Study on coverage area for LTE services in the rural area of Thailand

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ABSTRACT

Abstract – In this paper, propagation analysis for 4G LTE technology in Thailand's rural services area is presented by measuring signals using portable measuring instruments. We measure from the center of the base station exits to the edge of the cell coverage with different services, including calling, downloading data, and uploading data services. The measurement results were compared with 3GPP propagation equations of rural areas. The analysis results showed that the measurement results and calculations from the 3GPP wave propagation equation were approximately the same. With the capabilities of each service, it can be used at the lowest signal level of -120 dBm, where the download and upload data can be used lower than sometimes calls service.

Keywords: LTE, UE, 3GPP, RSRP, RSSI

I INTRODUCTION

The major challenge of mobile networks 4G long-term evolution has many different frequency bands with extra service distance. The study analyzes the length supported by LTE base station construction in Thailand. This measurement is on the actual use of the 4G network by the local network in the suburban area. The results of the study use engineering mode UE for testing software for measurement. Many measuring and analysis schemes The signal strength of LTE can be directed by measure. This paper's organized as follows, and Section II describes the test tool and mode measurement route planning. Section III describes how this paper test drives the calculation of the measurement parameter. Section IV results and discussion, and the last one is V conclusion.

II MEASUREMENT AND ANALYSIS PRINCIPLE

In this paper, we drive testing the measurement to analyze this study and the theory of radio wave propagation in mobile phones. Finding the area of coverage for a cell phone theoretically can refer to the idea of radio propagation. The frequency band used base station transmission power and height of the transmitter.

The propagation refers to communication in which the signal is not reflected with the earth's surface before it reaches the receiving side. There is the ideal transmission characteristic if communication takes place in an independent space. There are no obstacles between the transmitter and receiver. It assumes that the base station has transmitted power watts P_{tx} , and the ideal antenna isotropic has a spherical air distribution surface. The distance between the base station and the mobile phone is equal to the kilometers d and the distribution of waves from an isotropic origin point.

$$P_L = \frac{P_{tx}}{P_{rx}} = \frac{1}{G_{tx}G_{rx}}\left(\frac{4\pi d}{\lambda}\right)^2 \quad (1)$$

In decibels, The receiving power is proportional to the square of the wavelength. And is inversely proportional to the square of the distance. Depending on the size of the reception area of the receiving antenna, When the frequency of path increases, while sending the same receiving power will be reduced as follows.

$$P_L(dB) = 10\log_{10}\frac{P_{tx}}{P_{rx}}(dB) = P_{tx}(dB) - P_{rx}(dB) \qquad (2)$$

The forward power ratio is Path Loss or is the value indicating the attenuation of the signal from 3GPP [1],[2] in the rural area will be express as following equation,

$$\mathrm{L} = 95.5 + 34.1\log_{10}(R))$$

$$(R) = 69.55 + 26.16\log_{10}(f) - 13.82\log_{10}(Hb) + \left[44.9 - 6.55\log_{10}(Hb)\right]\log_{10}(R) - 4.78\left(\log_{10}(f)\right)^2 + 18.33\log_{10}(f) - 40.94 \qquad (4)$$

Where R is the distance between based station and UE (km)

f is carrier frequency (MHz)

Hb is height of UE (meters)

The totol pass loss normally includes the Log-Normally Distributed Shadowing (LogF) around 10 dB, which the pass loss can be express as the following equation,

$$P_L = L + LogF\ ) \qquad 5($$

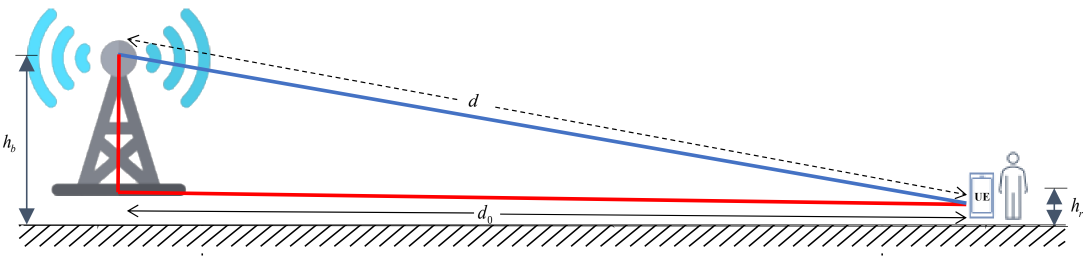


Fig 1. Model of propagation of waves in a production environment

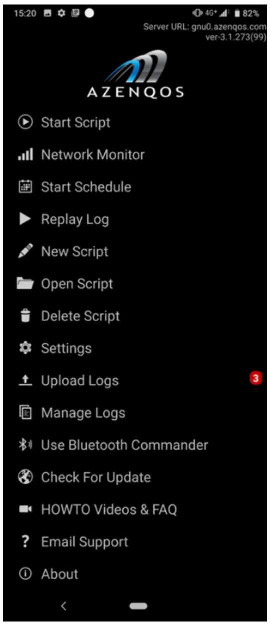
III SIGNAL ANALYSIS

Drive Test signal level measurement in a survey to measure the signal level in mobile phones' real-world use [3-6]. We are installed the mobile phone signal meters in front of the car shown in the Fig. 2. The Drive Test is open to receiving mobile phone signals by limiting the frequency band to be tested for 1800 MHz.

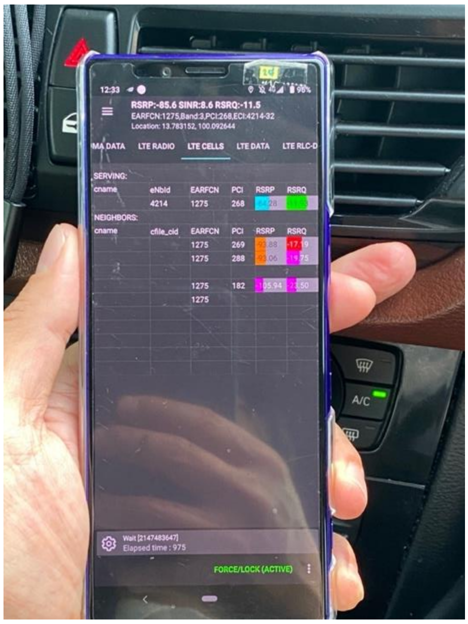
It will start to record the signal level and move the vehicle while saving the estimated signal level value to the Cloud Server to measure any parameter. There is a function of measuring different signals. Performing the signal measurement does not measure the coverage until the lowest value of each base station. By calculating the coverage area of each base station and the signal quality can be referenced from the mobile phone's handover signal level as shown in the details of the base station coverage area as shown in Fig 3. Mobile phones can continuously be resulting in the measurement of signal level.

The signal can be measured continuously, while the signal level is according to the base station and technology. The measured signal level may be lower than the handover level between base stations. The signal level in the handover process between cell phone base stations is one factor in determining mobile phone networks' performance. Because if there is a low level, it is more likely that the mobile phone will not continuously connect to the interconnection in the handover process between base stations than the higher-level signals.

Signal measurements to place the signal meter next to the car's front windshield and drive at a constant speed of approximately 60 kilometers/hour. The sampling signal every 200 msec. The measured signal level values by analyzed for the signal quality, such as the average signal strength level, The number of base station switching frequencies, etc. Each mobile phone technology has a different name for each system. Also, the SINR value by estimated for the transmission rate occurring in that area because mobile phones in the 3rd and 4th generation will have a way to change modulation or modify modulation methods to have the transmission speed following the quality of the channel.



a. Portable Mobile Measurement (UE)



b. LTE signal measurement

Fig 2. LTE Measurement equipment

Measuring the signal level with a base station. We count for the maximum coverage that the mobile phone used. The principle of testing each station's content is base on the strength of the signal level in the whole area. We designed the simultaneous use test into three applications which consist of:

1. Voice communication usage test (Call: Voice)

2. Data Upload Usage Test (UL: Upload Data)

3. Download Data Usage Test (DL: Download Data)

This paper has written a program to test the ability to communicate with both voices. Data upload and download for on-site testing with a sequence of workflows. Measurement and testing of the signal level as follows

Measuring base station signal levels requires determining the base station's Physical Cell ID (PCI) to be tested. Method for determining PCI values of each base station from measurements and surveys. The measured and surveyed the signal by having the measuring instruments detect the base station PCI values before testing the base station specified base station. The base station PCI screened for testing, and the PCI values are to identify the specific station pick-up. When it moves further from the center of the mobile base station to be tested or approaching the nearby mobile base station's center with a better signal level, the mobile phone client will try to communicate with the mobile base station. We test until can not be contacted (No Service) by assuming the signal level and the farthest distance that can be a mobile phone, and the client can still use either voice communication or data upload or data download as a waiting area

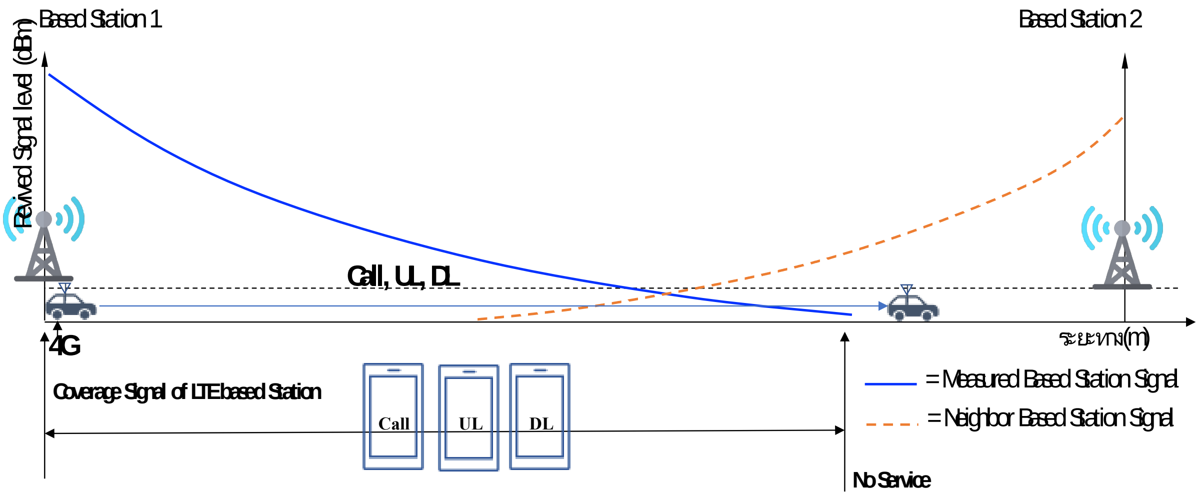
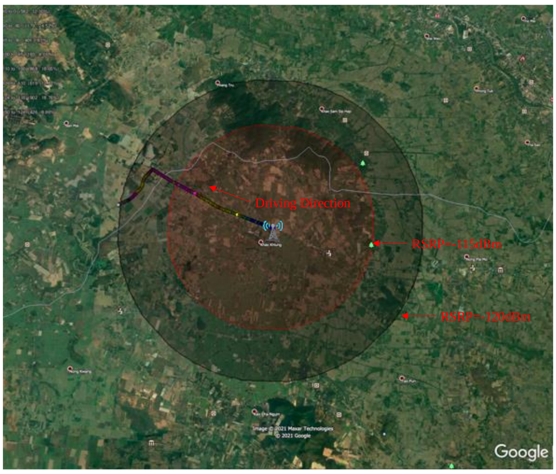


Fig.3 Coverage areas capable of providing voice communications

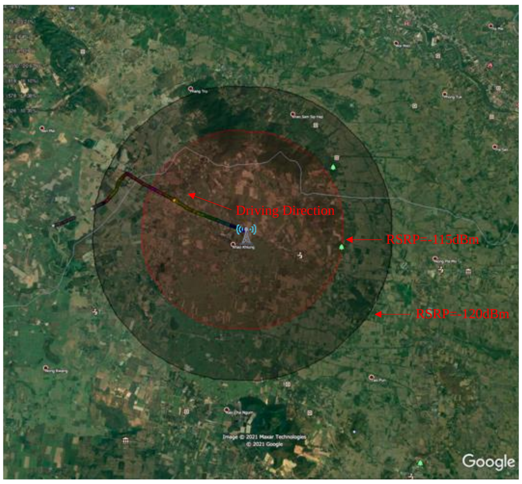
To analyze the signal levels obtained from the Test of real-space service, comparing it with propagation models. Analysis results showed signal level values that can still serve both audio communications. Data upload and download. We tested the lowest signal levels to provide mobile phone service, including voice service to upload and download data. In the Test, the tested several times with different base stations, In the urban area rural area on highways or open spaces along with fields. We found that other base station locations would affect usability levels at different minimum signal levels. Both base stations are measured to base station specified signal levels with the PCI mentioned above and EARFCN configurations. To force the cell phone to receive the signal and operate only through the specified base location until the signal level is lowest becomes unusable. Therefore, the minimum value is considered the value used to calculate all base stations' coverage in each frequency band.

IV RESULTS AND DISCUSSION

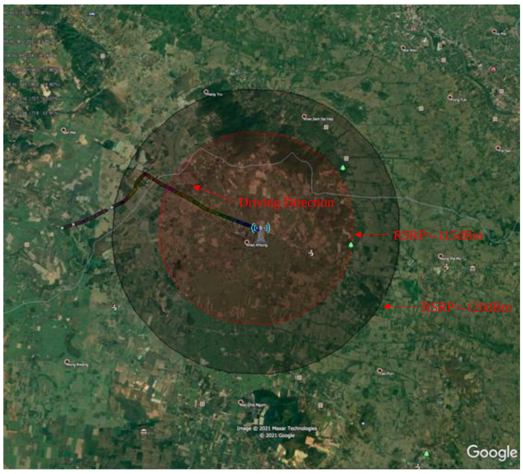
The signal level meter is ready to measure the signal by selecting the password only for the base station. As measurement starts from the base station's center, moving outside the base station, in the region of no signal from the neighboring base station, Not more than 60 kilometers per hour, the results in Fig.4 and 5. The experiment results in both base stations show that We can still use the lowest signal level via audio. Data upload and data download have similar signal levels. The lowest level is in the open area, and there is no base station next to the mobile phone. It has operability below -115 dBm.



a. Calling Service



b. Download service



c. Upload service

Fig 4 the RSRP versus the distance

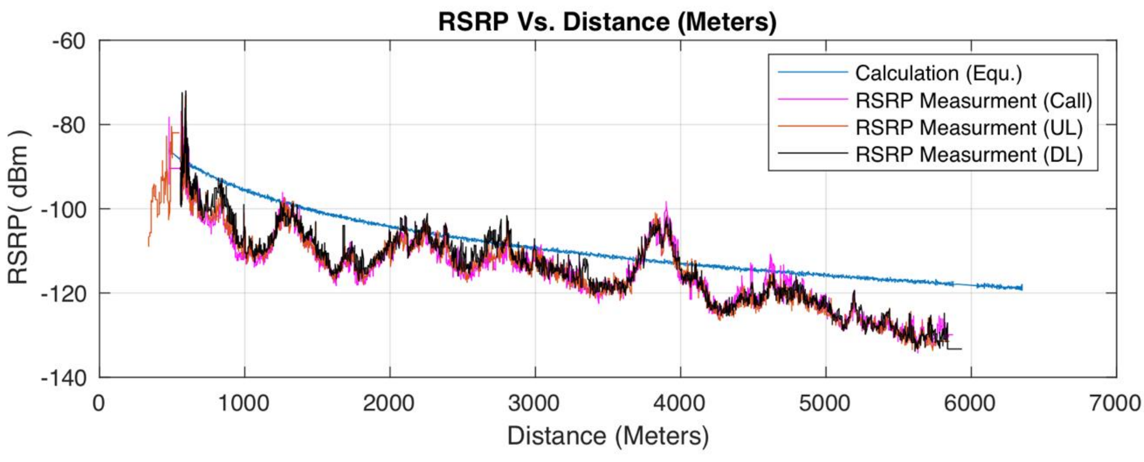


Fig 5 the RSRP versus the distance

A mobile base station's area and density affect the travel distance of the waves and the operator's design characteristics, which will vary from place to location. As a result of testing, we can still use the lowest signal level values. The test procedures and methods are the same for the Test for base station first and base station second by measuring the signal level from the center of the base station moving out of the base station's outer edge, as shown in Fig.5. We can illustrate the actual on-site measurements. Observing the lowest signal level Test, the decrease in signal strength was more slope than the example first base station and second base station because the operator has adjusted the angle of the antenna to bend down. Therefore when comparing it with the propagation equation, there is a reasonable difference. But the lowest level of the signal that the mobile phone can still use, the results are in line with the Test in a first base station and second base station, lower than -115 dB. Get all three services. Therefore, We selected the lowest signal level value to calculate the coverage area equal to -115 dBm for the computer-based simulation. We can use the wave propagation equation with the lowest signal level to find the coverage area.

V CONCLUSION

The results of the experiments compared with the simulation of computer propagation showed that the 3GPP propagation equation could be used in the cell coverage design of rural areas of Thailand and the coverage area of each station. The coverage edge of a base station can use a level at -115 dBm according to the National Broadcasting and Telecommunications Commission (NBTC) standards. It can be used for calling, data download, data upload services. In rural areas of Thailand, coverage of base stations longest coverage distance receives the signal up to -120 dBm. It can still be work in any service.

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