ANALISIS PERENCANAAN JARINGAN LONG TERM EVOLUTION (LTE) DI KOTA MAKASSAR

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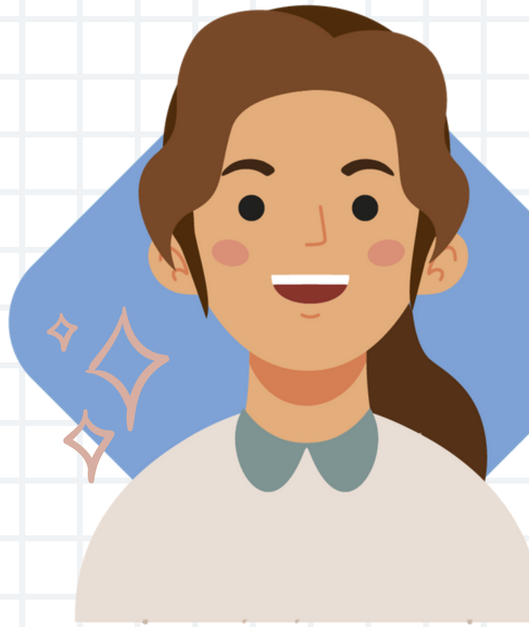

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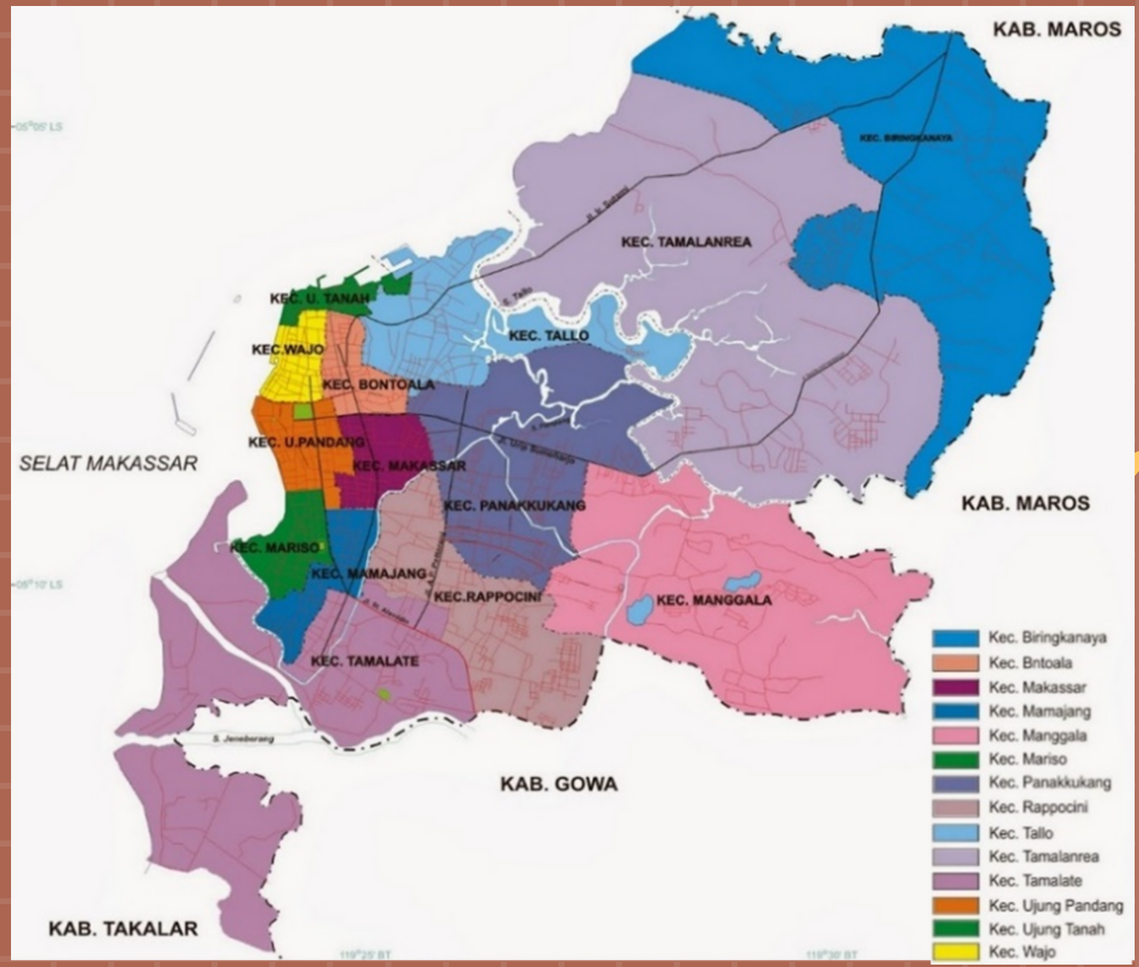
Profil Daerah

Daerah yang dipilih: Kota Makassar
Luas Wilayah: 175.77 km2
Kategori Wilayah: Dense Urban



Gambar 1.1 Peta Wilayah Kota Makassar

Parameter Perancangan

Tabel 1. Data Kependudukan Kota Makassar

Data Badan Pusat Statistik Kota Makassar					
Kota	Total Penduduk	Penduduk Produktif	Luas Wilayah	Laju Pertumbuhan Penduduk	Tahun Data Penduduk
Makassar	1423784 jiwa	988955 jiwa	175.77	1.18%	2020

Tabel 2. Spesifikasi umum yang diperlukan dalam perencanaan LTE

Spesifikasi Umum						
Antena	H_{ms}	H_{bts}	Frekuensi	Bandwidth	*Market Share*	LTE *Penetration*
Omnidirectional (MIMO 4 × 4)	1.5 m	30 m	1800 MHz	20 MHz	58.9%	73.8%

Capacity Planning

Tahapan dalam Capacity Planning adalah:

- Prediksi jumlah pengguna layanan LTE
- Menghitung Single User Throughput dan Network Throughput
- Menghitung kapasitas sel arah downlink dan uplink
- Melakukan kalkulasi total site.

Prediksi Jumlah Pengguna Layanan LTE

Tabel 3. Prediksi Jumlah Pengguna Layanan LTE

Prediksi Jumlah Pengguna Layanan LTE di Kota Makassar				
Tahun	**2020**	**2021**	**2022**	**2023**
Total Penduduk (jiwa)	1423784	1440585	1457584	1474783
Penduduk Produktif (jiwa)	988955	1000625	1012432	1024379
Market Share	58.9%	58.9%	58.9%	58.9%
Operator *Market Share* (jiwa)	582495	589368	596323	603359
LTE-A *Provider Penetration*	73.8%	73.8%	73.8%	73.8%
LTE-A *Provider User* (jiwa)	429881.3	434953.6	440086.4	445278.9

Single User Throughput dan Network Throughput

Tabel 4. Nilai Single User Throughput dan Network Throughput

Item	*Dense Urban*	
	Uplink	***Downlink***
$\sum$ *Target User*	445278.942	
Single User Throughput (Kbps)	10.80178878	44.77121044
Network Throughput IP (Mbps)	4629.130777	19754.99891
Network Throughput MAC Layer (Mbps)	4723.602834	20158.16216

Kapasitas Sel (Uplink dan Downlink)

Tabel 5. Cell Throughput dan Cell Average Throughput

Modulation	SINR min (dB)	SINR *Probability* (Pn)	*Uplink*		*Downlink*	
			Cell *Throughput* (Mbps) (Rn)	Cell *Average Throughput* (Mbps)	Cell *Throughput* (Mbps) (Rn)	Cell *Average Throughput* (Mbps)
QPSK 1/3	-1.5 – 0.3	0.28	19.199976	5.37599328	15.999976	4.47999328
QPSK 1/2	0.3 – 2	0.25	28.799976	7.199994	23.999976	5.999994
QPSK 2/3	2 – 4.5	0.17	38.399976	6.52799592	31.999976	5.43999592
16 QAM 1/3	4.5 – 6	0.13	57.599976	7.48799688	47.999976	6.23999688
16 QAM 2/3	6 – 8.5	0.1	76.799976	7.6799976	63.999976	6.3999976
16 QAM 4/5	8.5 – 10.8	0.05	92.159976	4.6079988	76.799976	3.8399988
64 QAM 1/2	10.8 – 12.5	0.01	86.399976	0.86399976	71.999976	0.71999976
64 QAM 2/3	12.5 – 13.5	0.01	115.19997	1.15199976	95.999976	0.95999976
Cell Average Throughput (MAC) (Mbps)= ∑ Pn x Rn				40.895976		34.079976

Kalkulasi Total Site

Tabel 6. Rangkuman Kalkulasi Total Site

Item	Uplink	Downlink
Area Wide (km^2)	175.77	
Total User	445278.942	
Network Throughput (Mbps)	4723.602834	20158.16216
Cell Average Throughput (Mbps)	40.895976	34.079976
Site Capacity (Mbps)	163.583904	136.319904
Number of Site	28.87571893	147.8739463
Number of User per Site	15420.5318	3011.206188
Cell Coverage (km^2)	6.08712117	1.188647523
Cell Radius (km)	1.530098183	0.676145047

Coverage Planning

Tahapan dalam Coverage Planning adalah:

- Perhitungan Link Budget
- Perhitungan d dengan Model Propagasi Cost-231
- Kalkulasi Total Site

Perhitungan Link Budget

Tabel 7. Link Budget Uplink

***Link Budget* Perencanaan Jaringan LTE (*Uplink*)**		
Transmitter	***Value***	***Calculation***
Max Total Tx Power (dBm)	23	A
RB to Distribute Power (dBm)	8	C
Subcarriers Distribute to Power (dBm)	96	D = 12*C
Subcarriers Power (dBm)	3.17728767	E = A-10*Log(D)
Tx Antenna Gain (dBi)	0	F
Tx Cable Loss (dB)	0	G
Tx Body Loss (dB)	0	I
EIRP (dBm)	3.17728767	J = E + F-G-I
Receiver	**Value**	***Calculation***
SINR (dB)	-2.5	K
Rx Noise Figure (dB)	2.3	L
Receiver Sensitivity (dBm)	-142.4390874	M = K+L-174+10*log(1500)
Rx Antenna Gain (dBi)	18	N
Rx Cable Loss (dB)	0	O
Interference Margin (dB)	0.87	Q
Min.Signal Reception Strength (dBm)	-159.5690874	R = M-N+O+Q
Pathloss & Shadow Fading Margin	**Value**	***Formula***
Penentration Loss (dB)	15	S
Shadow fading Margin (dB)	8	T
Path Loss (dB)	139.7463751	**U = J-R-S-T**

Tabel 8. Link Budget Downlink

***Link Budget* Perencanaan Jaringan LTE (*Downlink*)**		
Transmitter	***Value***	***Calculation***
Max Total Tx Power (dBm)	46	A
RB to Distribute Power (dBm)	100	C
Subcarriers Distribute to Power (dBm)	1200	D = 12*C
Subcarriers Power (dBm)	15.20818754	E = A-10*Log(D)
Tx Antenna Gain (dBi)	18	F
Tx Cable Loss (dB)	3	G
Tx Body Loss (dB)	0	I
EIRP (dBm)	30.20818754	J = E + F-G-I
Receiver	***Value***	***Calculation***
SINR (dB)	-9	K
Rx Noise Figure (dB)	7	L
Receiver Sensitivity (dBm)	-144.2390874	M = K+L-174+10*log(1500)
Rx Antenna Gain (dBi)	0	N
Rx Cable Loss (dB)	0	O
Interference Margin (dB)	3	Q
Min.Signal Reception Strength (dBm)	-141.2390874	R = M-N+O+Q
Pathloss & Shadow Fading Margin	***Value***	***Formula***
Penentration Loss (dB)	19	S
Shadow fading Margin (dB)	9.4	T
Path Loss (dB)	**143.0472749**	**U = J-R-S-T**

Perhitungan d dengan Model Propagasi Cost-231

Tabel 8. Hasil Perhitungan d

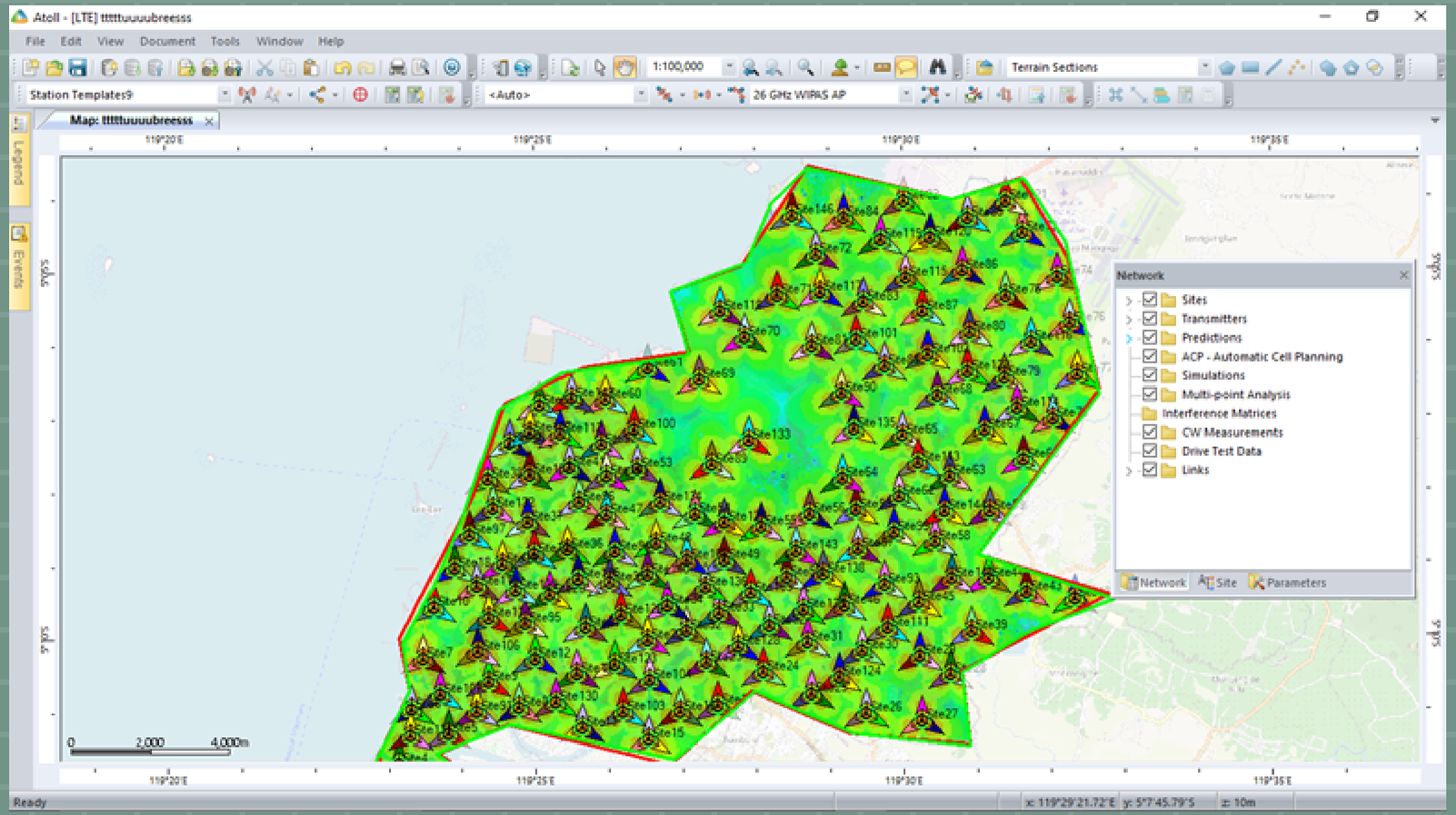
Uplink	***Downlink***
$L = 46.3 + 33.9\log(fMHz) - 13.82\log(ht) - a(hr) + (44.9 - 6.55\log(ht))\log\ d(Km) + CM$	
$d\ = 1.026965743\ km$	$d\ =\ 1.221830485\ km$

Kalkulasi Total Site

Tabel 9. Hasil Kalkulasi Total Site

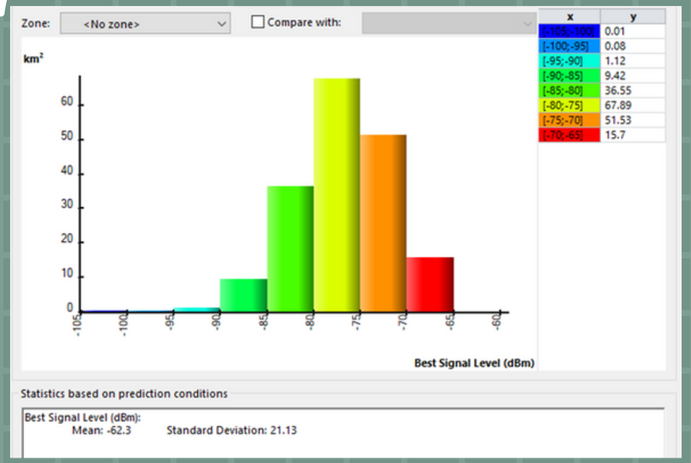
Total Site Calculation	
Cell Coverage Downlink	3.881461309 km^2
Cell Coverage Uplink	2.742112456 km^2
Cell Coverage Total	3.311786883 km^2
Total Site	53.07406733 *site*

Hasil Simulasi di Atoll

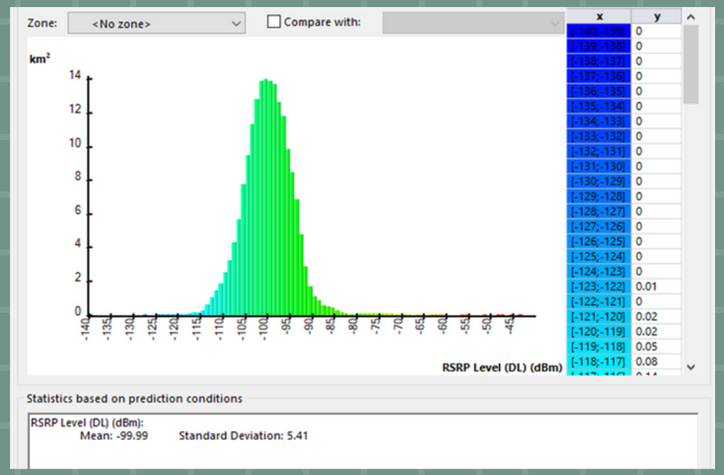


Gambar 2. Penempatan Site di Kota Makassar pada Atoll

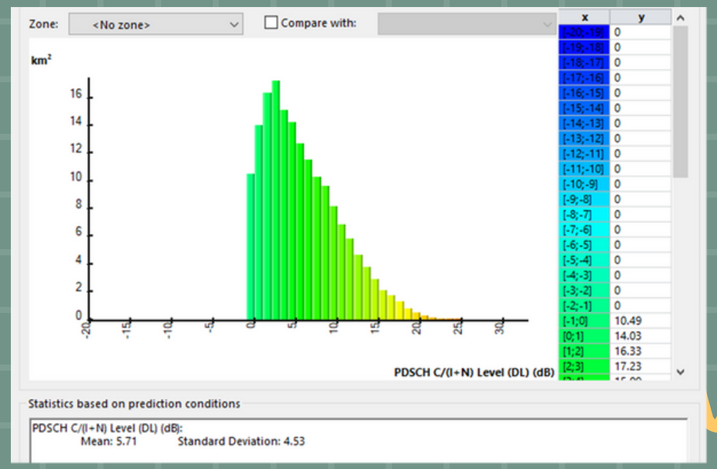
Hasil Simulasi di Atoll



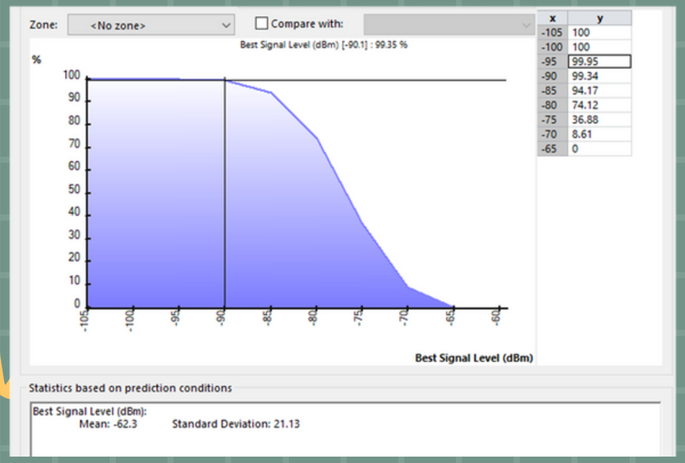
Gambar 3. Prediksi signal level pada Atoll

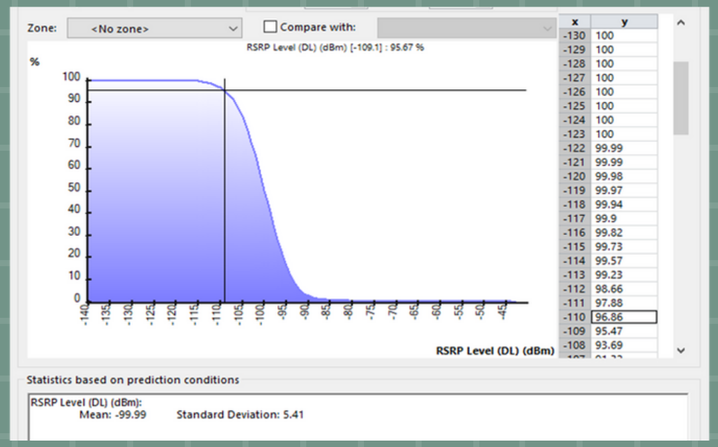


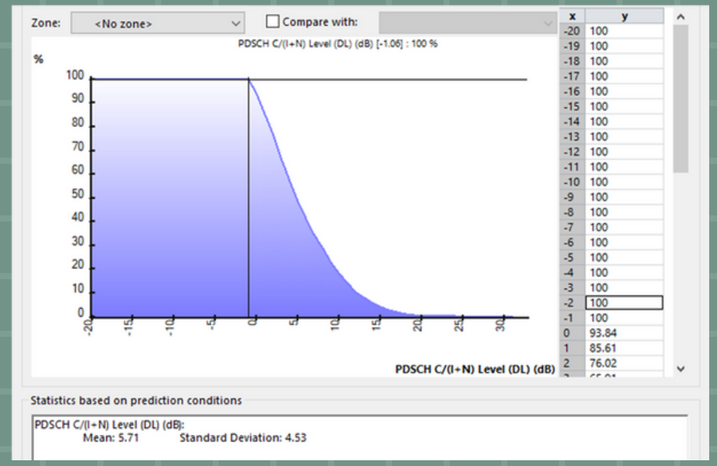
Gambar 4. Prediksi Effective Signal Analysis



Gambar 5. Prediksi Coverage by C/(I+N) Level







Kesimpulan

- Jumlah site pada capacity planning lebih banyak = biaya lebih mahal tetapi kualitas yang dicapai baik.
- Jumlah site pada coverage planning lebih sedikit = biaya lebih murah tetapi akan ada beberapa titik di Kota Makassar yang akan mendapatkan kualitas jaringan yang kurang baik.
- Pada perencanaan jaringan LTE di Atoll, digunakan jumlah site untuk capacity planning.
- Hasil prediksi signal level pada Atoll adalah -62.3 dBm, prediksi Effective Signal Analysis adalah -99.99 dBm, dan prediksi Coverage by C/(I+N) Level adalah 5.71 dB. Hasil tersebut sudah dapat dikatakan baik sehingga perencanaan dapat dikatakan sudah baik.


THANK YOU