SIMULATION AND ANALYZE DRIVE TEST MEASUREMENTS FOR 3G WIRELESS NETWORKS

Norhaniza binti Zainuddin
Project Supervisor: Ir. Muhammad bin Ibrahim
Faculty of Electrical Engineering
Universiti Teknologi MARA
40450 Shah Alam

Abstract- This paper presents a simulation study of drive testing with respect to power control. Drive testing is the process of performing radio frequency and protocol-level measurements throughout an area covered by a wireless communications network. The names drive testing results from the typical method of performing these measurements, where a car or van is used to drive measurement equipment throughout all service areas. Results of this project show that power control is one of critical importance in 3G system

1. INTRODUCTION

Third generation systems are designed for multimedia communication with them person-to-person communication can be enhanced with high quality images and video and access to information and services on public and private networks will be enhanced by the higher data rates and new flexible communication capabilities of third generation system.

One of the most importance requirements in a third generation system is the capability of *the* user equipment (UE) and base transceiver stations (BTS) to control their transmitter power output. Without it, a single mobile could block a whole cell. For example, user equipment UE1 and UE2 operate within the same frequency, separable at the base station only by their respective spreading codes. It may happen that UE1 at the cell edge suffers a path loss, say 70dB above that of UE2 which is near the base station. If there were no mechanism for UE1 and UE2 to be power controlled to the same level at the base station, UE2 could easily over shout UE1 and thus block a large part of the cell giving rise to the near-far problem of WCDMA [1].

The optimum strategy in the sense of maximizing capacity is to equalize the received power per bit of all mobile stations at all times. Not only power control required to combat the near- far problem, it is also required to combat the effects of Raleigh fading, where the received signal can suddenly drop by many decibels as a result of multi-path propagation., which results in multiple copies of a signal arriving at the receiver out of phase. Thus, power control is deployed both in the uplink and downlink:

2. POWER CONTROL

The basic principles for power control are:

1. Base Station determines UE transmit power (Uplink).
2. UE determines Base Station transmit power (Downlink).

In general, power control in WCDMA uses two main techniques which are opened loop power control and closed loop power control. With open loop power control, the terminal estimates the required transmission power based upon the signal power received from the base station and information broadcast from the base station regarding the transmit power from the base station.

Specifically, the base station broadcasts the transmit power used on the CPICH (Common Pilot Channel) and the terminal uses this information in conjunction with the received power level to determine the power that should be used on the uplink. Consequently, open-loop power control provides only a very rough estimate of the ideal power that the terminal should use. For this reason, open-loop power control is used only when the UE is making initial access on the PRACH (Primary Random Access Channel) [3].

Closed-loop power control means that the receiving entity (the base station or UE) measures the received Signal-to-Interference Ratio (SIR) and compares it to a target SIR value. The base station or UE then instructs the far end to increase the transmitted power if the SIR is too low or decrease the power if the SIR is too high. Closed-loop power control is also known as fast power control since it operates at a rate of 1500 times per second (1.5kHz) because there are 15slots available for each 10ms. This rate is sufficiently fast to overcome path loss changes and Raleigh fading effects for all situations except where the UE is traveling at high speed.

There is also another form of power control known as outer-loop power control, with the primary objective being maintaining the service quality at the optimum level. In general, the objective of power control is to maintain the SIR at the receiver at the optimum value, not to high and not to low. The target SIR value however is a function of the required quality for the service to be supported [2].

3. SOFT HANDOVER

Soft handover occur when a mobile station is in the overlapping cell coverage area of two sectors belonging to different base stations. The primary purpose of soft handover is to provide seamless handover and added robustness to the system. Without soft handover there would be near-far problem of a mobile station penetrating from one cell deeply into adjacent cell without being power-controlled by the latter. This is mainly achieved via three types of gains provided by the soft handover mechanism:-

1) **Macro diversity gain**: A diversity gain over slow fading and sudden drops in signal strength due to e.g UE movement around a corner.
2) **Micro-diversity gain**: A diversity gain over fast fading.
3) **Downlink load sharing**: A UE in soft handover receives power from multiple Node-Bs, which implies that the maximum transmit power to a UE.

The soft handover uses typically CPICH Ec/No (=pilot Ec/No) as the handover measurement quantity, which is signaled to RNC(Radio Network Controller) by using layer 3 signaling.

Active set: The cells in the active set form a soft handover connection to the UE.

Neighbor set/monitored set: The neighbor set or monitored set is the list of cells that the UE continuously measures, but whose pilot *Ec/No* are not strong enough to be added to the active set.

The Common Pilot Channel (CPICH) is a channel always transmitted by the base station and is scrambled with the cell-specific primary scrambling code. It uses a fixed spreading factor of 256 which equates to 30Kbps on the air interfaces. An important function of the CPICH is in measurements by the terminal for handover or call reselection as the measurements made by the terminal are based on reception of the CPICH.

For example, if the CPICH power transmitted on given cell is reduced, the effect is to make the CPICH reception from neighboring cells appear stronger, which may trigger a handover to a neighboring cell. This can useful for load-balancing in the RF network. It is possible to have more than one CPICH in a given cell. The primary CPICH is transmitted over the entire cell area while the secondary CPICH can be transmitted over the whole cell area or can be restricted by transmission on narrow-beam antennas to specific areas of the cell such as areas of high traffic.

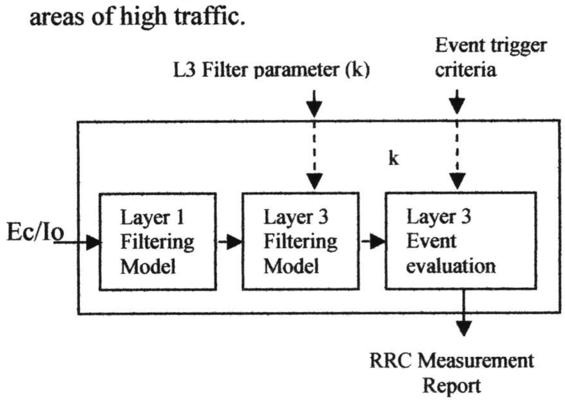


Figure 1: Handover measurement filtering and reporting.

The handover measurement filtering is described in figure1.Before the pilot *Ec/No* is used by the active set update algorithm in the UE, some filtering is applied to make the results more reliable. The measurement is filtered both on layer 1 and on layer 3. First, the measurement samples are filtered with the "Layer 1 filter" in order to average out of the impact fading. Furthermore, in order to give the operator the possibility to have a better control over the accuracy of the measurements, a special higher layer3 filter model is specified in:

$$Fn = (1\text{-}a)\, F_{n-1} + a.\, X_n$$
$$a = 2^{-k/2}$$

where

X_n is the latest received measurement result from the physical layer measurements,

Fn is the filtered output fro the layer 3 filter,

k is the L3 filter parameter supplied by the operator.

The accuracy and the delay of the handover measurements, e.g. CPICH Ec/No, is importance for the handover performance. Therefore, even though the exact implementation of the layer 1 filter model is not specified, the minimum performance requirements are given. These requirements include the minimum performance for the measurement accuracy and delay, and furthermore, the ability for parallel measurements.

For the P-CPICH Ec/No measurements, the technical specification defines that the measurements period is 200ms. This means that the reported measurement result after layer 1 filtering shall be an estimate of the average value of the measured quantity over the last 200 ms period. Typically, the choice of the measurement period is a tradeoff; if the averaging period is longer, the fast fading is more effectively averaged out, but at the same time the measurement delay is increased, which is not a good thing in particular for micro cellular networks.

Before we leave the area of handover measurements we note the size of the neighbor list. The maximum number of intra-frequency cells in the neighbor list. is 32. Additionally, they can be 32 inter-frequency and 32 GSM cells on the neighbor list. The neighbor list can be defined by the network planning tool or it can also be tuned automatically by network optimization algorithms based on the UE measurements. If there is a neighbor cell missing from the list, it can be noticed based on the UE measurements since UE is required to identify a new detectable cell that does not belong to the monitored set within 30s [1].

4. METHODOLOGY

The actual measurement and the evaluation of results drive test can be configured and carried out independently with ROMES simulation software. Measurement systems consisted of a single handset connected to a serial port of a PC for monitoring narrowband signals. GPS is also used for measurement mapping and geographical binning of data. The measurements include received signal strength measurement, network quality analysis, power control, layer-1and layer-3 paging message decoding and etc. The Figure 4.1 shows the drive test measurement where a car is used.

Figure 4.1: Drive test measurements

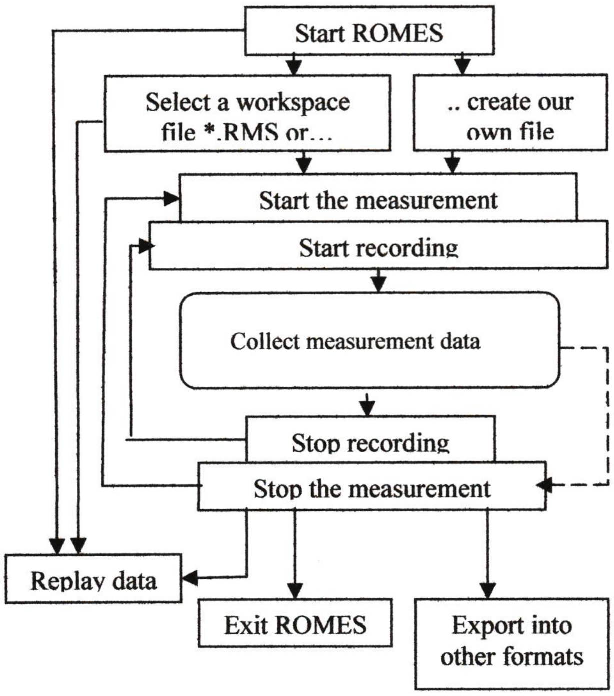


Figure 4.2: Overview of a measurement tour

The data can be viewed during the measurement without being stored (measurement mode), they can be viewed and stored at the same time (recording mode), or data recorded before can be loaded from a measurement file and analyzed (replay mode). The replay mode is an additional feature for pre-evaluation purposes. We can load and analyze the stored measurement data after the measurement tour, using different views that ROMES provide for display and evaluation.

5. RESULTS AND DISCUSSION

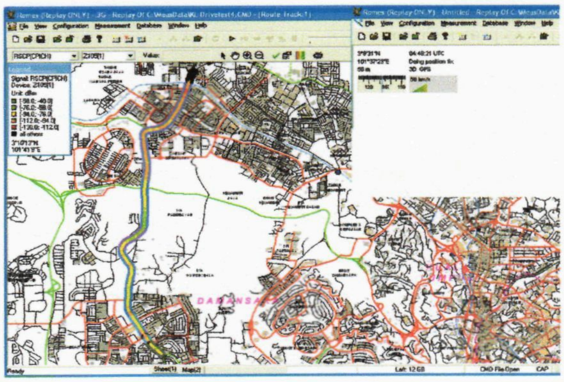


Figure 5.1: The Route Track and GPS info

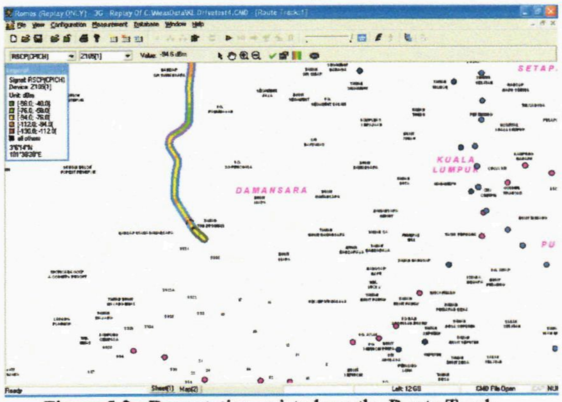


Figure 5.2 : Base station exist along the Route Track

Figure 5.1 shows a (vector) background map of the Selangor together with a length scale while Figure 5.2 shows Base station that exist along the Route Track. The drive test measurement is from Taman Kepong until Taman Tun Dr. Ismail. The signals along a measurement tour, event symbols, base stations and arbitrary bitmap of the explored area was projected onto the background map. The events recorded along the route and the base station located. The color of the curve indicates the signal value as explained in the legend. The green color indicates the highest signal strength while the read color indicates the lowest signal strength. From the figures 5.1 and 5.2, the color of the curve was always changes because the signal composed of a large number reflected rays because of scattering and reflections from building and obstruction. Besides that, there are handovers occurred from the base station during the measurements.

The GPS Info window shows the recorded GPS information and the calculated direction and speed of the test vehicle, compass heading and speed are displayed in a compass and speedometer if the GPS receiver provides these quantities. The compass and speedometer provide the direction and test of the test vehicle.

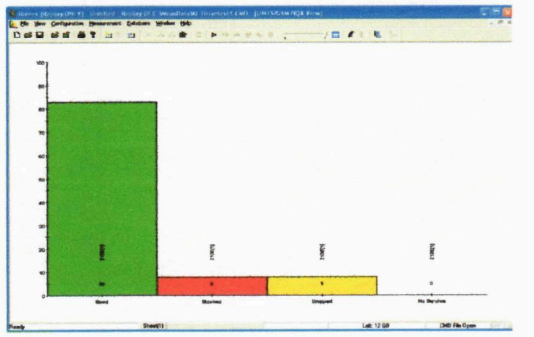
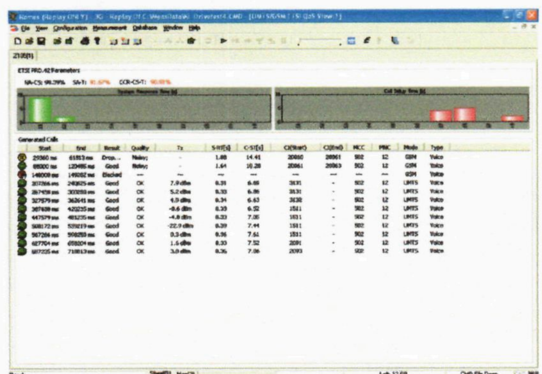


Figure 5.3 Network Quality Analysis (NQA)

Figure 5.3 shows the NQA classification for each call (Good, Blocked, Dropped and No Service). During this drive test measurement there are 83% good calls and 8.5% for blocked and dropped calls. The data are verified in figure below. From this figure shows, from 29360ms until 149282ms there are no transmit power. The generated calls result dropped calls from 29360 until 61813ms which made the quality are noisy while the blocked calls are from 148000 until 149282ms. All calls after 207266ms resulted good calls. The MCC and MNC in this graph represent mobile country code



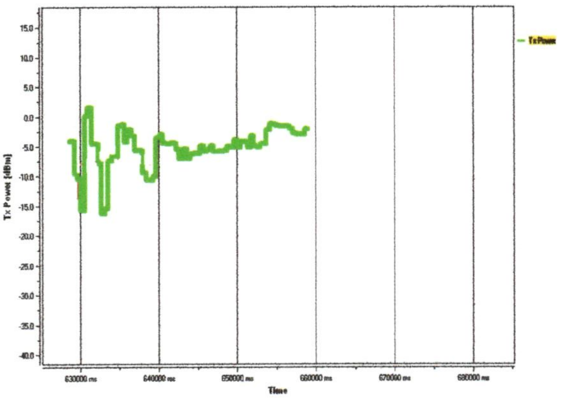


Figure 5.3: Transmit power at 1min

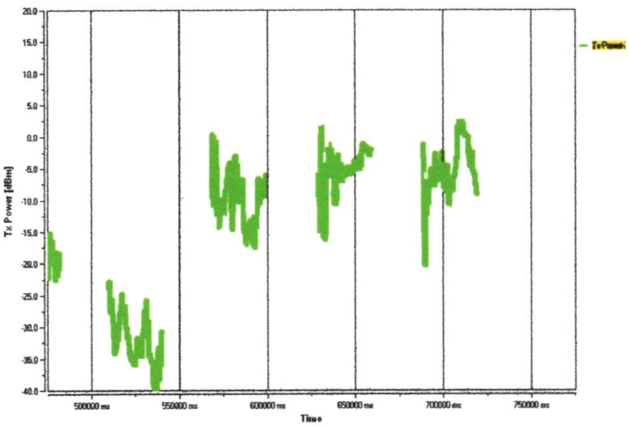


Figure 5.4: Transmit power at 5min

Figure 5.3 and Figure 5.4 shows the simulation results for the transmitted power (dBm) as a function of time for 1minute and 5minutes. A power control step size of 5.0dB is used. The compensation of the fading causes peaks in the transmission power. In Figure 5.3 very little diversity assumed, while in Figure 5.4 more diversity is assumed in the simulation. Variations in the transmitted power are higher in Figure 5.3 than in figure 5.4. This is due to the different in the amount of diversity. The diversity can be obtained for example multipath diversity, receive antenna diversity, transmit antenna diversity or macro diversity. With less diversity there are more variations in the transmitted power, but also the average transmitted power is higher. The statistics of the received energy for a short-term average are usually well described by the Raleigh distribution. The average value power transmit at 1min is -6.21dB dB while at 5minutes the average value is -11.4dBm.

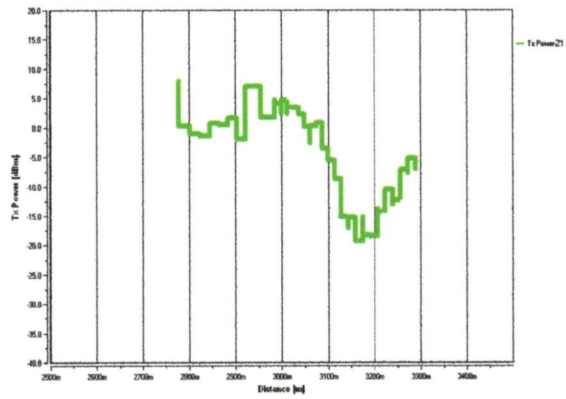


Figure 5.5: Transmit power at 1 km

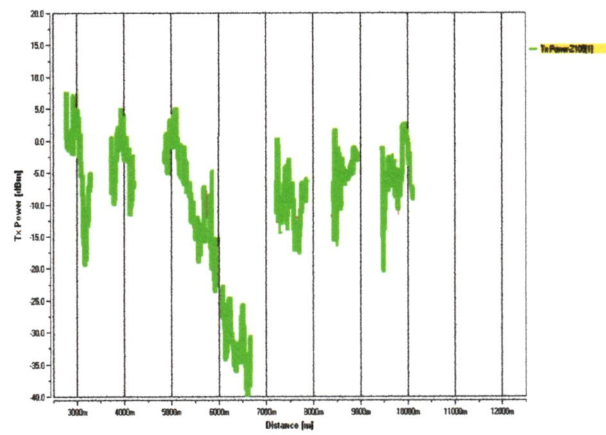


Figure 5.6: Transmit power at 10 km

Figure 5.5 and Figure 5.6 shows the simulation results for the transmitted power (dBm) as a function of distance for 1 km and 10 km. As the mobile moves through this signal pattern, the amplitude of the signal going alternately through maxima and minima. When phase cancellation called fast fading of multipath reflections occurs, the transmit power for 1 km dropped considerably by 20dBm while for 10 km the power dropped is much higher which is 40dBm. This is due to the signal is composed of a large number reflected rays because of scattering and reflections from building and obstruction while traveling at 10 km. The errors are larger when the mobile is closer to the cell border. As a result, over short distance, the average signal level received at any point remains virtually constant, but its instantaneous value varies randomly about the mean level with a Rayleigh distribution, The average value power transmit at 1km is -4.13dB while at 10km the average value is -7dBm.

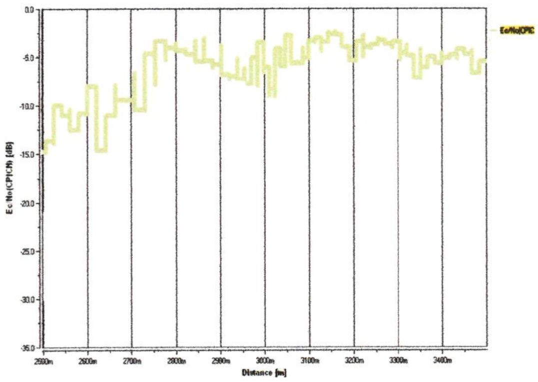


Figure 5.7: Ec/No (CPICH) at 1 km

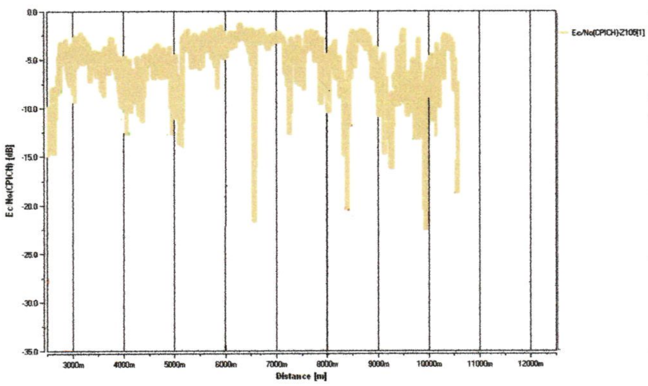


Figure 5.8: Ec/No (CPICH) at 10 km

Figure 5.7 and Figure 5.8 shows the simulation result measurement for Ec / No as a function of distance at 1 km and 10 k.m. Ec/ No representing the received signal code power divided by the total received power in the channel bandwidth performed from the common pilot channel (CPICH). The mobile detects pilot strength (Ec/No) and sends the Pilot Strength Measurement message to the base station. A power control step size of 5.0dB is used. The power for 1 km dropped considerably by 15dBm while for 10 km the power dropped is increased to 24 dBm. The larger measurement errors for 10km are due to the fact that 200 ms filtering period is not long enough to average out the impact of fast fading. The average value Ec/ No at 1 km is -6.3 dBm while at 10km the average value is -10dBm.

6. CONCLUSION

We can conclude that the power control system is very important since it will influence in 3G wireless network. The capability of the UE and base station to control their transmitter power output is one of the most requirements in 3G system especially to overcome near-far problem. An understanding of current drive test methodology and acknowledge of the equipment used is essential for developing deployment and maintenance strategies for 3G networks. The data rates in the future system will be much higher and make the power consumption of the terminals will increase. Thus UE may have a more compact design and longer battery life that result in improved speech quality, particularly in urban and dense urban areas.

7. FUTURE DEVELOPMENT

For future work, we can further this project by investigate other performance such as GPRS network, Wireless Local Area Networks (WLANs) and digital video broadcasting system by using the ROMES software simulation

8. ACKNOWLEDGEMENT

A special thank you to my supervisor, Ir Muhammad bin Ibrahim for his encouragement and supervision on the dissertation. His assistance and guidance would be much appreciated. Many people contributed to this work, either directly or indirectly, thank you very much.

9. REFERENCES

[1] Harri Holma and Antti Toskala, “WCDMA for UMTS,”Wiley, 2002.

[2] Clint Smith and Daniel Collins, “3G Wireless Networks,”McGrawHill,2002.

[3] M.R. Karim and Mohsen Sarraf, “W-CDMA and cdma2000 for 3G Mobile Networks,” McGrawHil,2002.