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Preface

2017 6th International Conference on Software and Computer Applications (ICSCA 2017) is held during Feb. 26-28, 2017 in Bangkok, Thailand.

ICSCA aims to provide a professional platform for academic researchers and industrial practitioners for the interchange of information on the latest development and applications in software and computer applications, and to promote friendship and interdisciplinary research collaborations.

ICSCA received 104 papers from universities, research institutes and industries this year. This volume includes 60 selected papers which were presented at the conference and each contributed paper has been strictly peer-reviewed by reviewers who were collected organizing and advisory Committee members as well as other experts in the field from different countries. The proceedings tend to present to the readers the newest researches results and findings in the field of software and computer applications, which include 9 chapters.

We'd like to give the credit of ICSCA success to the topic coordinators who have devoted their expertise and experience in promoting and in general co-ordination of the activities for the organization and operation of the conference. The coordinators of various session topics have devoted a considerable time and energy in soliciting papers from relevant researchers for presentation at the conference.

Also the organizing committee expresses its entire gratitude to all the authors who presented their works at ICSCA2017 and contributed in this way to the success of this event. Special thanks are due to the authors from abroad for attending the conference and to the reviewers for their support in improving the quality of the papers and finally for the assurance the quality of this volume.

We hope that the contents of this volume will prove useful for software and computer applications researchers and practitioners in developing and applying new technologies and processes.

Prof. Luigi Benedicenti,
Feb. 24, 2017

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4G-LTE 1800 Mhz Coverage and Capacity Network Planning using Frequency Reuse 1 Model for Rural Area in Indonesia

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ABSTRACT
4G LTE network planning included coverage planning and capacity planning. This research used existing Transceiver Network Base Station (BTS), the utilization of existing BTS in a plan to reduce the cost in terms of infrastructure and applications. The results of the research planning coverage using Frequency Reuse 1 were transmit power value -67.28 dBm and -67.53 dBm, the signal strength value 14.6 dB and 13.89. Capacity planning through simulation user in a rural area connected to the user obtained eNode B was 98.2% and not connected to the user obtained eNode B was 95.2%. Researchers used Software Planning Tool to gather the result.

CCS Concepts
• Information systems → Mobile information processing systems

• Networks→ Network performance modeling

• Networks→ Network simulations

Keywords
4G; LTE; coverage; capacity;Frequency Reuse 1

1. INTRODUCTION
Cellular networks can be classified into different generations, namely, First Generation (Example : AMPS) , Second Generation (Example : GSM), Third Generation (Example : UMTS) and Fourth Generation (Example : 4G LTE), see Figure 1 for 4G LTE Architecture [1]. In this paper the researchers studied the planning phases in order to upgrade the mobile operator network, to build a Fourth generation in parallel with the current deployed third generation network.

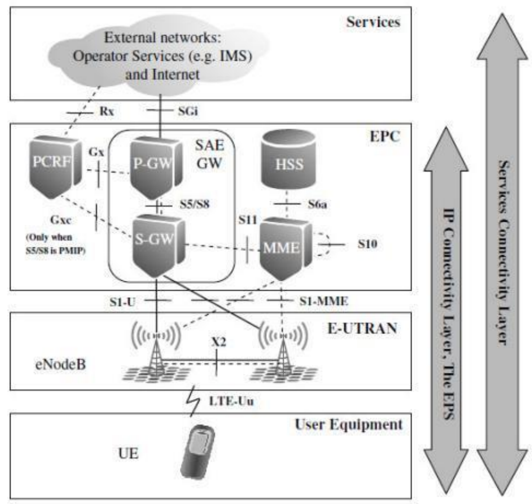

Figure 1. 4G LTE Architecture [1]

Many earlier works had been conducted regarding the 3G radio network planning [2], and our study was related to the 4G capacity and coverage planning for Magelang Rural Area in Indonesia[3], to support equalization technology in Rural Areas Magelang see Figure 2, researchers needed LTE network planning to cover the entire territory of Magelang.

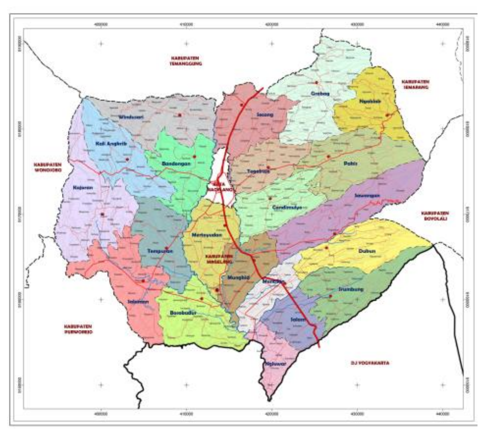

Figure 2. Magelang Map [3]

LTE Network Planning could use the software planning tool, which could be used to perform simulations in order to know how the state of location closer to the original state.[3]

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The planning process had some main attributes and factors such as the coordinates of the site, the number of sites, antenna height, direction antennas , antenna tilting, frequency, bandwidth, types of Duplex Technique, types of Frequency Reuse for Coverage Link Budget Purposes, see Figure 3 [4].

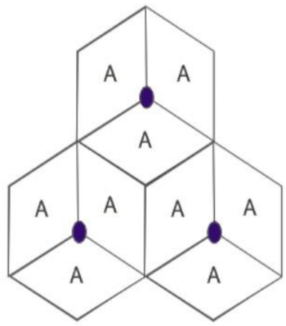

Figure 3. Frequency *reuse* 1 Schema [3]

The researchers used Reference Signal Receive Power (RSRP) and Signal To Noise Ratio (SINR) to know the Coverage signal strength and Quality signal strength.

RSRP (Reference Signal Receive Power) is the average power of Resource Elements (RE) that carries cell specific Reference Signals (RS) over the entire bandwidth, so RSRP is only measured in the symbols carrying RS. See Table 1 the RSRP Value

Table 1. RSRP Value from Indonesia Operator [5]

Value	Information
-70 dBm to -90 dBm	Good
-91 dBm to -110 dBm	Normal
-110 dBm to – 130 dBm	Bad

SINR is the reference value used in the system simulation and can be defined: Wide band SINR and SINR for a specific sub-carriers (or for a specific resource elements), See Table 2 showed the SINR Value

Table 2. SINR Value from Indonesia Operator [6]

Value	Information
16 dB to 30 dB	Good
1 dB to 15 dB	Normal
-10 dB to 0	Bad

See Table 3 the FDD Band and See Table 4 Link Budget calculation for 4G LTE Frequency Planning

Table 3. FDD Bands [6]

Band	Frequencies	
	UL (MHz)	DL (MHz)
1	1920-1980	2110-2170
2	1850-1910	1930-1990
3	1710-1785	1805-1880
4	1710-1755	2110-2170
5	824-849	869-894
6	830-840	875-885
7	2500-2570	2620-2690
8	880-915	925-960
9	1750-1785	1845-1880
10	1710-1770	2110-2170
11	1428-1453	1476-1501
12	698-716	728-746
13	777-787	746-756
14	788-798	758-768
17	704-716	734-746

Table 4. LTE Downlink Link Budget [7], [8]

LTE Downlink link budget			
Parameter	**Unit**	**Downlink Calculations**	**Calculation**
Tx RF Power	dBm	43	a
TX Diversity Gain	dB	3	b
Tx RF Line Loss	dBi	1	c
Tx Antenna Gain	dB	17	d
Tx AA Gain	dBm	0	e
EIRP	dB	62	f= a+b-c+d+e
Thermal Noise	dBm/Hz	-174	g
Subcarier Bandwidth	Hz	15000	h
Occupied Subcariers		600	i= 12*50
Noise Figure	dB	6	j
MCS	dBm	QPSK	k
SNR	dB	1.564	l
Fast Fade Margin	dB	4.5	m
Rx Diversity	dB	3	n
HARQ	dB	0	o
Rx Faded Sensitifity	dBm	-95.3	p = g + ^{10}LOG (h*i) + j + l + m - n-o
Rx Antenna Gain	dB	7	q
Rx RF Line Loss	dB	0	r

Effective Rx Faded Sensitivity	dBm	-102.3	s = p-q+r
Body, Vehicle, Building Loss	dB	10	t
Interference Margin	dB	2	u
Log Normal margin	dB	6.5	v
MAPL	dB	145.89	w= f -s-t-u-v

Subscriber profiled forecasting and the calculation of the service traffic demand, in addition to the capacity coverage requirements [9],[10]

For this traffic simulation, there were types of user activity

a. Connected UL+DL, Upload and Download User Activity
b. Connected UL , Upload User Activity
c. Connected DL : Download User Activity
d. Inactive : Not Active User
e. No Coverage : User did not get best server area or service area.
f. No Service : User did not get bearer because lower SINR.
g. Schedule Saturation : Not listed at scheduling.
h. Resource Saturation

This paper ended up with a proposed for an applicable 4G network to be deployed in the selected cities.

2. RESEARCH METHODOLOGY

The methodology used in telecommunications network planning Long Term Evolution included:

Block Diagram

LTE network planning could be made a block diagram of the design of the arrangement as in see Figure 4.

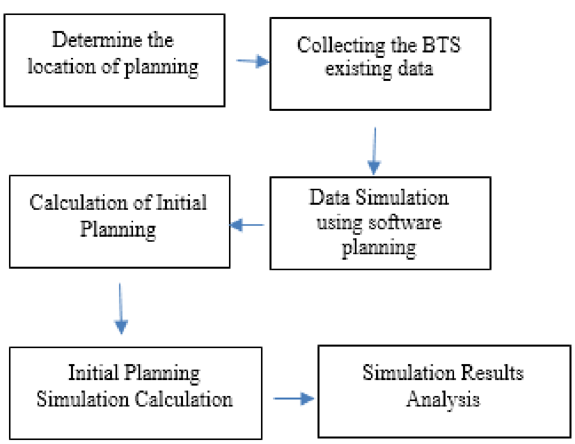

Figure 4. Block Diagram

The following was an explanation of the parts on the block diagram.

- Determine the location of planning.

Planning Location was an Rural Area (Magelang City) in Indonesia.

- Collecting the BTS existing data.
  - The coordinates of the site.
  - The number of sites
  - Antenna height,
  - Direction antennas and antenna tilting : 65deg 17dBi 2tilt 1800 Mhz
  - Type of frequency : 1800 Mhz
  - Bandwidth : 10 Mhz
  - Types of Duplex Technique : Frequency Division Duplex.
  - Type os Frequency reuse (Researcher used Frequency reuse 1 where each cell used the same frequency of the frequency band provided. 1 frequency reuse could be written with 1X1X1 if the type of cell was the cell omnidirectional and sectoral 1X3X1)
- Data Simulation using software planning. Simulations used Software planning to plan the coverage and capacity of existing eNodeB to serve the user.
- Calculation of Initial Planning.
  Initial calculations included the coverage and capacity planning, the results of this calculation were eNodeB amount.
- Initial Planning Simulation Calculation.
  Simulations were performed to adjust on the calculation the number of parameters eNodeB.
- Simulation Results Analysis
  The simulation calculations were compared with the existing BTS, in coverage as well as capacity. Analyses performed were RSRP, SINR and traffic predictions (predictions user served by eNodeB).

3. RESULTS AND DISCUSSION

3.1 BTS Existing Simulation Results

There were two parameters that must have been analyzed, there were RSRP and SINR from coverage aspect. There were user (uplink and downlink) connected with eNodeB from Capacity Aspect. See Figure 5 for the result of the prediction for Coverage Signal Level (RSRP).

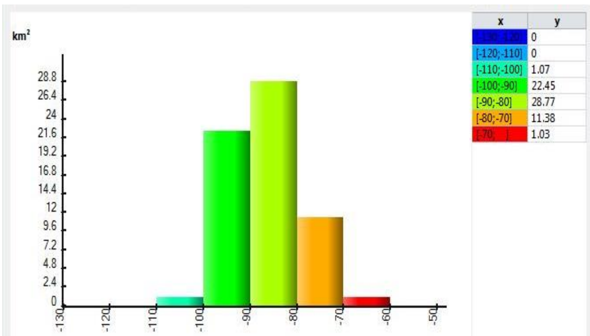

Figure 5 . *Result Prediction , Coverage Signal Level*

See Figure 6 that the average signal strength was obtained for a prediction use 16 eNodeB was -67.28 dBm, meaning that the signal strength was excellent. Research showed the average quality of the signal obtained for predictions using 16 eNodeB was 14.6 dB, meaning that the quality of the signal was normal. Capacity prediction was usefull to know how many users were served by eNodeB.

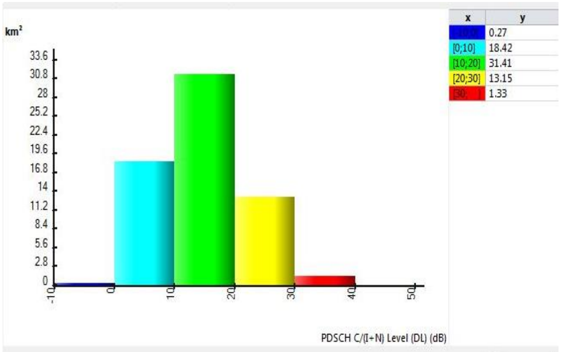

Figure 6. ***Result Prediction,*** **signal quality** ***Level***

See Figure 7 the result form Monte carlo simulation. There were 1.8% users who didn't get service from eNodeB because of signal quality and signal strength. There were 98.2% users who got service from eNodeB. eNodeB services were voip, video conferencing, High Speed Internet dan Mobile Internet Access.

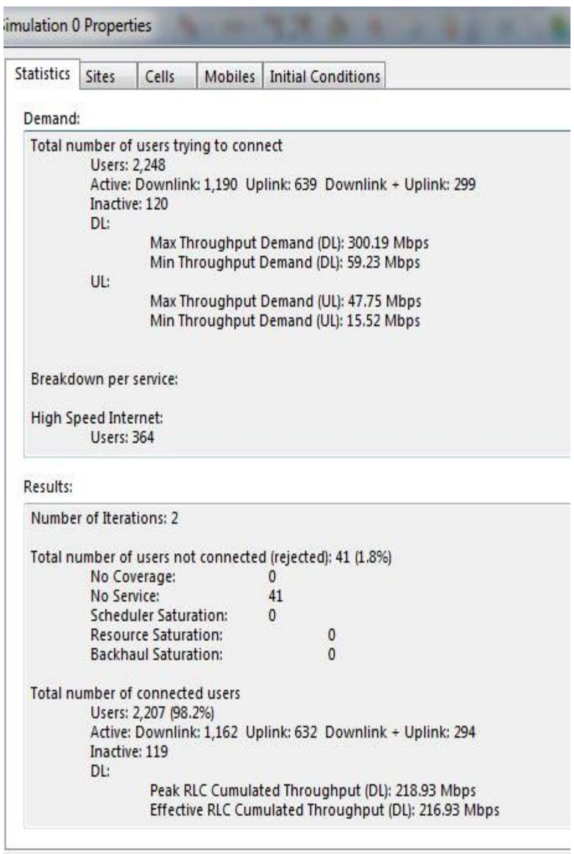

Figure 7. ***Result Prediction,*** **Monte Carlo Simulation**

3.2 Simulation Results Calculation

The results obtained from the first prediction was -67.53 dBm (Coverage By trasnmitter) with Number 9 eNodeB that was used to cover the area of Magelang, See Figure 8

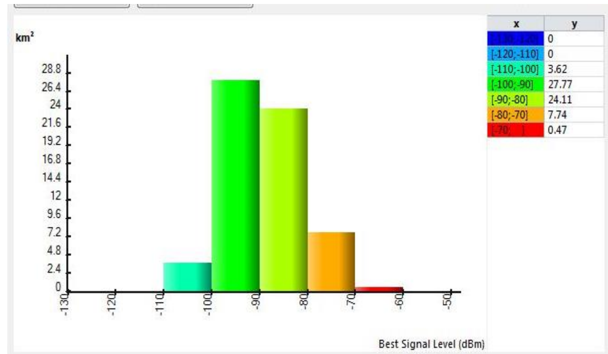

Figure 8 . ***Result Prediction, Coverage Signal Level***

The results of the second prediction was 13.89 dB (Coverage By C (I + N))., See Figure 9

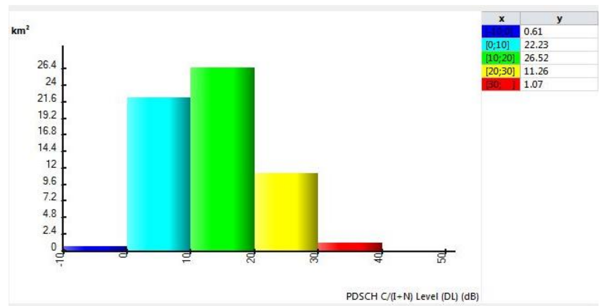

Figure 9. ***Result Prediction,*** **signal quality** ***Level***

The third simulation was simulated users that could be served by 9 eNodeB with traffic predictions. The simulation results were 4.8% traffic users who were not served, users who did not receive the services because of the value of quality and poor signal strength in the area, so that the users were underserved. and 95.2% of users could be served by the eNodeB. Users got service - from eNodeB services such as VoIP, High speed Internet, Uplink and downlink. See Figure 10.

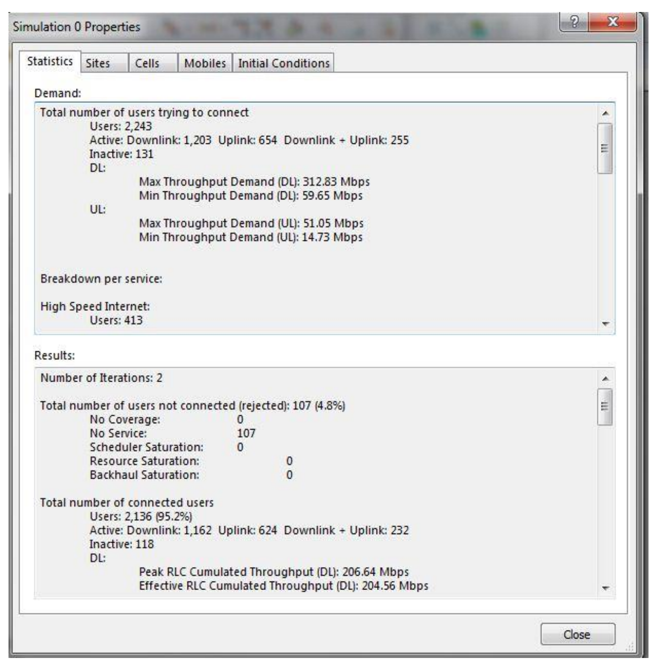

Figure 10. ***Result Prediction,*** **Monte Carlo Simulation**

See Table 5 the comparison result between existing and calculation

Table 5. Existing and Calculation Comparison

Prediction	Existing	Calculation
Coverage Signal Level	-67.28 dBm	-67.53 dBm
Coverage By C(I+N)	14.6 dB	13.89 dB
Monte Carlo	98.2 %	95.2%

4. CONCLUSION

4.1 LTE network planning based on simulation with existing BTS obtained -67.28 dBm for signal strength, 14.6 dB for signal quality value and 98.2% of users could be served by the eNodeB.

4.2 Planning LTE network based on a simulation calculation for the values obtained -67.53 dBm signal strength, 13.89 dB for signal quality value and 95.2% of users could be served by the eNodeB.

4.3 The number of base stations affected the outcome of the coverage and capacity.

5. RECOMMENDATIONS

5.1 The network Planning could be developed by using two different frequencies, 1800 Mhz and 900 Mhz with Carier Agrregation features.

5.2 The network planning was done not only between eNodeB and the EU, but also between the eNodeB and the eNodeB.

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