					



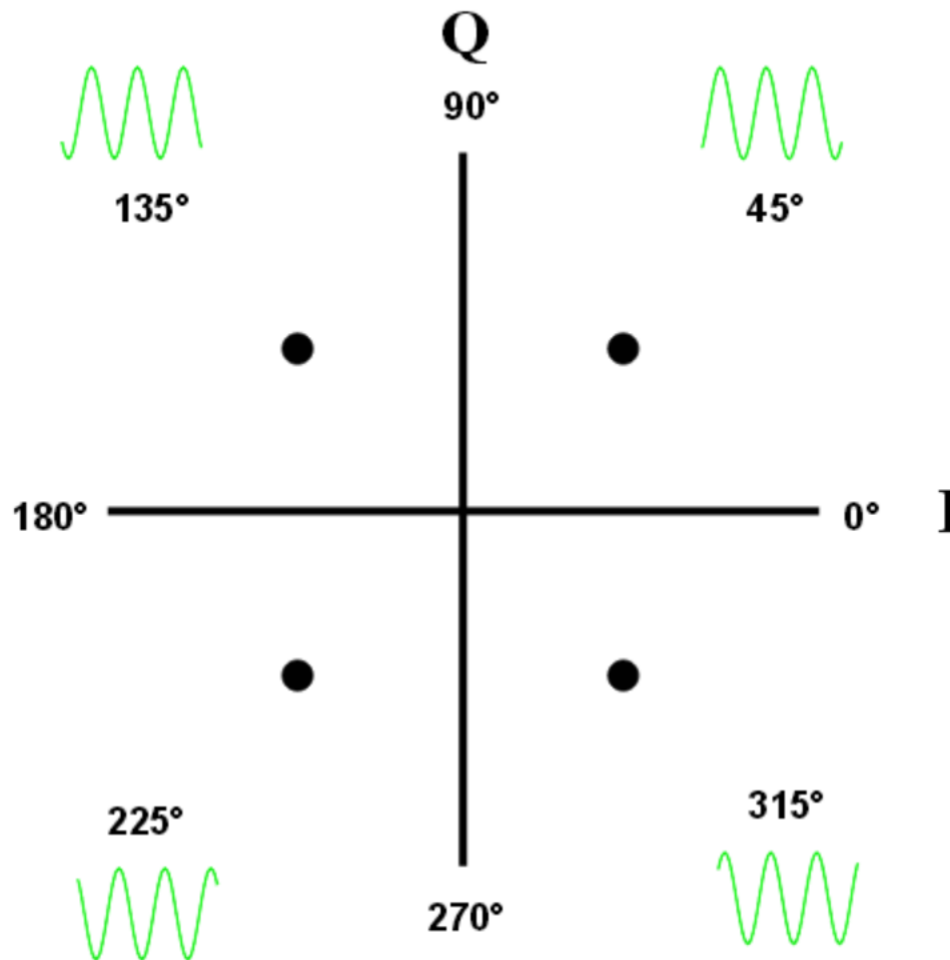
00:19:be:74:53:9e

Association ID: 0

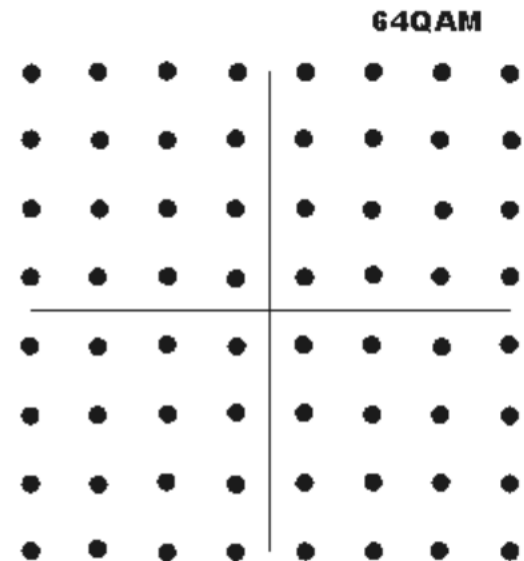
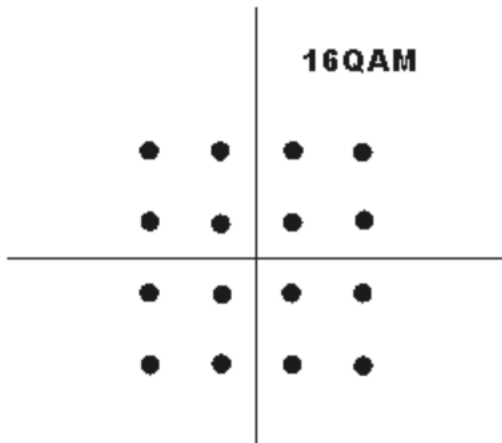
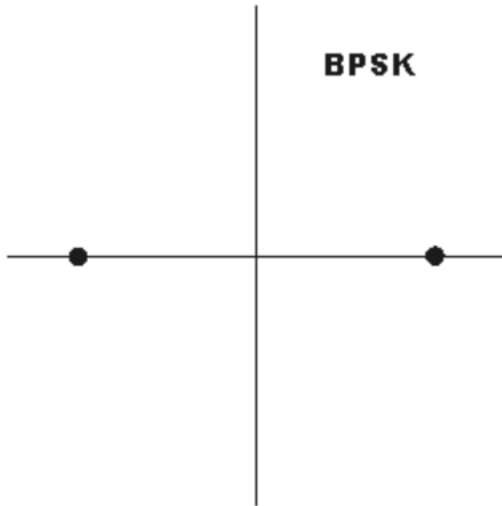
Encryption	Advertised Cipher	Power Save		
open	none	off		
Deauthentication	Disassociation			
0	0			
	Data	Multicast	Management	Control
Receive	366012	60118	2	0
Transmit	968600	0	2	0
Received Signal Strength (RSSI)	TX Data Rate (Mbps)			
-70	130.0			
RX Duplicate Frames	RX CRC Errors			
0	0			

Thank You

QPSK and Phase relationship



BPSK 16QAM



Bit rate for modulation

MODULATION	BITS PER SYMBOL	SYMBOL RATE
BPSK	1	1 x bit rate
QPSK	2	1/2 bit rate
8PSK	3	1/3 bit rate
16QAM	4	1/4 bit rate
32QAM	5	1/5 bit rate
64QAM	6	1/6 bit rate

Altai A8Ein and C1n Rx Sensitivity

2.4 GHz	MCS	Data rate	Throughput	A8n Rx Sensitivity	C1n Rx Sensitivity
11b		1	0.7	-95	-96
		2	1.2	-94	-95
		5.5	3	-92	-94
		11	5	-90	-91
11g		6	2	-93	-94
		9	3	-93	-94
		12	4	-93	-94
		18	7	-92	-93
		24	9	-89	-90
		36	13	-85	-87
		48	18	-81	-83
		54	20	-80	-81
11b/g/n, HT20, SGI	0 (BPSK 1/2)	7	4	-94	-94
	1 (QPSK 1/2)	14	9	-93	-93
	2 (QPSK 3/4)	22	13	-90	-91
	3 (16QAM 1/2)	29	17	-87	-88
	4 (16 QAM 3/4)	43	26	-84	-85
	5 (64QAM 1/2)	58	35	-81	-81
	6 (64QAM 3/4)	65	39	-79	-79
	7 (64 QAM 5/6)	72	43	-77	-77
	8 (BPSK 1/2)	14	9	-91	-93
	9 (QPSK 1/2)	29	17	-90	-91
	10 (QPSK 3/4)	43	26	-88	-88
	11 (16QAM 1/2)	58	35	-84	-85
	12 (16 QAM 3/4)	87	52	-81	-82
	13 (64QAM 1/2)	116	69	-78	-78
	14 (64QAM 3/4)	130	78	-76	-76
15(64 QAM 5/6)	144	87	-74	-75	

Higher the data rate,
Higher RX sensitivity

- InSSIDer – Free, mapping and DL RSSI checking
- Fluke AirCheck
 - General DL RSSI checking
 - Check DL Noise and SNR
 - Check channel usage (incl. non-WiFi usage)
- MetaGeek Chanalyzer
 - For locating interference, very rare to use in real operation