Performance Evalution Of Corner Effect In 3G Network In User Perspective

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Abstract - **The purpose of this project is to analyze corner effect in 3G network. In this paper, two 3G service provider in Malaysia were selected in order to obtain more accurate data. Software used in this drive test is RF signal tracker and G-Net track from Google Play installed on android mobile phone. The drive test data was collected alongside Jalan Tun Razak, Jalan Ampang and Jalan Yap Kwan Seng. The drive test data further analyze by using Google Earth, and graph was plot by using Microsoft Excel .The main parameter to determine corner effects are Ec/No and RSCP level of User Equipment. From drive test conducted, Celcom show a better performance in 3G signal quality as compare to U Mobile. Corner effect was happen near to Ampang Park and both service providers experienced the same problem. Corner effect happen when user equipment experience sudden drop in signal level. Problem occur because of blockage in line of sight between user equipment and Node B. Detail analysis on corner effect included in next part of this paper.**

I. Introduction

Third generation of mobile radio communication network, or famously known as 3G was introduced in 2000. 3G networks represent by International Mobile Telecommunications-2000 (IMT-2000) or Universal Mobile Telecommunication System (UMTS). IMT-2000 provides multimedia and high bit rate packet data. Wideband Code Division Multiple Access (WCDMA) is a part of IMT-2000 3G standards. WCDMA allows very high speed multimedia service for voice, internet access and video conferencing.

Handover play a major role in term of wireless network performance because it associates with moving user [1]. Handover happen when ongoing call was transfer from one cell to another cell due to movement of user through coverage area. This process happens by changing the channel frequency, time slot, spreading code or combination of them. Handover consist of two major types which are soft handover and hard handover. Soft handover use make before break method. Make before break means that, when the pilot signal from a new base station is stronger than the threshold value, a new link to the base station is establish while maintaining the existing link. Soft handover is the process of moving one Node B from monitor set to active set and moving one Node B from active set to monitor set. It also includes the addition, deletion, and interaction of radio links. In the UMTS network, all algorithm of handover is based on the results of measurements. Handover are critical issue in cellular communication system because, neighboring cells are always using a disjoint subset of frequency bands. Thus negotiation must take place between user equipment, current serving Node B and next potential Node B. Soft handover consist of few parameters such as time to trigger, channel and capacity, add and drop window, and downlink power transmit. Each parameter is related for each other. Thus, to have the best system all the parameters need to be considered in planning phase. In certain place such as corner of street intersection, the signal level received by user equipment will be suddenly drop due to corner effect.

A. Problems Statement

Nowadays, the ability to having mobility network seems as compulsory in user perspective. Thus, handover between cells were perfect solution to support this feature. However, when user equipment move along cell there will contribute to certain drop in received signal power. This problem occur when user move from one area to another area especially around the corner such as at street intersection. This problem known as corner effect and this problem occur because mobile equipment loss the line of sight with the serving base station. Corner effect contributed to drop call if the user equipment does not link up with the new base station fast enough.

B. Objectives of Project

1. To evaluate and compare performance between two 3G service provider in Malaysia
2. To evaluate the parameter that could affect performance in 3G network
3. *To analyze the behavior of* corner *effect in 3G* network.

C. Scopes and limitation of Project

The scopes of this project are:-

1. The project is focus on selected area of urban environment only
2. Study will focus on Celcom and U Mobile operator only
3. Drive test data collected by using RF signal tracker and G-Net track from Google Play
4. Drive test data analyzed using Google Earth and *Microsoft Excel*

II. LITERATURE REVIEW

Corner effect is close related with time to trigger, add and drop window, and power transmit,. Hence the knowledge in soft handover parameter is crucial while researching on corner effect. G Nurzaliza evaluates the performance of corner effect in UMTS network [1]. From her finding, she concluded that corner effect happen due to sudden drop in received signal power by user equipment. The problem happens because of sudden loss of LOS between user equipment with base station due to existence of tall building. Moreover, she also mentioned about effect in street intersection that contribute to corner effect. In her research, only one 3G service provider involved. In this research, Ec/No effect over distance are briefly explained.

Brahmjit Singh focuses on outage probability analysis in soft handover. In this paper, Brahmijit analyze the performance of soft handover algorithm based on pilot signal strength measurements [2]. The outage probability is used as the performance metric. In addition, Brahmjit also investigate impact of averaging window size and time to trigger on the outage probability. From his research, Brahmjit conclude that time to trigger was effective in reducing handover event reporting.

Another study is made by Yue Chen on optimized downlink transmit power control during soft handover in WCDMA systems. In this paper, a new power control strategy during soft handover in WCDMA systems was proposed [3]. According to Yue Chen the link qualities of the downlink channels involved in soft handover, the transmit powers of the base stations in the active set are dynamically allocated. This new optimized power control scheme reduces the additional interference caused by the multiple site transmission during soft handover. Compared with the unbalanced and balanced power control scheme adopted by 3GPP, the proposed scheme shows better performance. It increases the downlink capacity and makes the whole system more robust to the fluctuating attenuation of the radio environment. Performance of downlink power control depends closely on the relationship between the transmit powers of base stations. Balanced power control maximizes the macro diversity gain, but increases the interference. Unbalanced power control reduces the interference, but decreases the gain of macro diversity. The relationship between the transmit powers is dynamically changed according to different situations.

Wan Nazirah did a research on add and drop window impact on network performance. In this paper, the network performances are focusing on soft handover transport network overhead [4]. Drive test was conducted to collect real measurement data in live UMTS network. The data are analyzed and simulated to examine the behaviour of Soft Handover events. It is shown that the addition and drop windows have decisive effects on the SHO transport network. Thus, the parameter for addition and drop windows setting should be planned properly to mitigate the SHO transport network overhead and effect.

Shu Ming Tseng proposed drop rate optimization by tuning time to trigger for WCDMA system [5]. In this paper, Shu proposed to use different time to trigger in Event 1A and time to trigger in Event 1B. The reason to use different time to trigger in both events is related to drop rate obtained. From field test, results show that the drop rate is better. Moreover, soft handover rate and block error rate obtained are in desired range. In this paper Shu Ming Tseng also provide few algorithms for time to trigger.

X Yang in his paper presents a comprehensive analysis on the UTRA soft handover performance optimization by using system level simulator. X Yang also investigate effect of different soft handover parameter such as adding and dropping threshold, time to trigger, and averaging window size on handover performance [6]. The simulation results show that in soft handover optimization, all the parameters mentioned have a decisive effect upon the handover performance which has a direct impact on the system, in example radio and network resource efficiency and also service quality. From his research, X Yang suggesting that by carefully tuning and setting appropriate values for the handover parameters, a higher system performance can be achieved.

III. METHODOLOGY

This chapter discuss about the method or approach that was used to implement the idea to accomplish the objectives. The project was based on the workflow because it helps indicate which process was difficult to complete, hence give the ability to planning more time in that process.

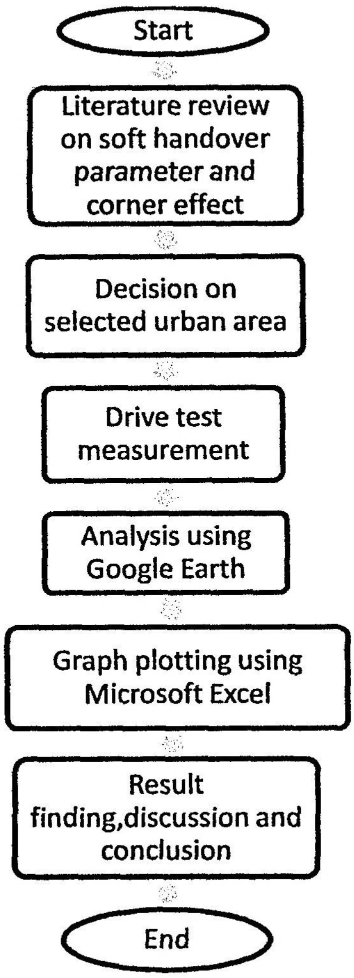


Figure 3.1: Flowchart of research approach stages

Decision on selected route

From detail discussion, Jalan Ampang, Jalan Tun Razak and Jalan Yap Kwan Seng were selected as potential urban area that contributes to corner effect. Combination of the three selected route produce triangle area. Thus, the corner effect from the triangle generated can be further analyzed after drive test data obtain. **Figure 3.2** show the selected route.

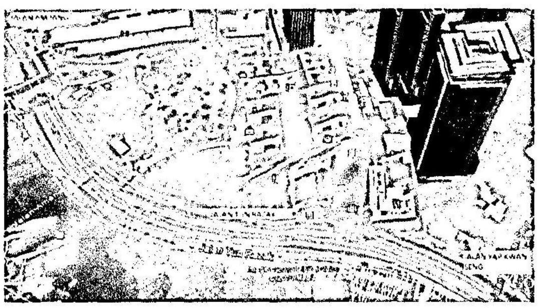


Figure3.2. Shows selected route

Drive test measurement

Drive test measurement was done on selected area. Drive test equipment for this project are shown in **Figure 3.3.** Following are list of drive test equipment.

1) 2 sets of andoid mobile phone with GPS and mobile data installed with RF signal tracker and G Net track.
2) 2 sets of mobile phone for voice sequence reception
3) A laptop with installed Google Earth

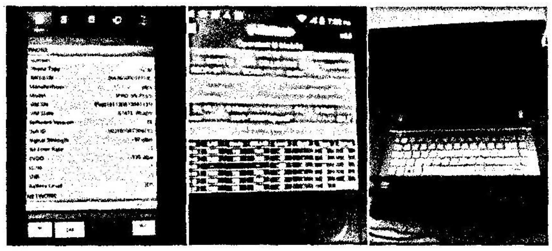


Figure3.3. Shows drive test equipment [7][8][9]

Analysis using Google Earth

Data from drive test will be exported in KML format that only can be view by Google Earth software. Log file from drive test can be open by Microsoft Excel. **Figure 3.4** show Google Earth workspace screen capture.

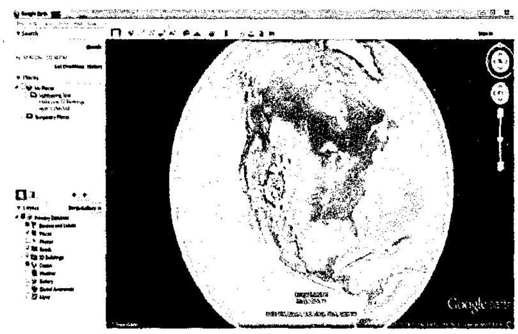


Figure3.4. Show Google Earth workplace screen capture

The main parameters in this paper are Energy per chip to total received power of the CPICH (Ec/No) and Received signal code power (RSCP).**Table 3.1** a)RSCP b)Ec/No represent standard signal range obtain from service provider.

Colour Indicator	Range(dBm)	Status
Green	≥-85	Good
Yellow	-95≤RSCP<-85	Acceptable
Red	<-95	Poor

a)

Colour Indicator	Range(dBm)	Status
Green	≥-8	Good
Yellow	-12≤RSCP<-8	Acceptable
Red	<-12	Poor

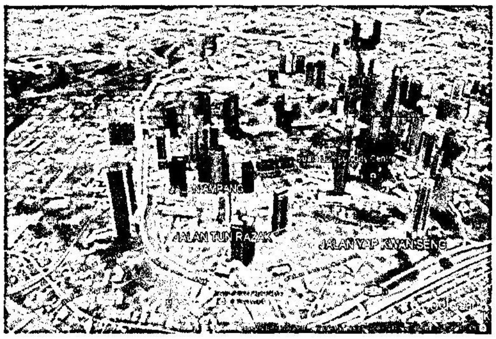
b)

Table 3.1 show standard range given by service provider a) RSCP b) EcNo [1]

IV. RESULTS & DISCUSSION

Signal performance comparison

Since one of objective of this project is to compare 3G performance between two service providers in Malaysia, drive test was conducted using same route at the same time for both service provider to obtain more precise result. Result of the drive test measured in real environment as shown in **Figure 4.1.**



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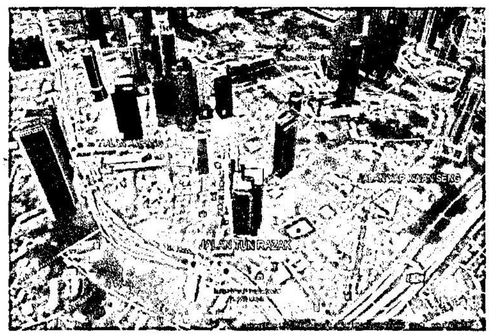


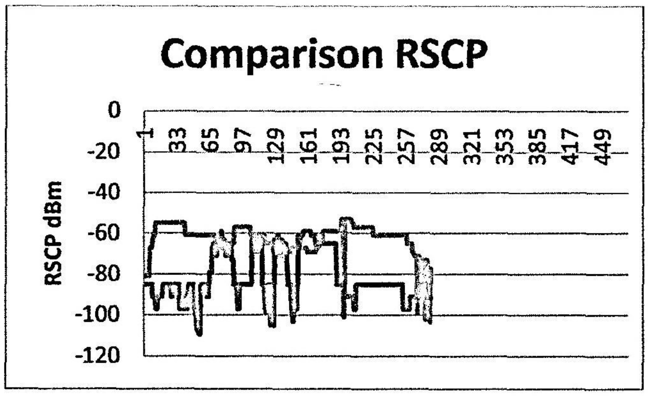
b)

Figure4.1. Shows complete drive test signal strength for a)Celcom b) U Mobile

From **Figure 4.1,** shown user equipment recorded different signal strength alongside the selected route. The different signal strength was represented by different colour. Red show good signal coverage with value around -60 dBm, green show acceptable signal coverage with value around -80dBm and blue show poor signal coverage with value around -95dBm.

Comparison of 3G service provider performance

During drive test execution, mobile user travel at different speed along the road due to heavy traffic around selected route. However, based on analysis done, speed does not give a huge impact on RSCP and Ec/No. The comparison between service provider in term of RSCP and Ec/No shown **in Figure 4.2**



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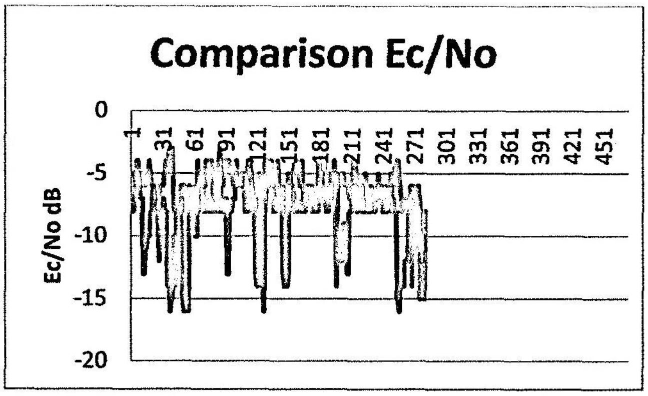

b)

Figure 4.2 Show the comparison between 3G service provider in term of a) RSCP b)Ec/No

From **Figure 4.2** blue represent Celcom and red represent U Mobile. The highest RSCP strength for Celcom was record at -53 dBm and the lowest RSCP recorded at -103 dBm. For Celcom Ec/No, highest signal strength recorded at -3dB and lowest signal strength recorded at -15dB. As a comparison, U Mobile highest RSCP recorded at -59dBm with lowest RSCP recorded at -109dBm. For U Mobile Ec/No, the highest signal strength is recorded at -4dB and lowest signal strength for Ec/No recorded at -16 dB.

Comparison was made to determine which service provider offer a better signal coverage. As a result, Celcom show better signal coverage with 98.5866% as compared to U Mobile that have 86.9258% of signal coverage. This is because, from drive test conducted, user equipment recorded only 4 points as poor signal coverage for Celcom. Meanwhile, for U Mobile, there are more than twenty points recorded by user equipment as poor signal coverage. Several factors contributed to the lower performance of U Mobile network such as limited infrastructure for cell coverage and weak cell planning ability

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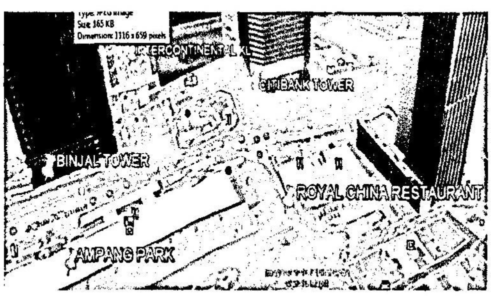
Corner Effect

From the drive test, several locations with poor value of RSCP and Ec/No was selected to be analyzed. The poor value of RSCP and Ec/No was contributed by handover that happen when user equipment moving between microcell along the road. This effect is known as corner effect and usually happens at road intersection due to sudden loss of line of sight between user equipment with Node B. In a moving receiver, multipath component are interfering between each other. These components are added constructively or destructively in the receiver resulting in large fluctuation in received signal level. Since in this area considered as non line of sight situation, there is no dominant component received. The phases of received signal components are uniformly distributed and amplitude has different values. **Figure 4.3** shows Corner Effect recorded for Celcom in two different places a)Ampang Park b)Malaysia Rubber Board. **Figure 4.4** shows corner effect recorded for U Mobile in two different places a) Ampang Park b)Ambank Tower



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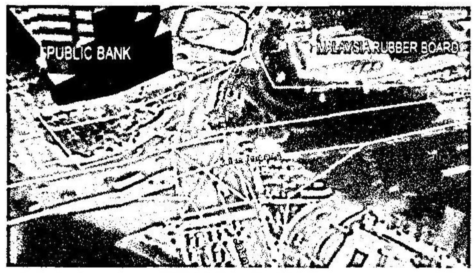
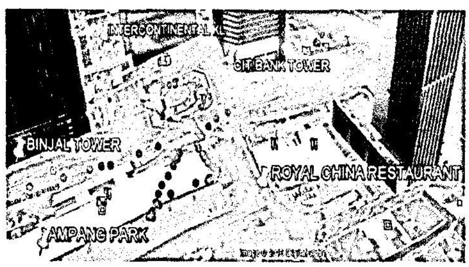


b)

Figure 4.3 Shows Corner Effect recorded for Celcom at a)Ampang Park b)Malaysia Rubber Board

From **Figure 4.3a,** we can see that three point record poor signal strength, the value for RSCP recorded are -99, -102 and -103 dBm. Meanwhile, the value of RCSP recorded are -14,-15 and -15 dB. In this area, mobile equipment was served by Node 124 and cell id number is 13203 Based on standard range obtain from service provider, the signal measured are classified as poor signal. In this area, user equipment was surrounded by tall building such as Binjal Tower, Intercontinental KL and Citibank Tower. Thus, the potential of corner effect is high due to loss of line of sight component between user equipment and node B. From **Figure 4.3b,** we can see that only one point record a bad signal in front of Malaysia Rubber Board building. The poor signal was recorded at the intersection of Jalan Ampang and Jalan Yap Kwan Seng with value of RSCP -101dBm and Ec/No -14dB. From log data, at this area, user equipment was served by Node 124 and was located in cell number 21051.



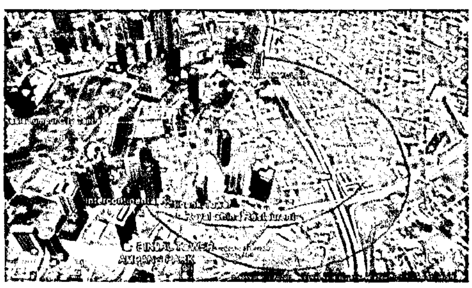
a)

b)

Figure 4.4 Shows Corner Effect recorded for U Mobile at alongside a)Ampang Park b)Ambank

From **Figure 4.4a**, several points record a poor signal with RSCP value from -97dBm to -105dBm. Moreover, Ec/No value recorded by this point also classified as poor signal alongside Jalan Ampang in front of Ampang Park, Citibank Tower and Intercontinental KL building. The poor signal coverage is due to blocking by building around the location resulting in loss of line of sight between user equipment and serving Node B. Serving Node B number is 111 and the cell id is 336. From **Figure 4.4b,** there was poor coverage in Lorong Yap Kwan Seng starting in front of KL Dental Center until Ambank Tower. The worst signal coverage was recorded in front of Ambank Tower with RSCP value range from -101 to -109dBm with Ec/No of -13 to -16dB. The user equipment was served by Node 111 and the cell id number is 535.

Corner effect at Ampang Park was chose to be analyzed further due to both service providers experienced a problem in that area. **Figure 4.5** represent Celcom cells a) Red represent cell 23203 coverage area and blue shows cell 13203 coverage b) Closed up of both cell.



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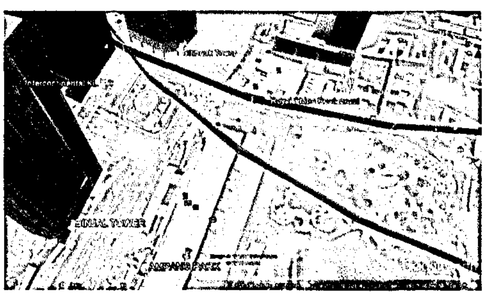
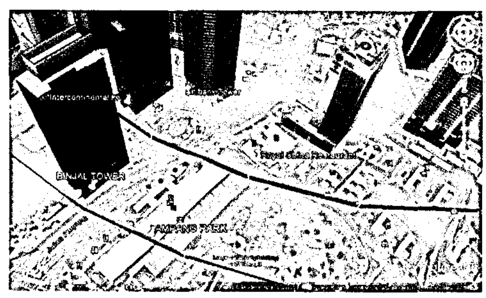


b)

Figure 4.5 Represent Celcom cells a) cell number 13203 and 23203 b) Closed up for both cells

From **Figure4.5**, user equipment was attached with cell 23203 denoted by red with Ec/No value -7dB, before moving along the road and enter cell 13203 denoted by blue with Ec/No value -15dB. When moving towards boarder of red cell, user equipment starts to search for a new cell to handover voice data due to drop in received signal strength from red cell. This process is known as reporting range. After soft handover trigger condition is fulfilled, user equipment start to add a link with blue cell in active set, without removing establish link with red cell. Before connection between user equipment with red cell being drop due to handover dropping condition is fulfilled, user equipment transmits a signal to both cell antenna and both cell antennas received the signal simultaneously. Then the signal is pass forward to RNC for selection combining. The better frame is selected and the other discarded. However, after mobile user establish link with blue cell, suddenly the Ec/No value drop to a poor value due to some factors. The area consists of many tall building that resulting in blockage of line of sight between user equipment and node B. Node 124 located nearer to Kampung Baru Kuala Lumpur. Thus signal probably being blocked by Ambank tower, Public Bank tower, Tokio Marine Tower, Bank of China, Hampshire Tower and Corus Hotel. Blocking in line of sight make the signal experienced reflection, refraction, diffraction, fading and scattering that resulting in poor signal coverage.

a)



b)

Figure 4.6 show U Mobile cells a) Red show Cell 345 coverage and blue show Cell 336 coverage b) Closed up of both cell

From **Figure4.6**, user equipment was attached with cell 345 denoted by red with Ec/No value -8dB, before moving along the road and enter cell 336 denoted by blue with Ec/No value -14dB. When moving towards boarder of red cell, user equipment starts to search for a new cell to handover voice data due to drop in received signal strength from red cell. The area consists of many tall building that resulting in blockage of line of sight between user equipment and node 111.

V. CONCLUSION & RECOMMENDATIONS

Conclusion

As a conclusion, all objective defined managed to be accomplished. Celcom offer better 3G services coverage as compared to U Mobile. RSCP and Ec/No were most important parameter in mobile network as a key indicator to determine the quality of service offers by service provider. Corner effect happened due to sudden loss of line of sight between user equipment and Node B due to reflection, refraction, diffraction, fading and scattering by nearby building. The problem can be solve by doing Tilling at antenna that responsible for cell number 13203 for Celcom and number 336 for U Mobile.

Recommendations and Suggestions

There are some recommendations that will help to achieve better improvement of the problems that affect the functionality and performance of this project:

a) Adjustment of the antenna direction for U Mobile will increase service quality in Lorong Yap Kwan Seng

b) Do the Tillting at antenna that responsible in cell 13203 for Celcom and 336 for U Mobile to increase service quality nearby Ampang Park.

c) *Do drive test by using android G-Net track software* along professional software such as Nemo to obtain more accurate data.

d) Put the micro site on street level at low signal area to overcome problem of signal strength

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