Rural MikroTik Wireless Project

[Mapping, Design & Alignment]

Muhti Subiyantoro

Spectrum
Network Infrastructure Unit

About Me

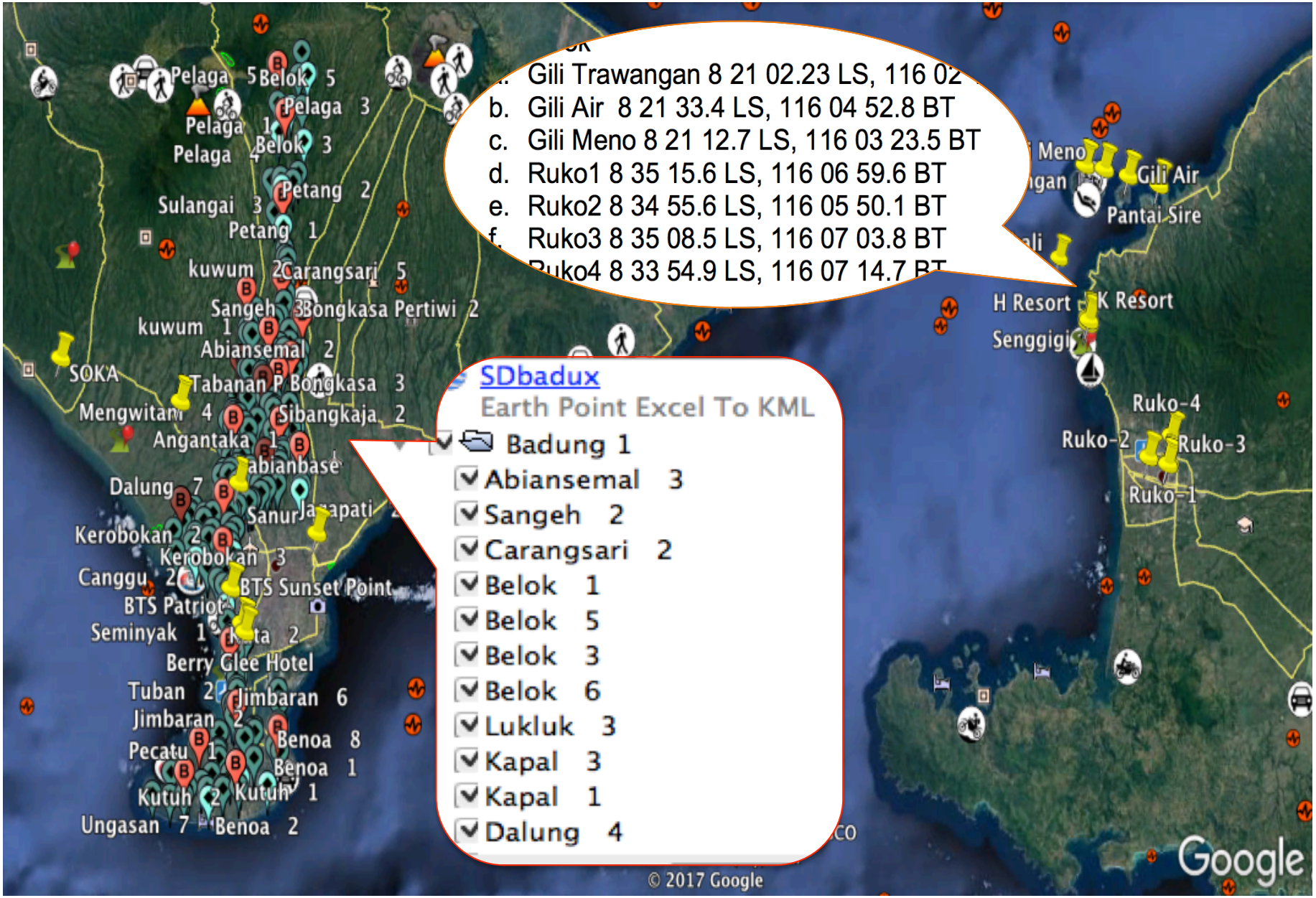
- 1974 - Born in Trenggalek
- 1999 – Graduated Electronic Eng. Universitas Muhammadiyah Malang
- 1999 – Start Working in Wireless Internet Service Provider (WISP)
- 2004 – Using MikroTik
- 2006 - PT. Spectrum Indowibawa, Surabaya
  - Technical & Training Manager
  - MikroTik Certified Trainer
  - MikroTik Academy Coordinator

About Spectrum

Network Infrastructure Unit

- Reseller Wireless & Router Equipment
- MikroTik
  - Consultant
  - Certified Training Partner
  - Network System Integrator

Wireless Project...?


b. Gili Air 8 21 33.4 LS, 116 04 52.8 BT
c. Gili Meno 8 21 12.7 LS, 116 03 23.5 BT
d. Ruko1 8 35 15.6 LS, 116 06 59.6 BT
e. Ruko2 8 34 55.6 LS, 116 05 50.1 BT
f. Ruko3 8 35 08.5 LS, 116 07 03.8 BT
Gili Air
Pantai Sire
Ruko-4
Ruko-2
Ruko-3
Ruko-1
SDbadux
Earth Point Excel To KML
Badung 1
Abiansemal 3
Sangeh 2
Carangsari 2
Belok 1
Belok 5
Belok 3
Belok 6
Lukluk 3
Kapal 3
Kapal 1
Dalung 4
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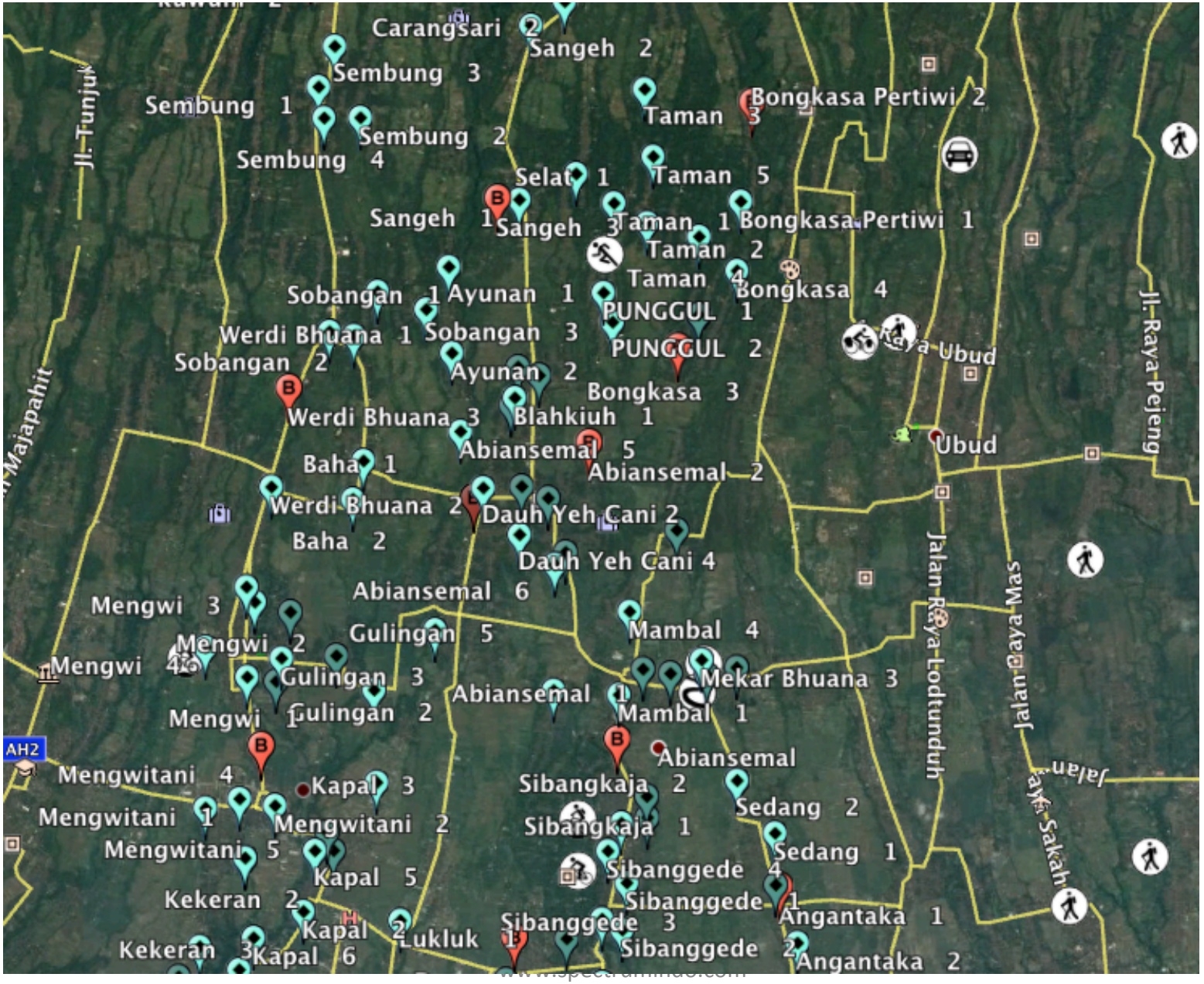
Gili Trawangan
Gili Meno
Gili Air
Pantai Sire
Jl. Raya Tj.
Ferry a bali
K Resort
H Resort
Senggigi
Ruko-4
Ruko-3
Jl. Gora 2
Ruko-2
Ruko-1


Carangsari 2
Sangeh 2
Sembung 3
Sembung 1
Sembung 2
Sembung 4
Taman 3
Bongkasa Pertiwi 2
Selat 1
Taman 5
Sangeh 1
Sangeh 3
Taman 1
Bongkasa Pertiwi 1
Taman 2
Taman 4
Bongkasa 4
Sobangan 1
Ayunan 1
PUNGGUL 1
Werdi Bhuana 1
Sobangan 3
PUNGGUL 2
Sobangan 2
Ayunan 2
Bongkasa 3
Werdi Bhuana 3
Blahkiuh 1
Abiansemal 5
Baha 1
Abiansemal 2
Werdi Bhuana 2
Dauh Yeh Cani 2
Baha 2
Dauh Yeh Cani 4
Abiansemal 6
Mengwi 3
Gulingan 5
Mambal 4
Mengwi 2
Mengwi 4
Gulingan 3
Abiansemal 1
Mekar Bhuana 3
Mengwi 1
Gulingan 2
Mambal 1
Abiansemal
Mengwitani 4
Kapal 3
Sibangkaja 2
Sedang 2
Mengwitani 1
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Sibangkaja 1
Mengwitani 5
Sedang 1
Kapal 5
Sibanggede 4
Kekeran 2
Sibanggede 1
Kapal 2
Sibanggede 3
Angantaka 1
Kekeran 3
Kapal 6
Lukluk 1
Sibanggede 2
Angantaka 2
Ubud
Jl. Raya Ubud
Jl. Raya Pejeng
Jl. Majapahit
Jalan Raya Lodtunduh
Jalan Raya Mas
Jalan Raya Sakah
AH2

Challenge…

- Link Possibility
- Heigh of tower
- Equipment type
- Efficiency (Time, Material, Resource)
- Accuration

Step to Do

- Mapping
  - Special tools for Radio Analisys
- Topology
  - PTMP, PtP
  - RING, STAR or MESH
- Link Budget
  - Device choice
- Installation
  - Efficient & Accurate

Mapping

- Software Tools
  - Special for Radio Signal Analysis
  - Matrix Connection Possibility Support
  - Wireless Network Report
  - Polar Coverage Support
  - Radio Link Report

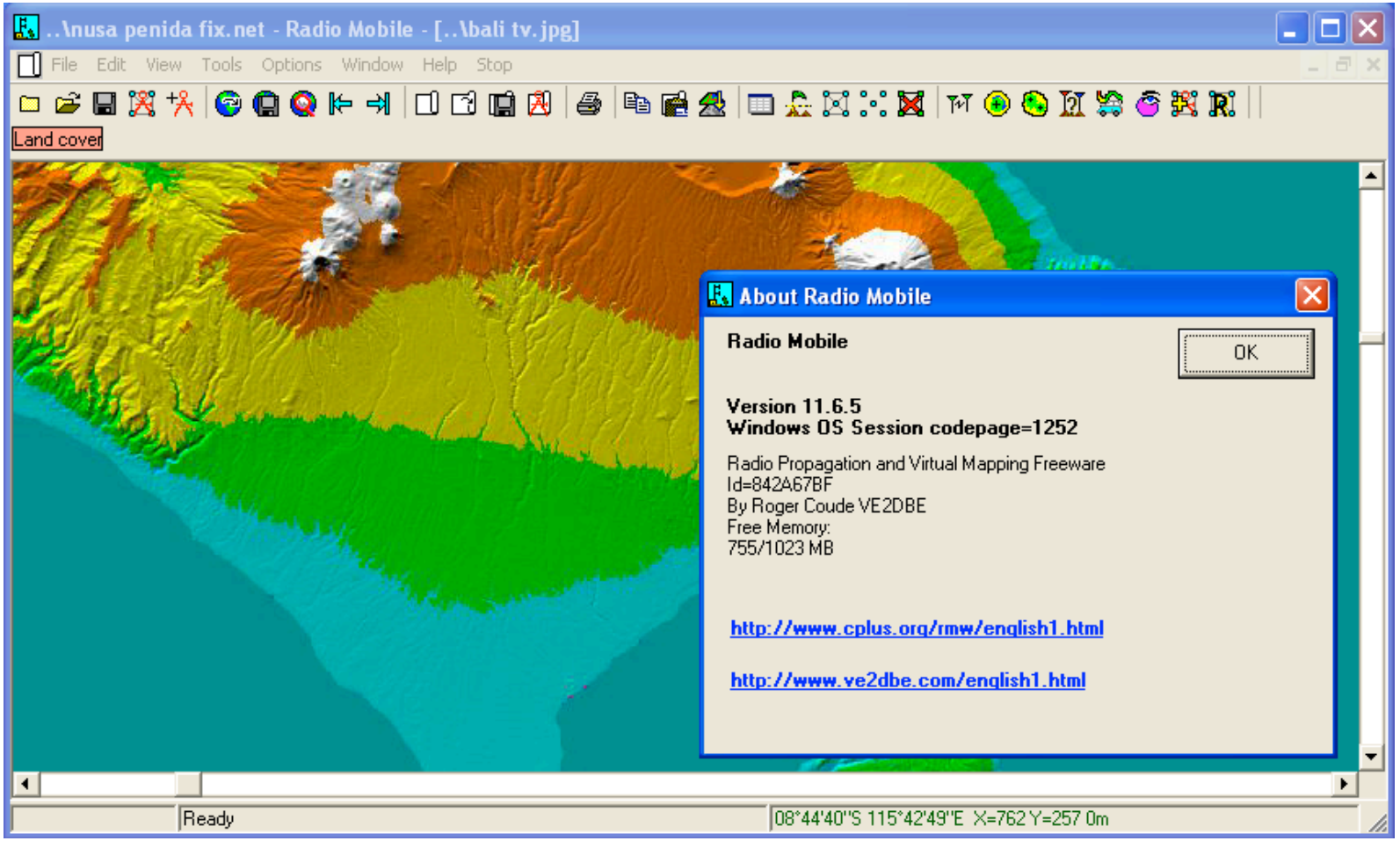
Matrix Connection Possibility Map

- Possibility Link beetween sites
  - Grouping Sites as Cell Network
  - Point as Center of Cell
  - Link as BackBone to other site

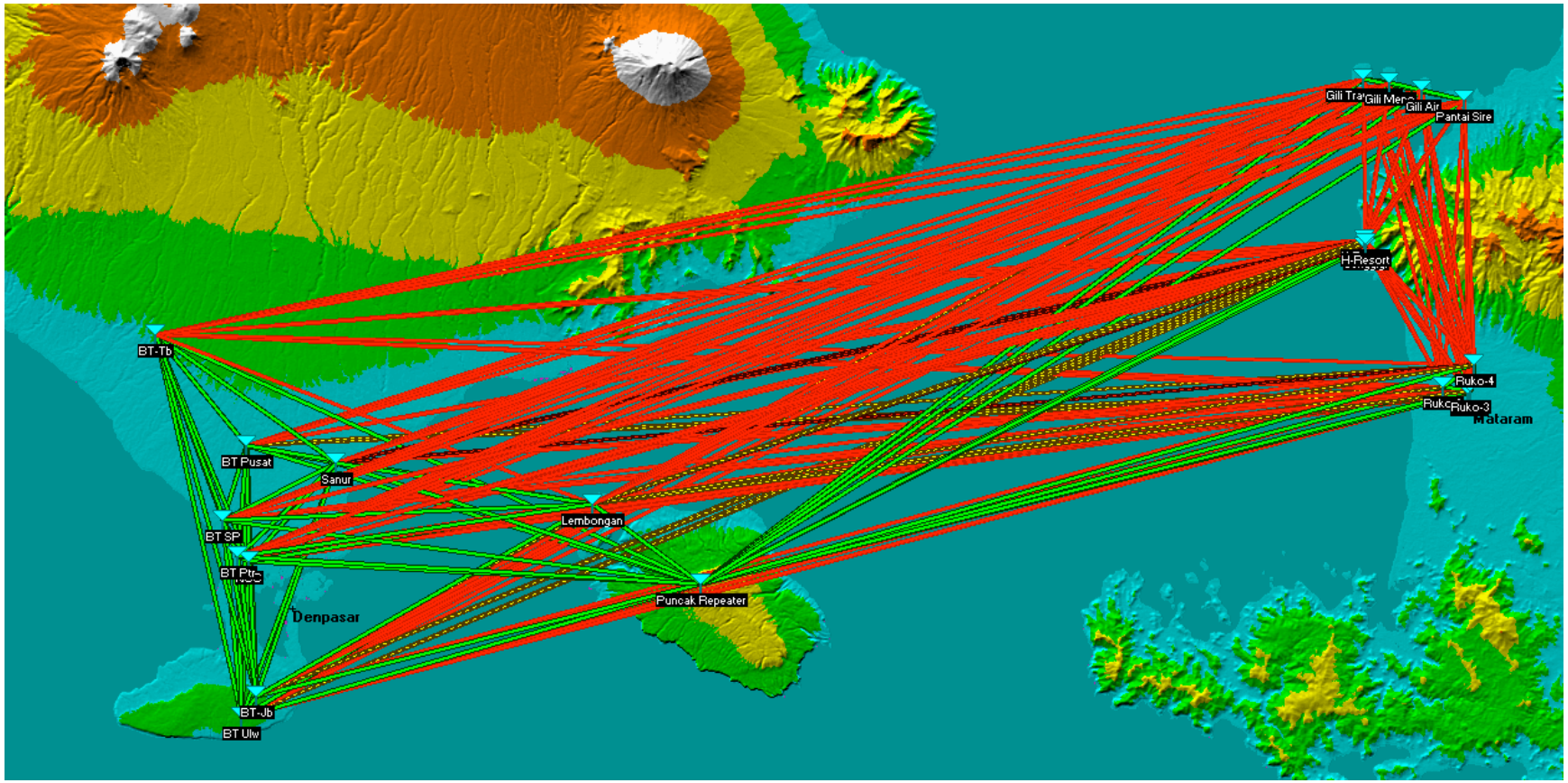
Refference Parameter

- Assume
  - Max Tower height : 30 m
  - Antenna Gain : 30 dBi
  - Antenna Beam : 360^{o} (Omni)
  - Tx power : 23 dBm
  - Receive Sensitivity : -90 dBm

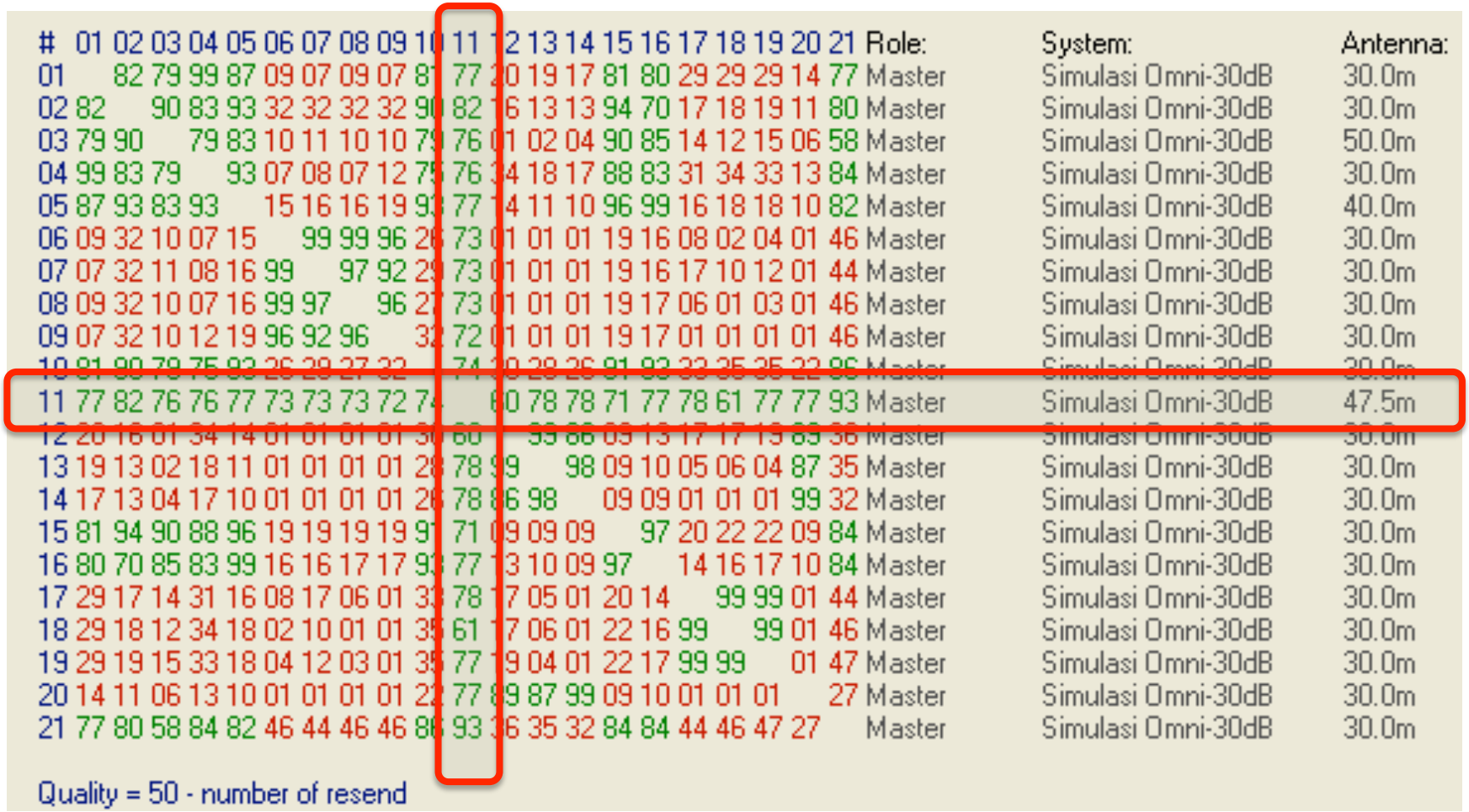
Sotware Tools



Matrix Connection Map



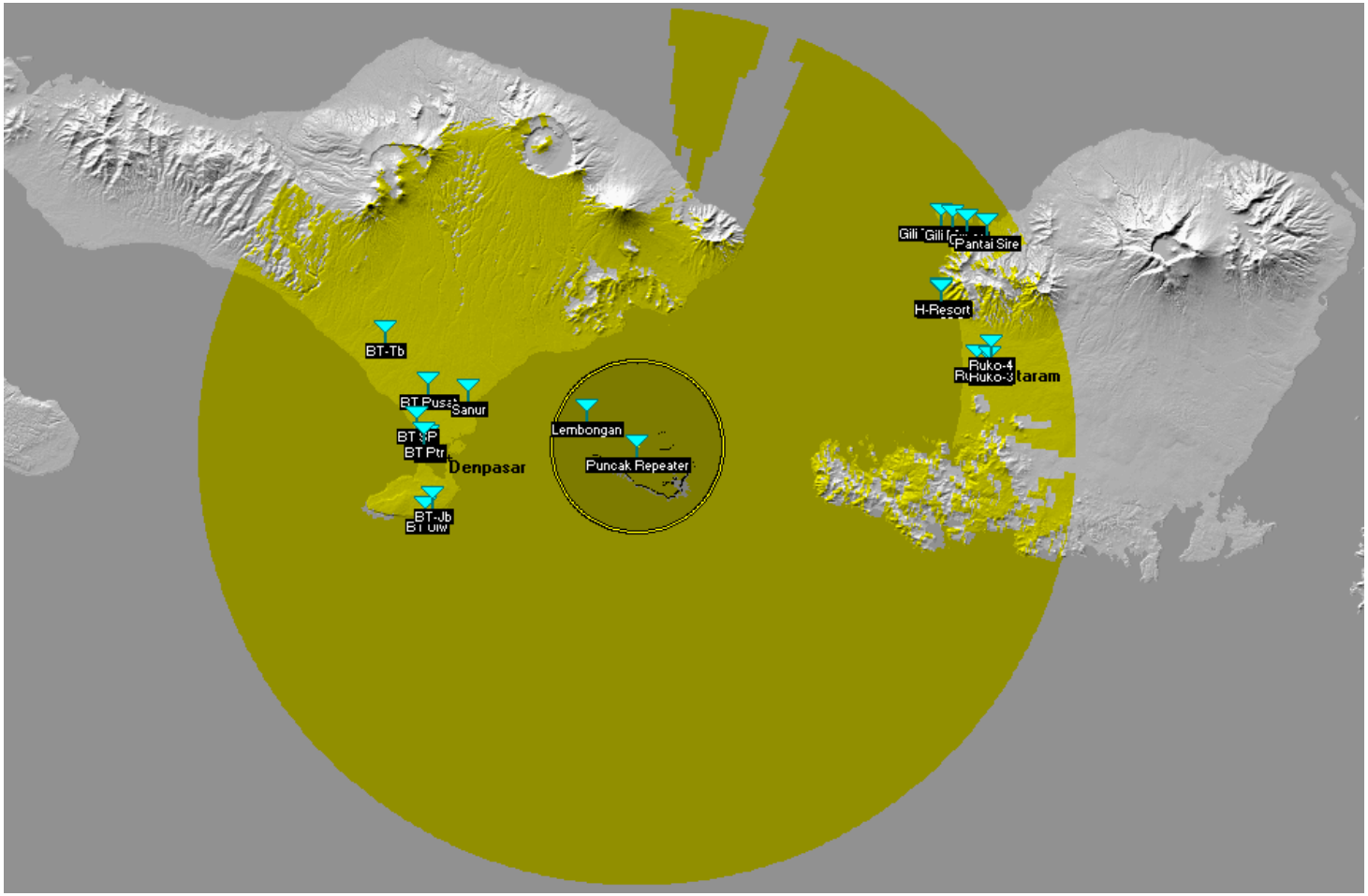
Wireless Networks Report



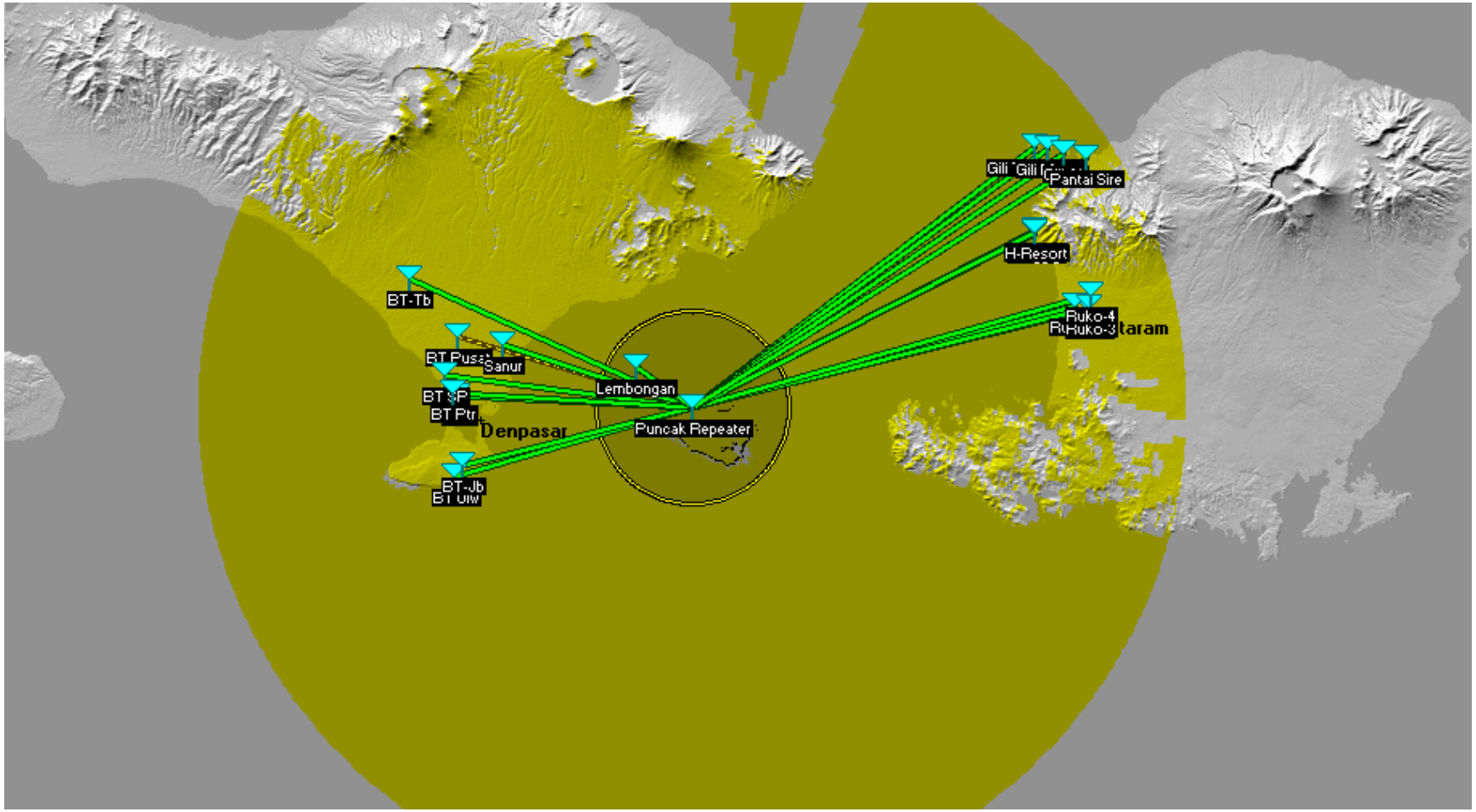
#	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Role:	System:	Antenna:
01		82	79	99	87	09	07	09	07	87	77	20	19	17	81	80	29	29	29	14	77	Master	Simulasi Omni-30dB	30.0m
02	82		90	83	93	32	32	32	32	90	82	16	13	13	94	70	17	18	19	11	80	Master	Simulasi Omni-30dB	30.0m
03	79	90		79	83	10	11	10	10	79	76	01	02	04	90	85	14	12	15	06	58	Master	Simulasi Omni-30dB	50.0m
04	99	83	79		93	07	08	07	12	75	76	14	18	17	88	83	31	34	33	13	84	Master	Simulasi Omni-30dB	30.0m
05	87	93	83	93		15	16	16	19	93	77	14	11	10	96	99	16	18	18	10	82	Master	Simulasi Omni-30dB	40.0m
06	09	32	10	07	15		99	99	96	26	73	01	01	01	19	16	08	02	04	01	46	Master	Simulasi Omni-30dB	30.0m
07	07	32	11	08	16	99		97	92	29	73	01	01	01	19	16	17	10	12	01	44	Master	Simulasi Omni-30dB	30.0m
08	09	32	10	07	16	99	97		96	27	73	01	01	01	19	17	06	01	03	01	46	Master	Simulasi Omni-30dB	30.0m
09	07	32	10	12	19	96	92	96		32	72	01	01	01	19	17	01	01	01	01	46	Master	Simulasi Omni-30dB	30.0m
10	81	90	79	75	93	26	29	27	32		74	10	28	26	91	93	33	35	35	22	86	Master	Simulasi Omni-30dB	30.0m
11	77	82	76	76	77	73	73	73	72	74		60	78	78	71	77	78	61	77	77	93	Master	Simulasi Omni-30dB	47.5m
12	20	16	01	34	14	01	01	01	01	30	60		55	86	05	13	17	17	15	85	36	Master	Simulasi Omni-30dB	30.0m
13	19	13	02	18	11	01	01	01	01	28	78	99		98	09	10	05	06	04	87	35	Master	Simulasi Omni-30dB	30.0m
14	17	13	04	17	10	01	01	01	01	26	78	86	98		09	09	01	01	01	99	32	Master	Simulasi Omni-30dB	30.0m
15	81	94	90	88	96	19	19	19	19	91	71	09	09	09		97	20	22	22	09	84	Master	Simulasi Omni-30dB	30.0m
16	80	70	85	83	99	16	16	17	17	93	77	13	10	09	97		14	16	17	10	84	Master	Simulasi Omni-30dB	30.0m
17	29	17	14	31	16	08	17	06	01	33	78	17	05	01	20	14		99	99	01	44	Master	Simulasi Omni-30dB	30.0m
18	29	18	12	34	18	02	10	01	01	35	61	17	06	01	22	16	99		99	01	46	Master	Simulasi Omni-30dB	30.0m
19	29	19	15	33	18	04	12	03	01	35	77	19	04	01	22	17	99	99		01	47	Master	Simulasi Omni-30dB	30.0m
20	14	11	06	13	10	01	01	01	01	22	77	89	87	99	09	10	01	01	01		27	Master	Simulasi Omni-30dB	30.0m
21	77	80	58	84	82	46	44	46	46	86	93	36	35	32	84	84	44	46	47	27		Master	Simulasi Omni-30dB	30.0m

Quality = 50 - number of resend

Center of Cell Coverage



Fix Link of Cell

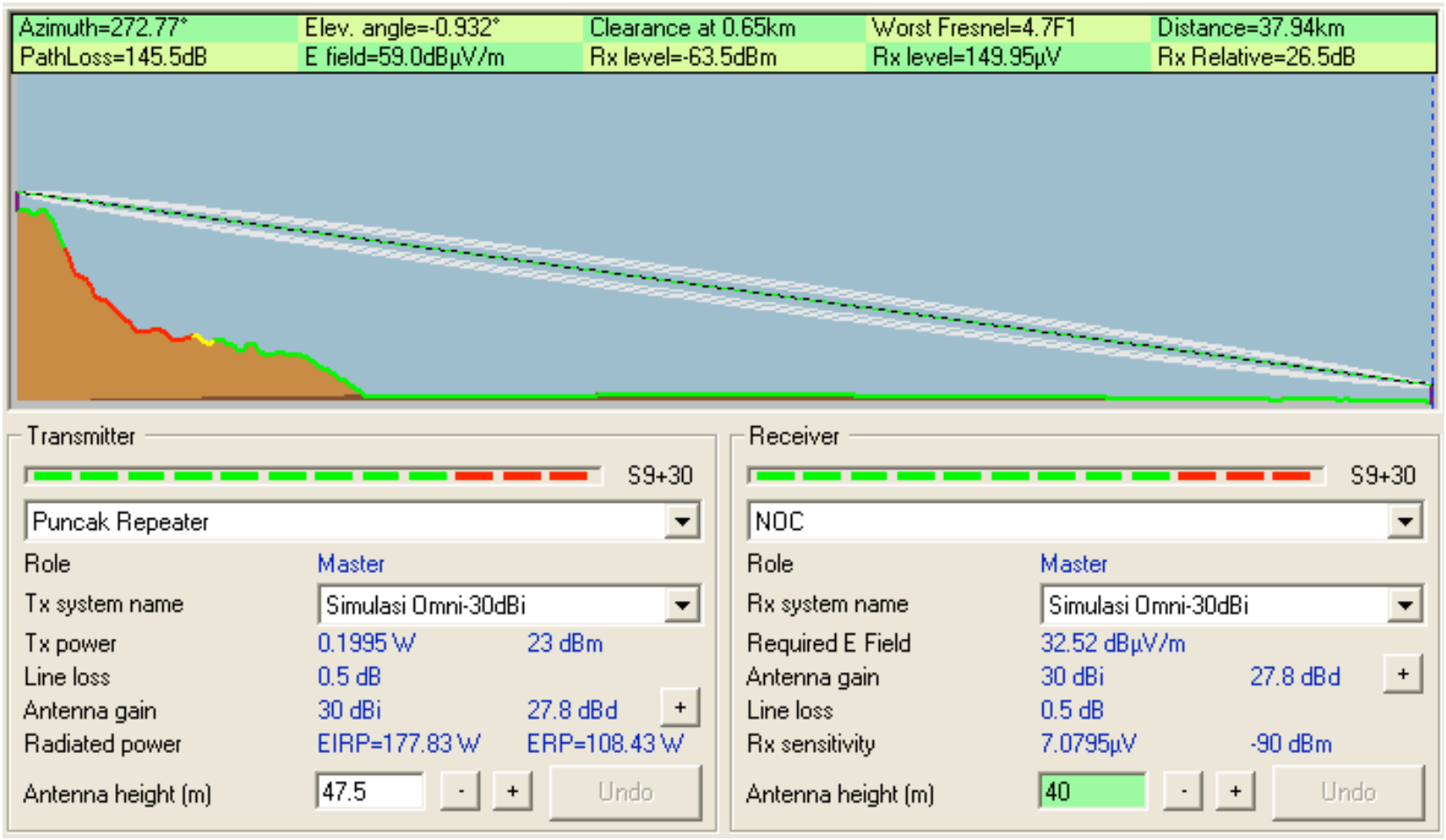


Fix Wireless Network Report

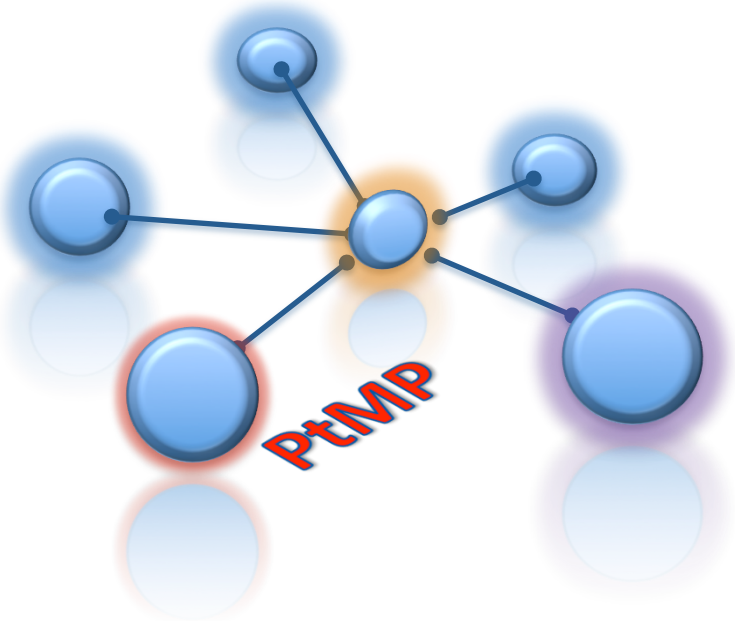
#	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Role:	System:	Antenna:
01											77											Slave	Simulasi Omni-30dB	30.0m
02											82											Slave	Simulasi Omni-30dB	30.0m
03											76											Slave	Simulasi Omni-30dB	50.0m
04											76											Slave	Simulasi Omni-30dB	30.0m
05											77											Slave	Simulasi Omni-30dB	40.0m
06											73											Slave	Simulasi Omni-30dB	30.0m
07											73											Slave	Simulasi Omni-30dB	30.0m
08											73											Slave	Simulasi Omni-30dB	30.0m
09											72											Slave	Simulasi Omni-30dB	30.0m
10											74											Slave	Simulasi Omni-30dB	30.0m
11	77	82	76	76	77	73	73	73	72	74		60	78	78	71	77	78	61	77	77	93	Master	Simulasi Omni-30dB	47.5m
12											60											Slave	Simulasi Omni-30dB	30.0m
13											78											Slave	Simulasi Omni-30dB	30.0m
14											78											Slave	Simulasi Omni-30dB	30.0m
15											71											Slave	Simulasi Omni-30dB	30.0m
16											77											Slave	Simulasi Omni-30dB	30.0m
17											78											Slave	Simulasi Omni-30dB	30.0m
18											61											Slave	Simulasi Omni-30dB	30.0m
19											77											Slave	Simulasi Omni-30dB	30.0m
20											77											Slave	Simulasi Omni-30dB	30.0m
21											93											Slave	Simulasi Omni-30dB	30.0m

Quality = 50 - number of resend

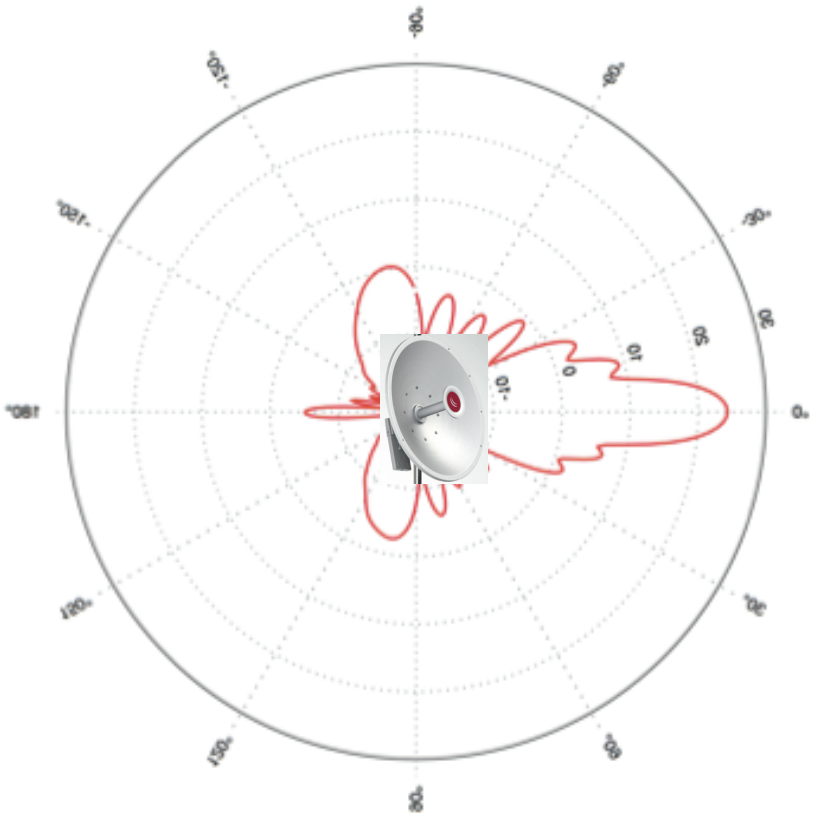
Radio Link Report

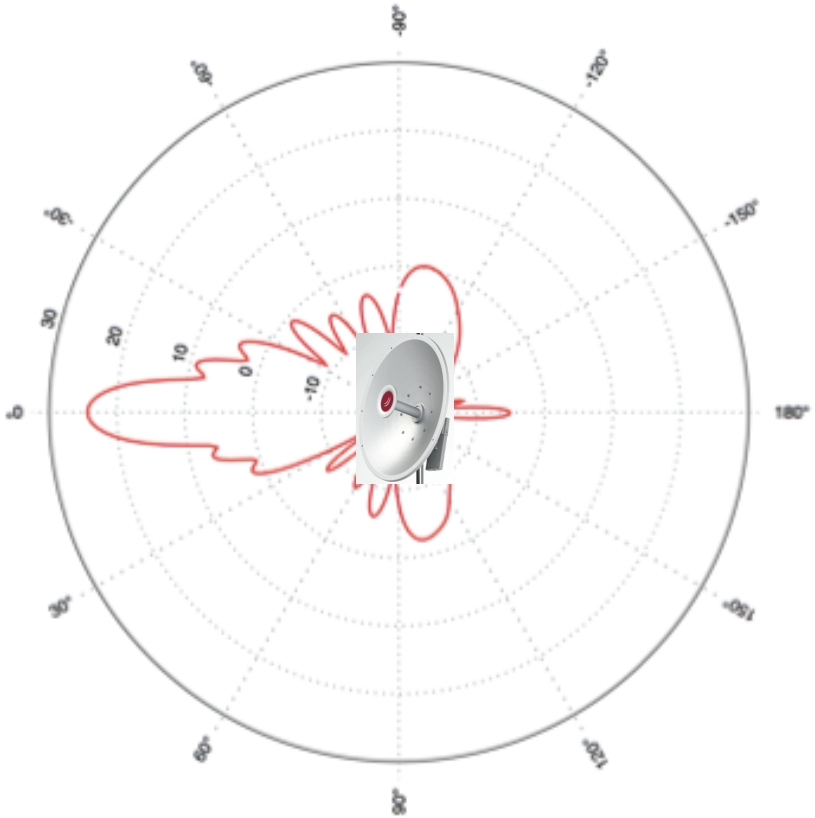


Topology

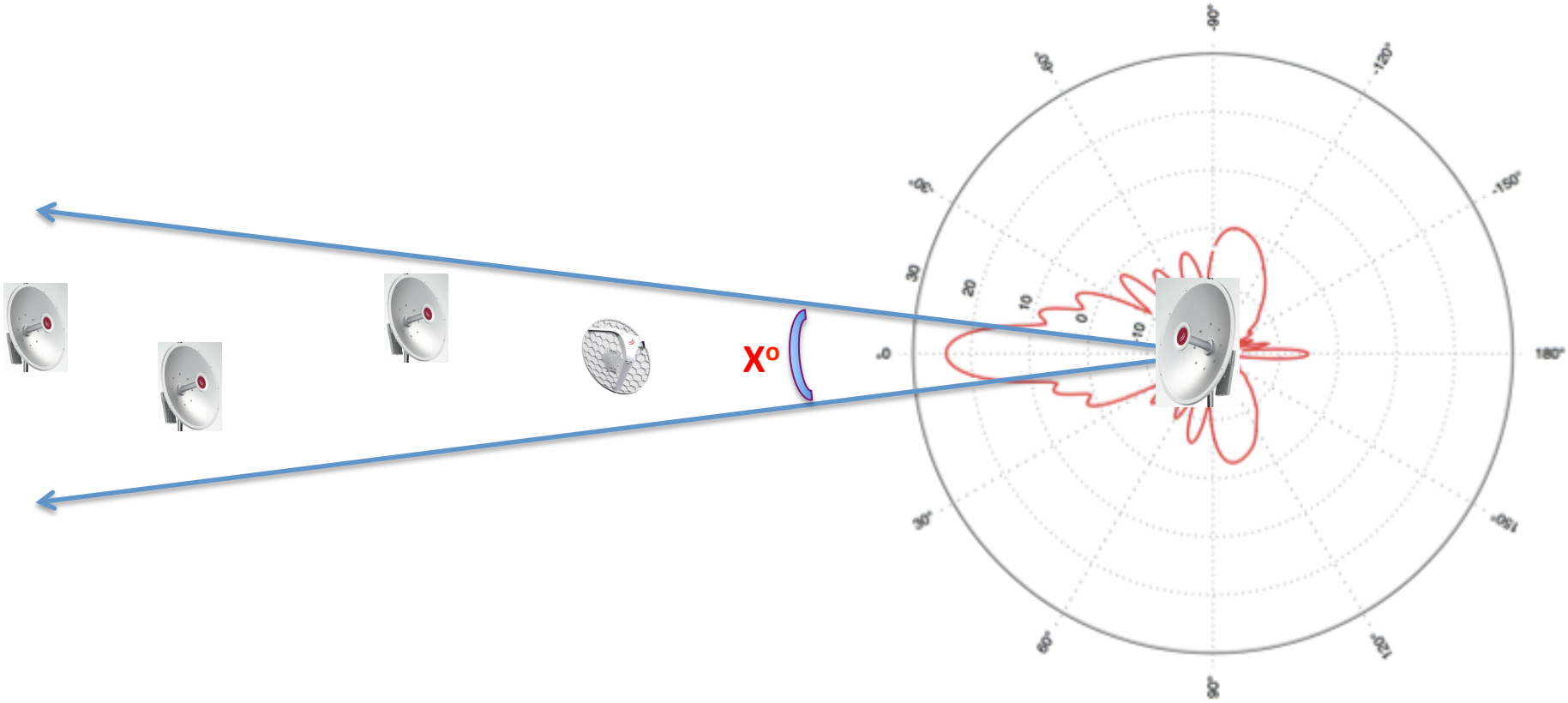


Point to Point





Point to Multipoint



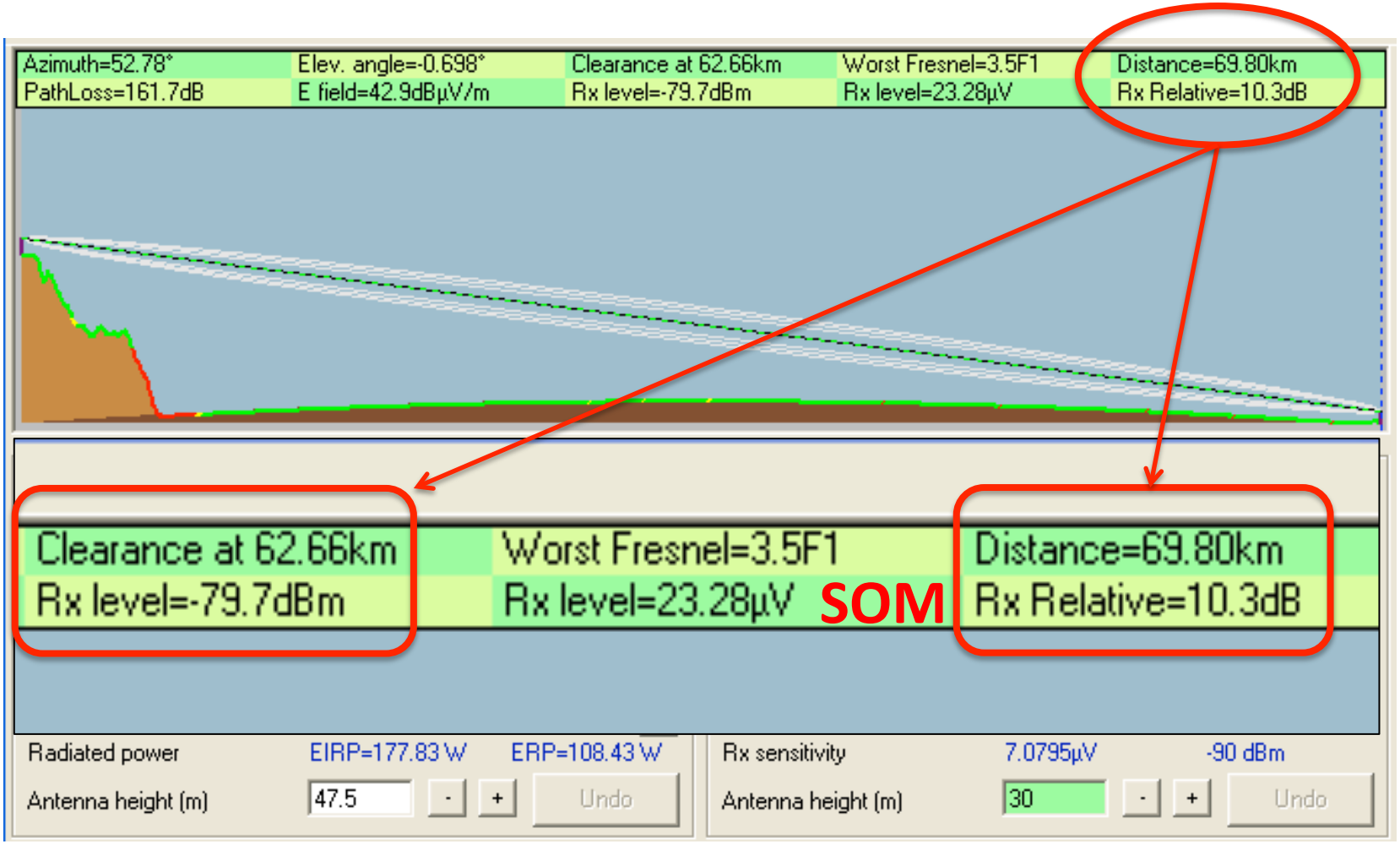
Project Requirement

- Throughput Client Allocation
- Max Tower Height each site
  - Device Type
  - Topology
  - Cell Capacity

Device Selection

- Long / Short Distance
  - Tx Power
  - Antenna Gain
- Wind Load
  - Wide/Narrow Antenna Reflector
  - Solid/Mesh Reflector
- Throughput Capacity
  - Protocol 802.11a/b/g/n/ac
- Type of Tower
  - Monopole
  - Guy Wire
  - Self Standing Tower

Radio Selection Methode



Product Approach Selection Methode

- Antenna Gain: 30dBi
- Tx power : 23dBm
- Rx Signal : -79dBm
- Signal Operating Margin Minimum: 5dbm
  - Device Type?
  - Maximum Data Rate?
  - Maximum Throughput?

Device Option #1

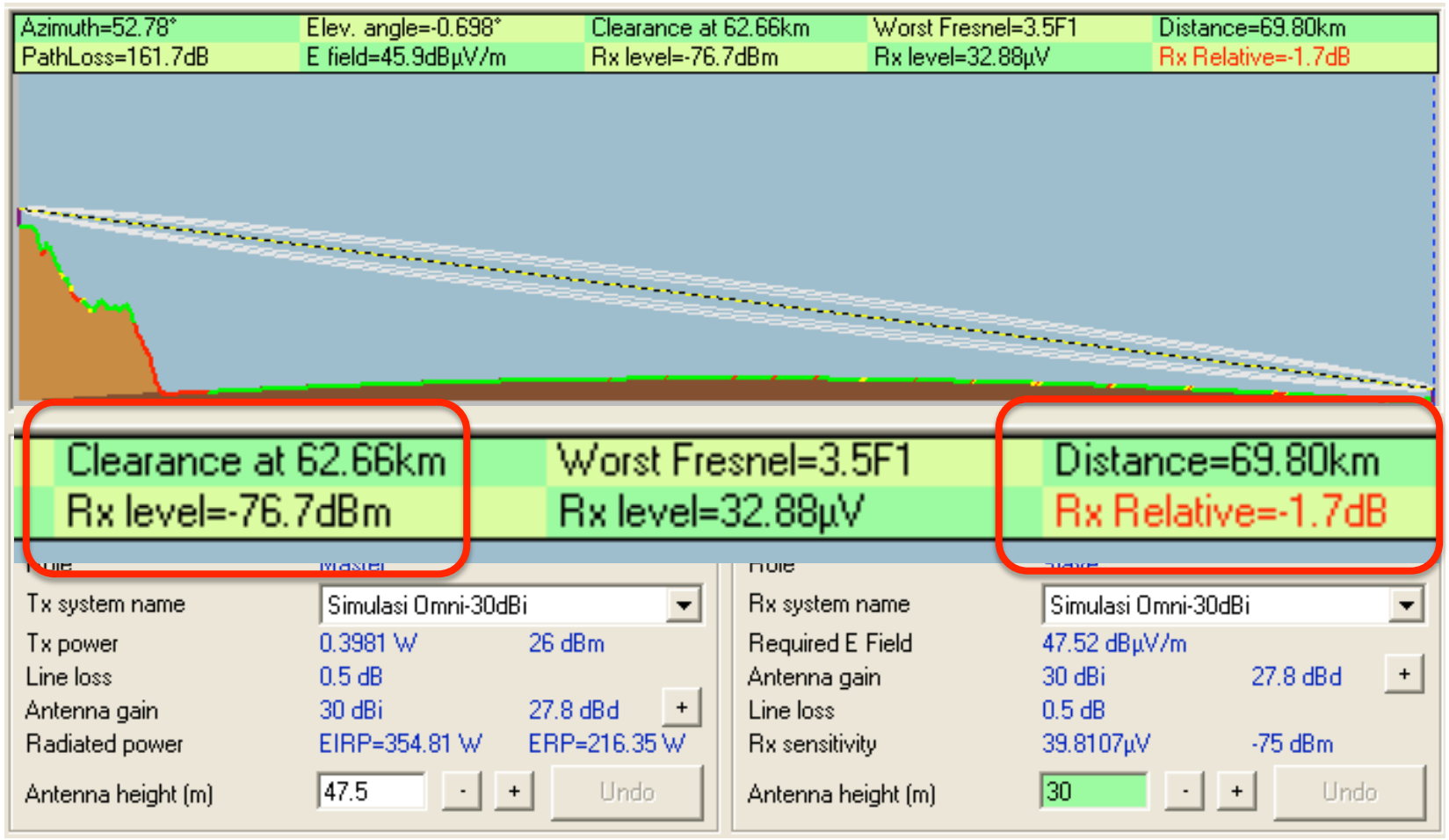
- Antenna mANT30
- Radio: BaseBox 5 - chain 2x2
  - RB912UAG-5HPnD-OUT

Wireless specifications

5 GHz

	Transmit (dBm)	Receive Sensitivity
6MBit/s	30	-96
54MBit/s	27	-78
MCS0	30	-96
MCS7	26	-75

Tx Power=26dBm, Sensitivity=-75dBm Adjustment



MCS 802.11ac 2x2

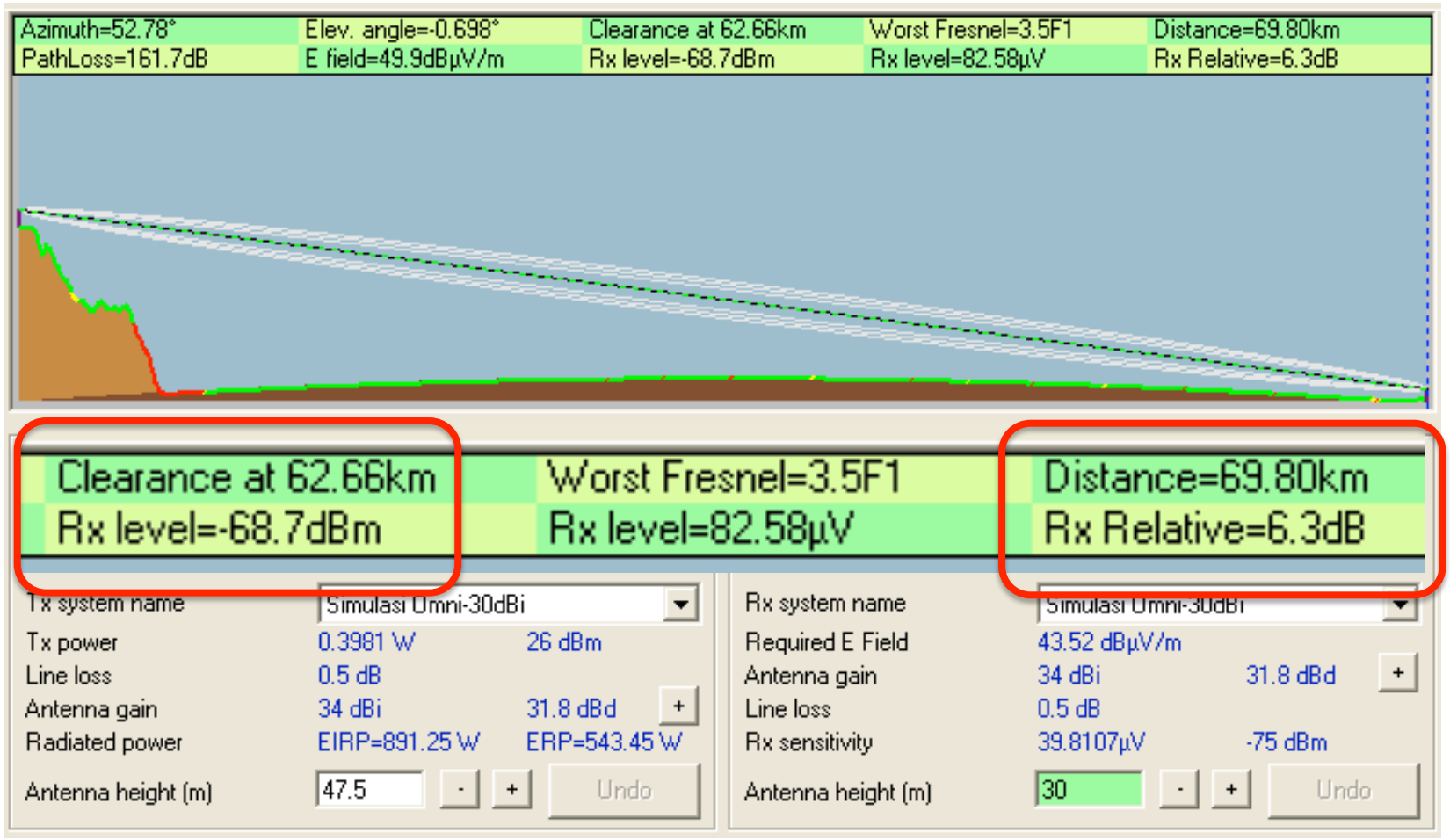
Modulation and coding schemes

MCS index[a]	Spatial Streams	Modulation type	Coding rate	Data rate (in Mbit/s)[7][b]							
				20 MHz channels		40 MHz channels		80 MHz channels		160 MHz channels	
				800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI
0	2	BPSK	1/2	13	14.4	27	30	58.5	65	117	130
1	2	QPSK	1/2	26	28.9	54	60	117	130	234	260
2	2	QPSK	3/4	39	43.3	81	90	175.5	195	351	390
3	2	16-QAM	1/2	52	57.8	108	120	234	260	468	520
4	2	16-QAM	3/4	78	86.7	162	180	351	390	702	780
5	2	64-QAM	2/3	104	115.6	216	240	468	520	936	1040
6	2	64-QAM	3/4	117	130.3	243	270	526.5	585	1053	1170
7	2	64-QAM	5/6	130	144.4	270	300	585	650	1170	1300
8	2	256-QAM	3/4	156	173.3	324	360	702	780	1404	1560
9	2	256-QAM	5/6	N/A	N/A	360	400	780	866.7	1560	1733.4

Link Estimation Troughput

- Antenna mANT30, 30dBi
- Radio: BaseBox 5 - chain 2x2
  - RB912UAG-5HPnD-OUT
    - Tx power: 26dBm
    - Rx Signal: -76.7dBm ~ MCS 4
    - Data rate Max: 180 Mbps
    - Throughput Max: 0.5x180 → ***90 Mbps***

Antenna Gain=34dBi Adjustment



MCS 802.11ac 2x2

Modulation and coding schemes

MCS index[a]	Spatial Streams	Modulation type	Coding rate	Data rate (in Mbit/s)[7][b]							
				20 MHz channels		40 MHz channels		80 MHz channels		160 MHz channels	
				800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI
0	2	BPSK	1/2	13	14.4	27	30	58.5	65	117	130
1	2	QPSK	1/2	26	28.9	54	60	117	130	234	260
2	2	QPSK	3/4	39	43.3	81	90	175.5	195	351	390
3	2	16-QAM	1/2	52	57.8	108	120	234	260	468	520
4	2	16-QAM	3/4	78	86.7	162	180	351	390	702	780
5	2	64-QAM	2/3	104	115.6	216	240	468	520	936	1040
6	2	64-QAM	3/4	117	130.3	243	270	526.5	585	1053	1170
7	2	64-QAM	5/6	130	144.4	270	300	585	650	1170	1300
8	2	256-QAM	3/4	156	173.3	324	360	702	780	1404	1560
9	2	256-QAM	5/6	N/A	N/A	360	400	780	866.7	1560	1733.4

Link Estimation Troughput

- Antenna 34dBi
- Radio: BaseBox 5 - chain 2x2
  - RB912UAG-5HPnD-OUT
    - Tx power: 26dBm
    - Rx Signal: -68.7dBm ~ MCS7
    - Data rate Max: 300Mbps
    - Throughput Max: 0.5x300 → ***150 Mbps***

Device Option #2

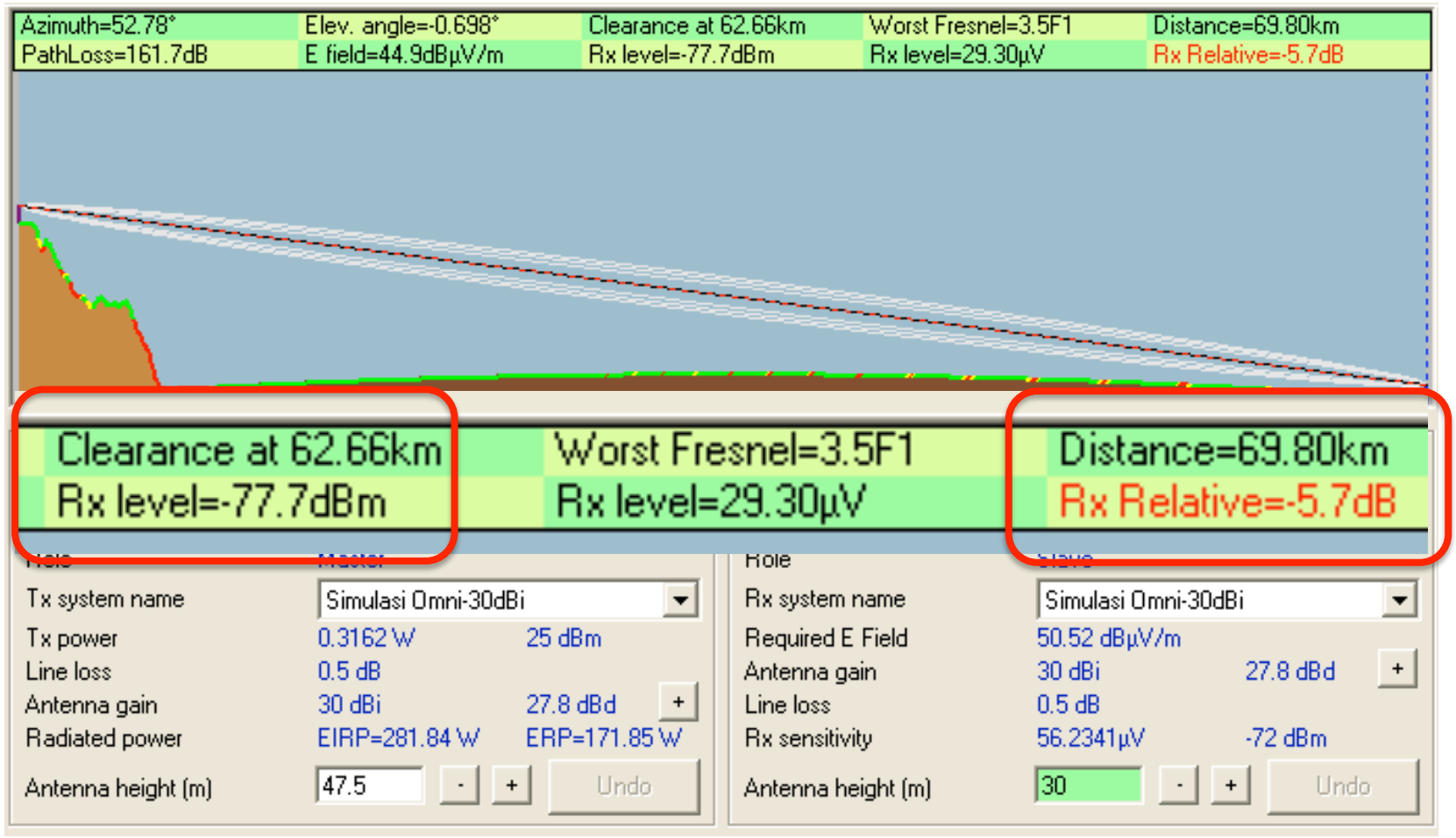
- Antenna mANT30
- Radio: NetMetal 5, chain 2x2
  - RB921UAGS-5SHPacD-NM

Wireless specifications

5 GHz

	Transmit (dBm)	Receive Sensitivity
6MBit/s	31	-96
54MBit/s	29	-81
MCS0	31	-96
MCS7	29	-77
MCS9	25	-72

Tx Power=25dBm Rx Sensitify=-72dBm Adjustment



MCS 802.11ac 2x2

Modulation and coding schemes

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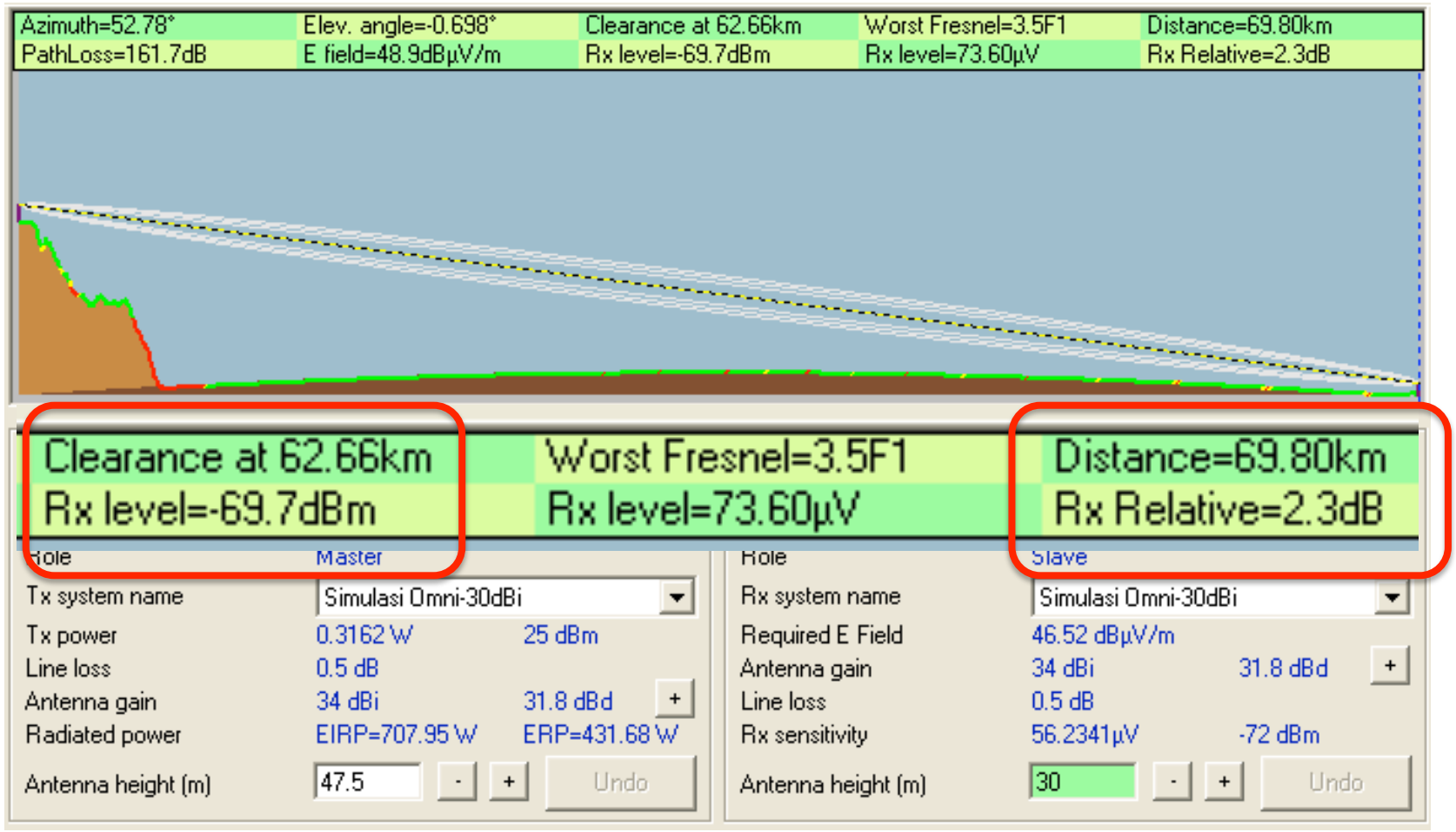
8	2	256-QAM	3/4	156	173.3	324	360	702	780	1404	1560
9	2	256-QAM	5/6	N/A	N/A	360	400	780	866.7	1560	1733.4

Link Estimation Troughput

- Antenna mANT30
- Radio: NetMetal 5, chain 2x2
  - RB921UAGS-5SHPacD-NM
    - Tx power: 25dBm
    - Rx Signal: -77.7dBm ~ MCS4
    - Data rate Max: 390Mbps
    - Throughput Max: 0.5x390 → ***195 Mbps***

Antenna Gain=34dBi Adjustment



MCS 802.11ac 2x2

Modulation and coding schemes

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0	2	BPSK	1/2	13	14.4	27	30	58.5	65	117	130
1	2	QPSK	1/2	26	28.9	54	60	117	130	234	260
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3	2	16-QAM	1/2	52	57.8	108	120	234	260	468	520
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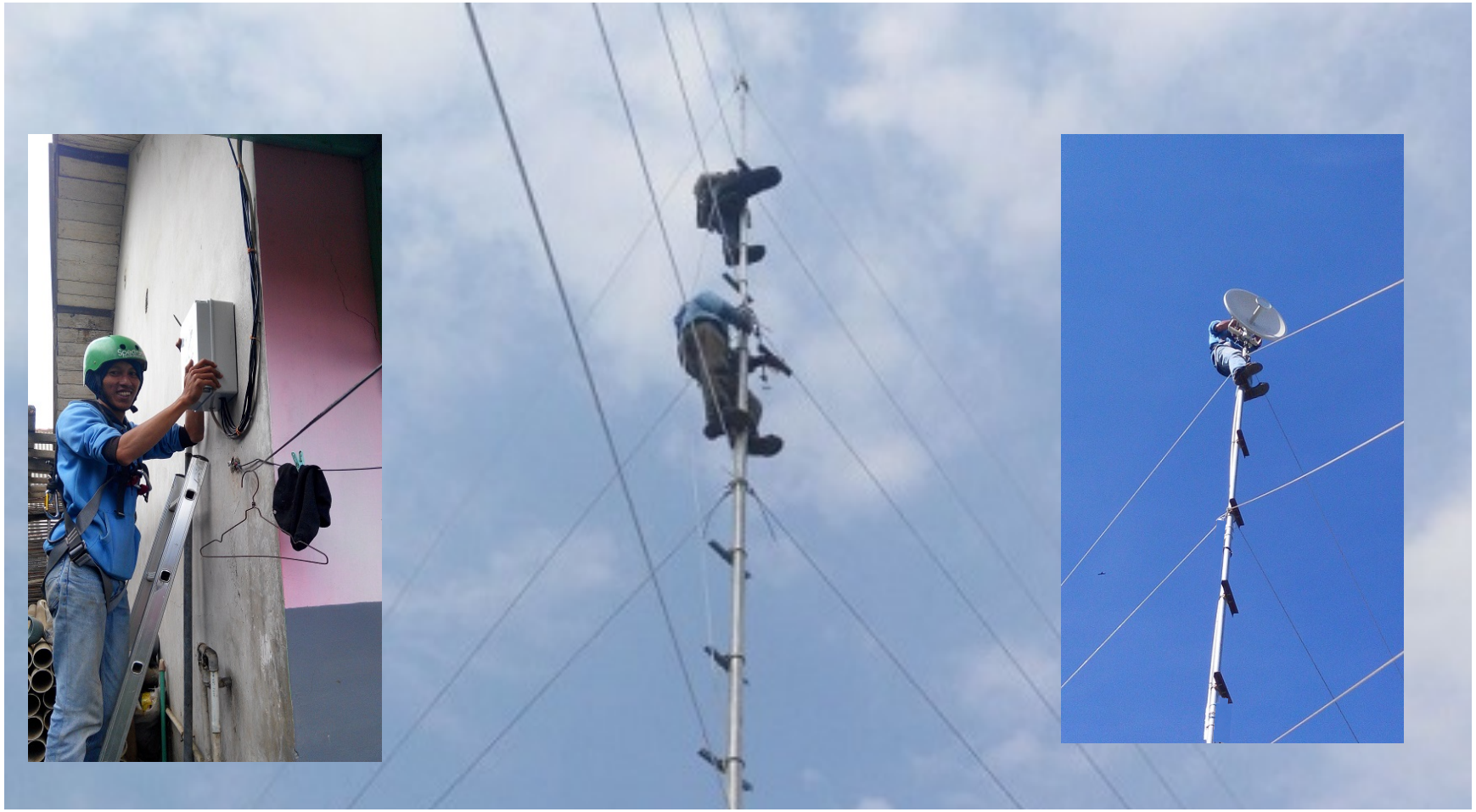
6	2	64-QAM	3/4	117	130.3	243	270	526.5	585	1053	1170
7	2	64-QAM	5/6	130	144.4	270	300	585	650	1170	1300
8	2	256-QAM	3/4	156	173.3	324	360	702	780	1404	1560
9	2	256-QAM	5/6	N/A	N/A	360	400	780	866.7	1560	1733.4

Link Estimation Troughput

- Antenna 34dBi
- Radio: NetMetal 5, chain 2x2
  - RB921UAGS-5SHPacD-NM
    - Tx power: 25dBm
    - Rx Signal: -69.7dBm ~ MCS8
    - Data rate Max: 780Mbps
    - Throughput Max: 0.5x866.7 → ***390 Mbps***

Antenna Alignment



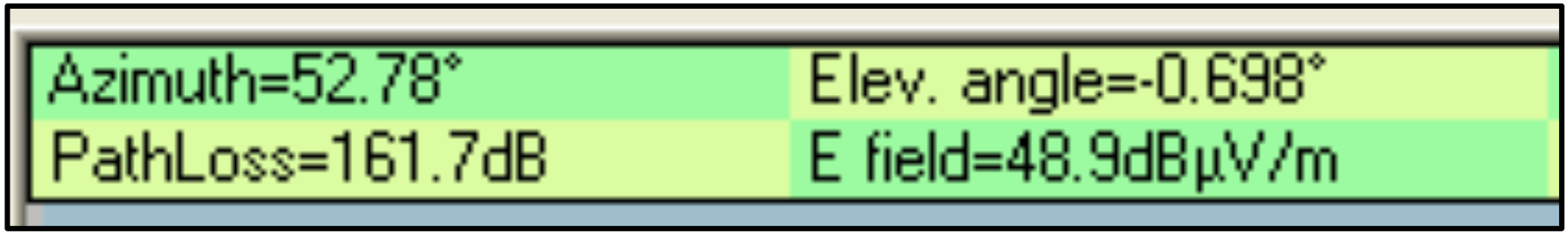
Direction Antenna Type

mANT30

LHG5

Azimuth & Elevation

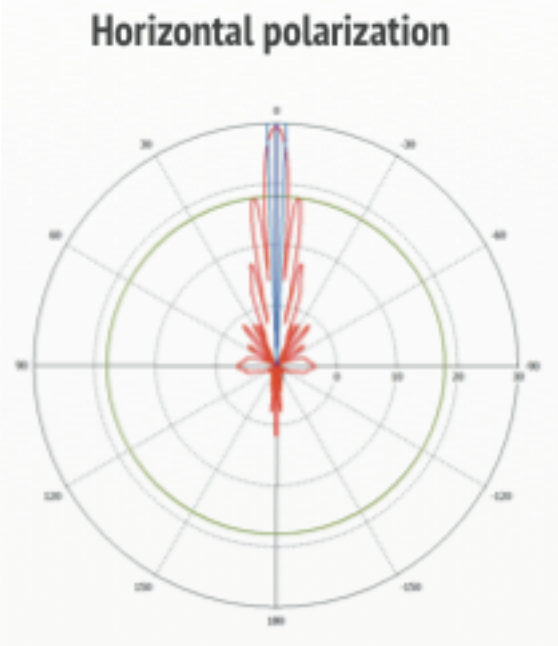
- Azimuth
  - Horisontal Antenna Beam
- Elevation
  - Vertical Antenna Beam

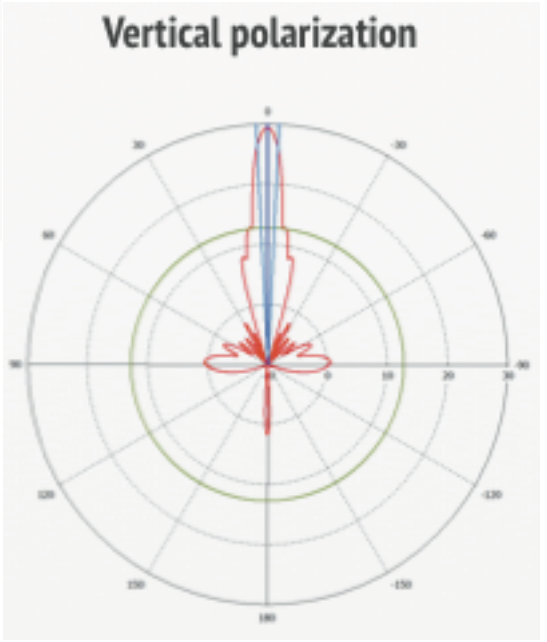


mANT30 Specification

Electrical Specifications

Frequency Range	4.7-5.875 GHz
Gain	30 dBi typically
Polarization	Dual (Vertical and Horizontal)
3dB Beamwidth	+/-2.5 deg
Standards	Complies with EN 302 326 DN1, DN2, DN3, DN5
VSWR	≤ 1.4 typ, ≤ 1.8 max
Port to Port Isolation	>40dB min
Front-to-Back Ratio	>30 dB
Cross Polarization	>40 dB
Power Rating	100 watts
Impedance	50 ohms
Elevation adjustment range	+/- 20 deg (MTAD-5G-30D3), +/- 15 deg (MTAD-5G-30D-PA)





Tools

- Compass
- Inclinometer

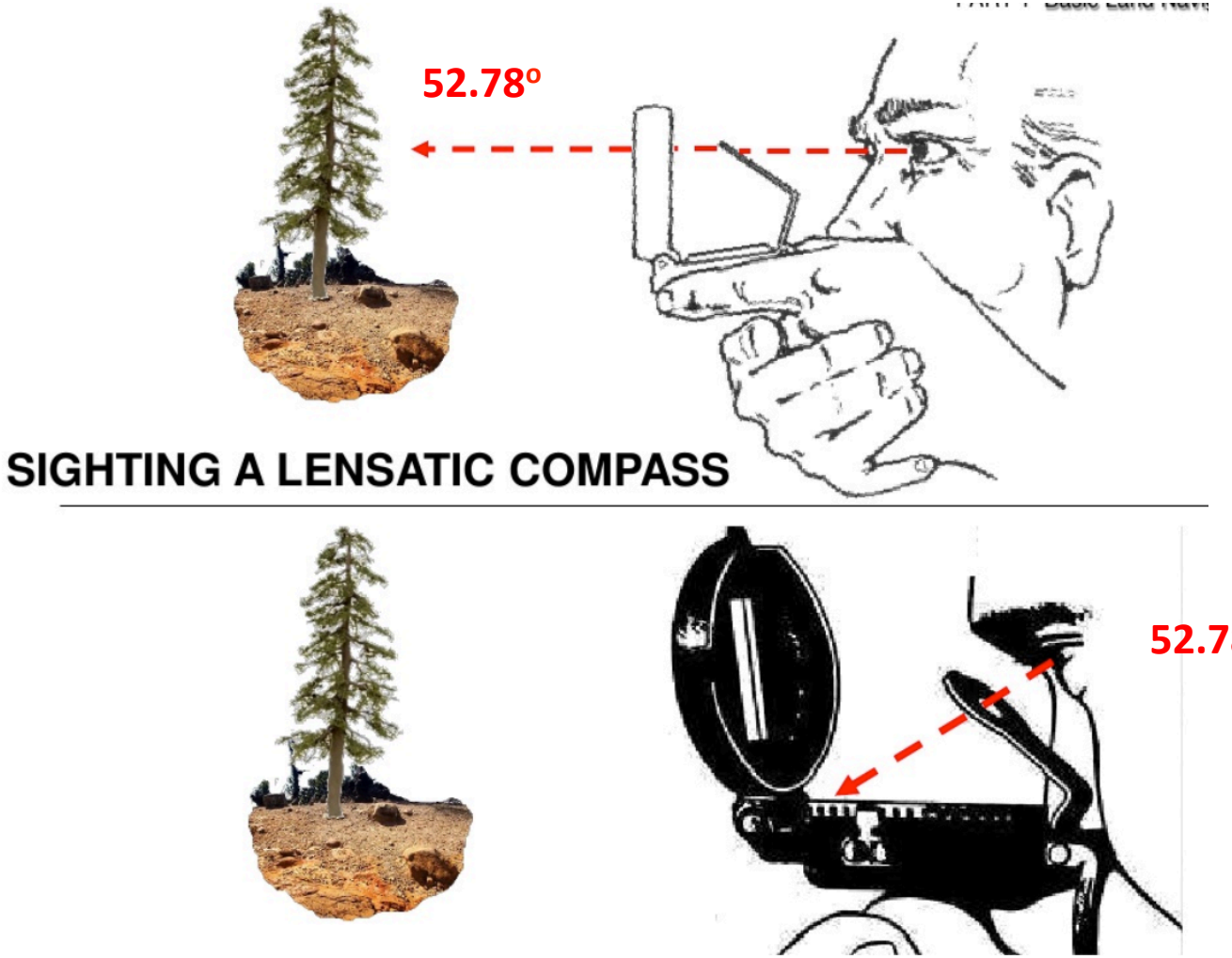
Azimuth

- Direction to remote site

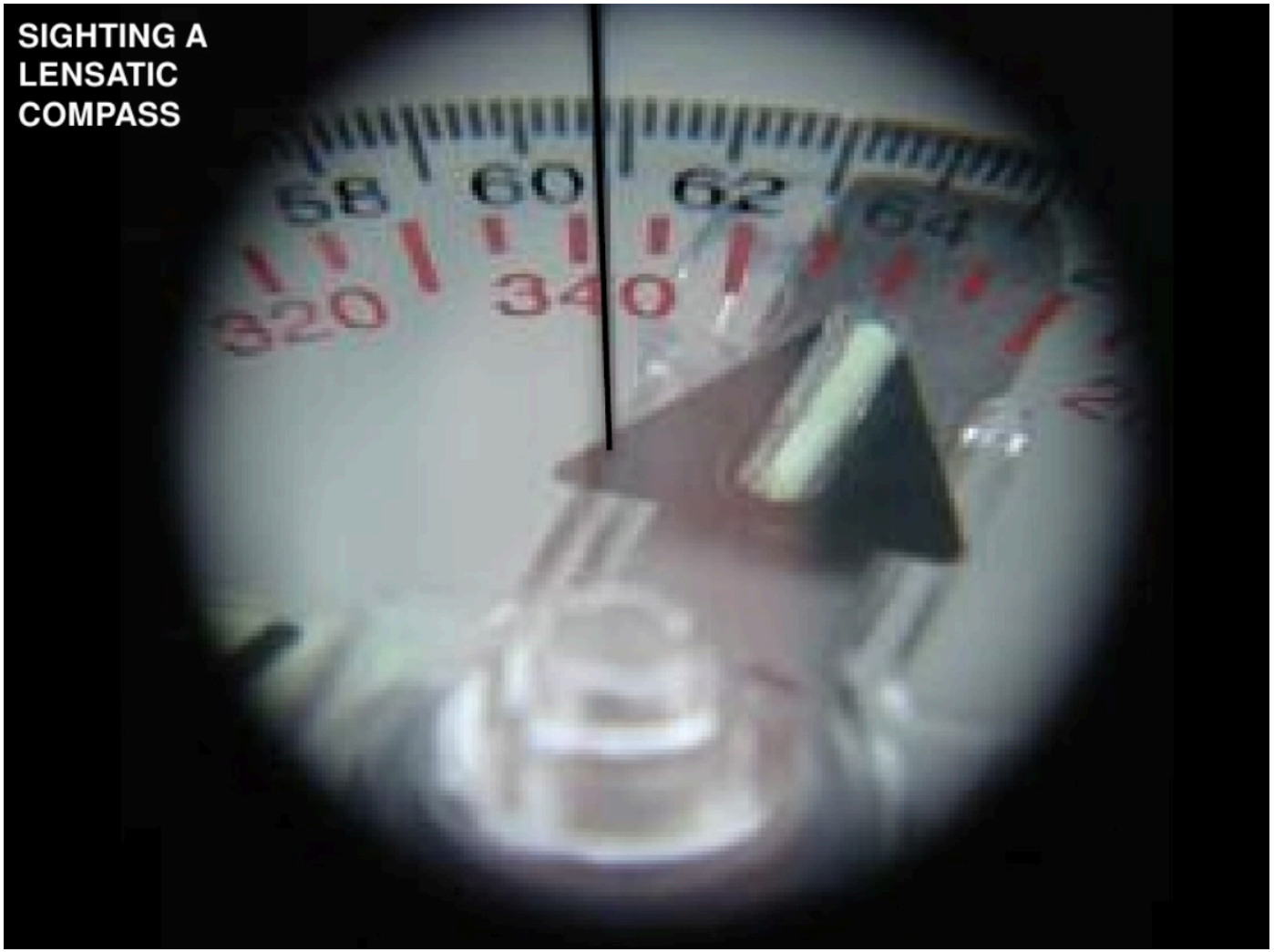
Direction Alignment #1

- Azimuth Data as refference [52.78^{o}]
- As close as possible to the tower
- Compass paralel water level
- See viewfinder, rotates body, untill index line in the direction of the azimuth 52.78^{o}
- Take object inline with Azimuth as reference
- Adjust antenna direction to the object

How To Sighting

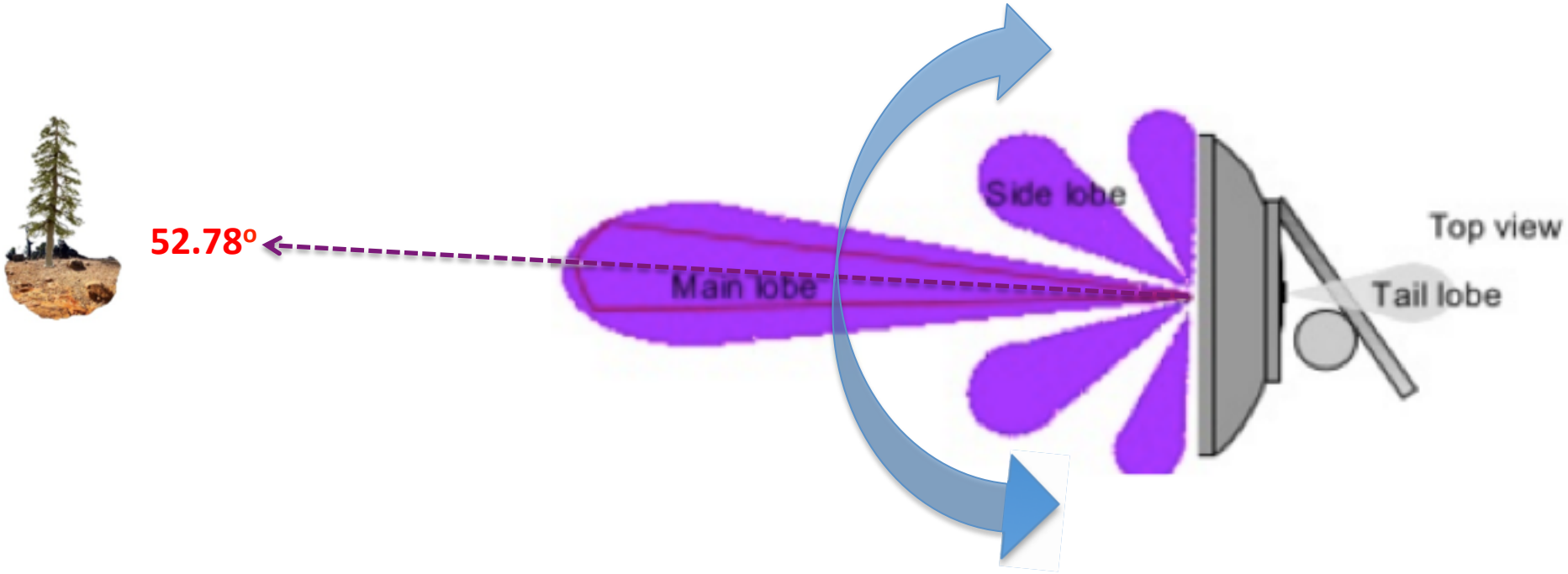


Reading Compass



Sighting Object

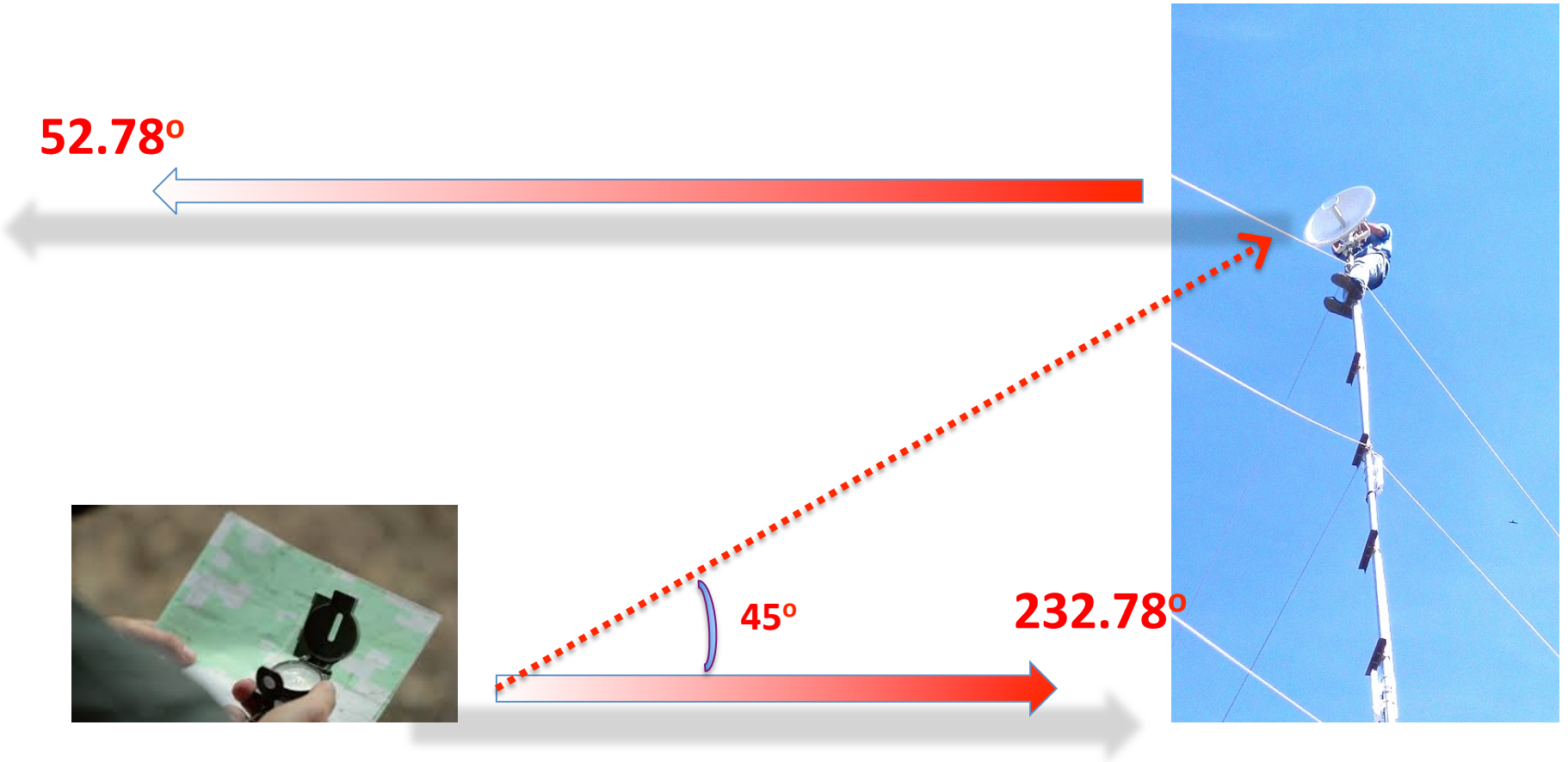
Centre Beam Direction



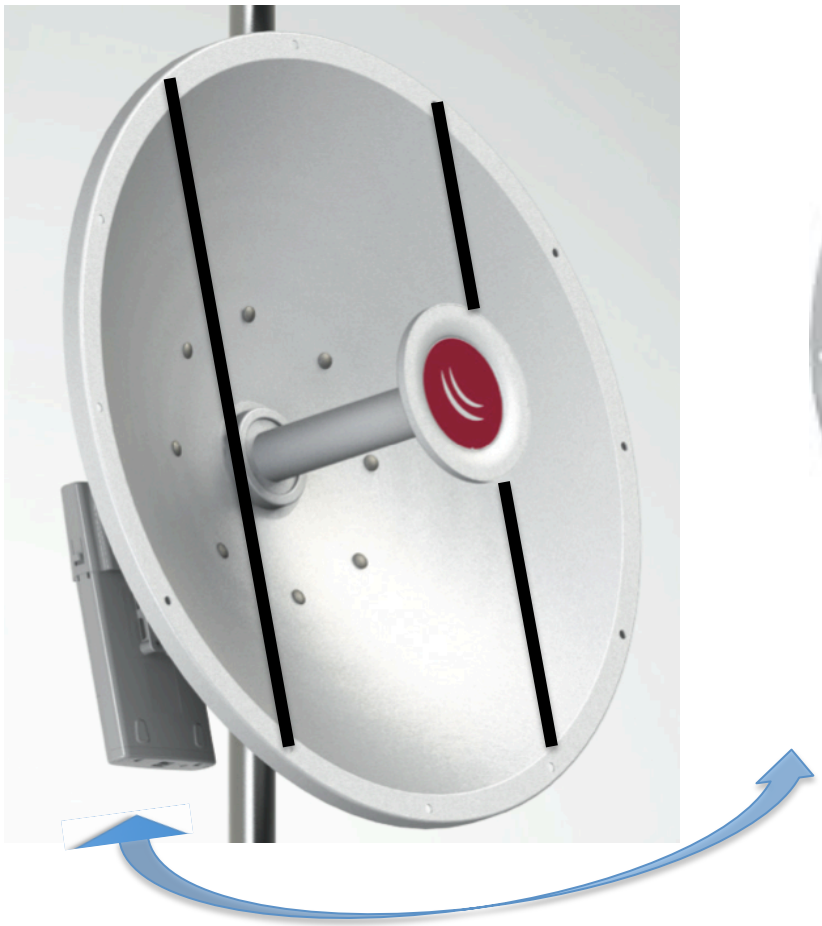
Direction Alignment #2

- Reverse Direction Methode
- 2 person incharge:
  - Tower Man
  - Supervisor Direction

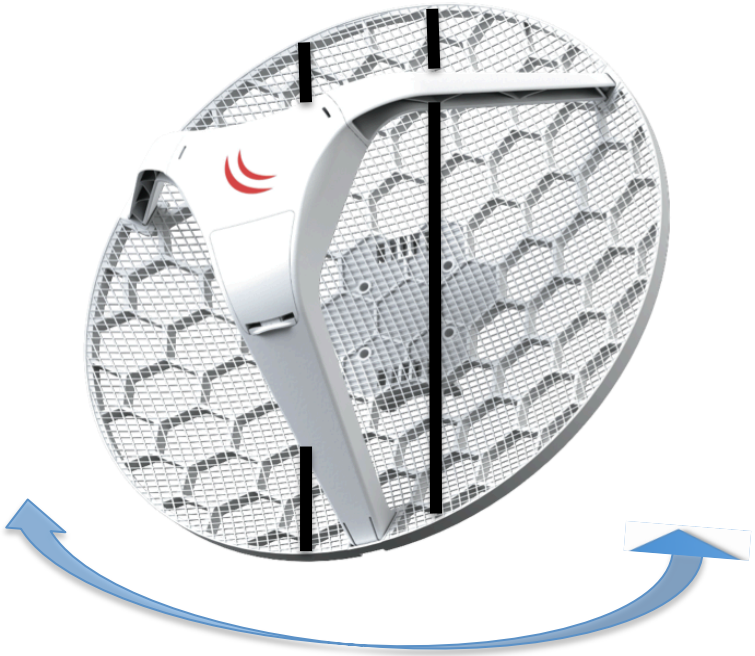
Reverse Direction Alignment

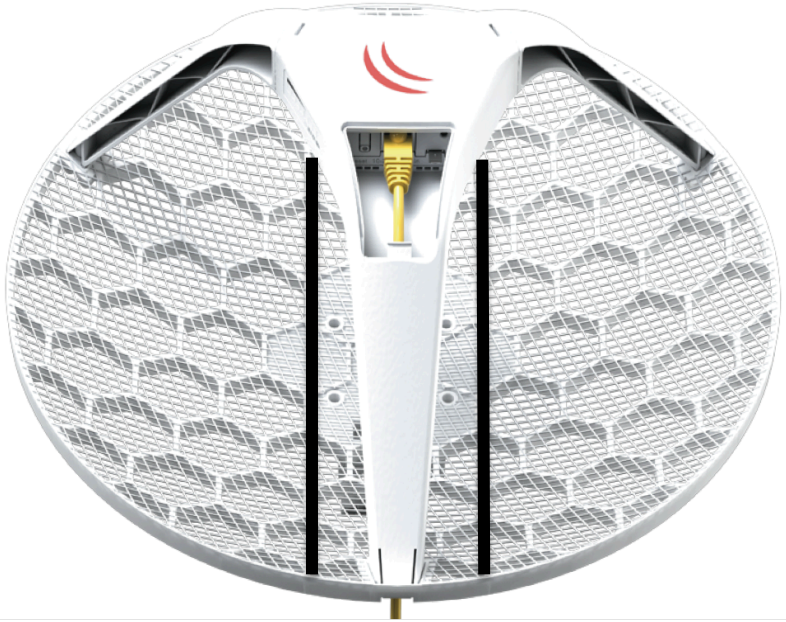


mANT30 Type Alignment

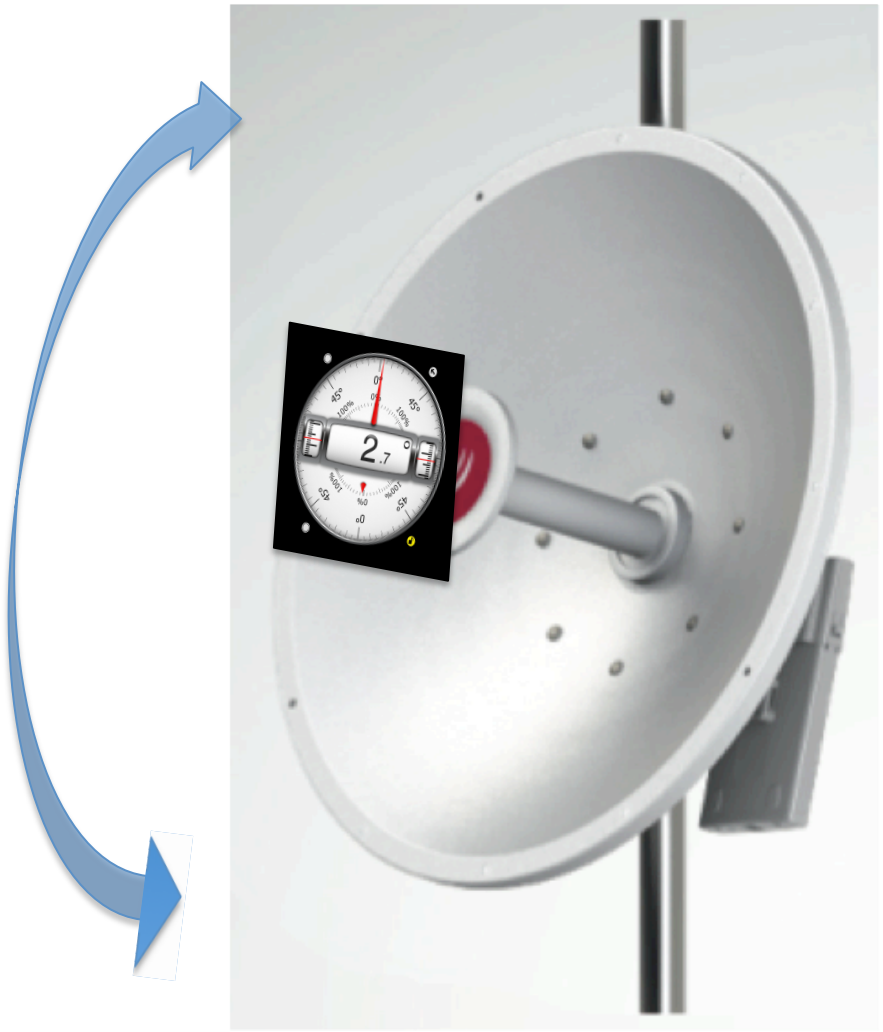


LHG Type Alignment





Antenna Elevation



http://
www.spectrumindo.com

Complete LHG5 Alignmet


Questions

Thank You...

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