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Path Losses in Urban and Rural Scenario Near Nagpur

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Abstract:
Path loss is an important parameter in the area of the communication system. It is a hindrance in the path of a proper communication channel. This paper aims at providing clear knowledge of the impact on path loss values due to attenuation factors like Seasonal variations , buildings, trees and vegetations and areas like Urban and Rural and traffic hours. The measurement has been carried out continuously for six months from December to May in Urban area of Nagpur , near and inside of government office ,as the campus of that office consists of trees and buildings in proper structure and also in Rural area of the city. The operating telephonic frequency was 950MHz for Urban area and 958 MHz for Rural area. Spectrum analyzer, temperature and humidity datalogger and GPS Navigator have been used for measurements. The path loss has been measured and being analyzed to see the amount at which the path loss get affected by the attenuation factors.

1. INTRODUCTION

Over the last few decades, the telecommunication technology has been increased drastically. To ensure the proper coverage and call establishment the number of base transceiver stations(BTS) have grown up. Even though there is an increase in BTS count but the problem of Call drop, call conjunction, crosstalk still exists. The main reason for the call drop, call conjunction and crosstalk are Path loss(PL). When a signal travels along its path, from the transmitter to receiver, it suffers from many losses that is known as Path Loss. The PL is due to trees, building structures , building materials, weather condition, vegetation, scattering, diffraction, area, etc.

ATTENUATION FACTORS:

1. Seasonal variations:

A.I Idim et al. (2014) have performed the experiment from the month of January to June in Nigeria and calculated the PL. The result showed that PL in the month of June is higher than the PL in the month of January, PL increases with increased humidity and that the volume of rainfall was greatest in the month of June amongst all others under consideration. The difference in PL values was around 2 dB to 3dB.

2.Buildings:

A.I Idim et al. (2014) considered two buildings one made up of concrete and other of the wooden block for his experiment to see the effect of building materials on PL in Orhuwhorun, Nigeria. After the six months of measurement, they found that concrete attenuates more than the wooden block. The digi presented a note that states that concrete was having attenuation factor of 35dB while wooden block was having attenuation factor of 17dB. Similar kind of work performed by J.Beekhuizen et al.(2014) by considering 101 primary schools and 30 private homes in Amsterdam as their measurement spots.

3.Trees:

Previous studies show that trees and vegetation affect the traveling signal as well. T.Tamir (1977) firstly performed the measurement in the forest and vegetated area. He found that the electric field strength changes inside and outside the forest area. Later on C.G. Joshi et. Al. (2005) concluded that the measured path-loss for dense foliage condition is 11–18 dB more compared to the PL observed for no-foliage condition data . (See among others Mohammed S.H. Al-Salameh, Saul A.Torrico et al. 1996, Julio Cesar R.Dal Bello et al. 2000).

4. Area(Urban or Rural)

To measure the Path losses in different scenario the Propagation PL models have been used. It helps in calculating the PL in the measurement area. Previous many research has been carried out based on the calculation of PL in Urban or Rural area, than comparing the measured value obtained in Urban area and Rural area with each other. W.A. Shitta et al.(2008) carried out the experiment in Urban and Rural areas of Nigeria, and he came out with the result that Rural area is having less PL than Urban area. The similar experiment carried out in Urban, sub-Urban and Rural areas of Karnataka (N.Rakesh et al., 2013) by using spectrum analyzer at 940MHz frequency(See among others MVSN Prasad et al. 2001 , Ogbulezie et al. 2013 , KNR Surya Vara Prasad et al. 2014 , Yahia Zakaria et al. 2015 , O. Shoewu et al. 2010 , P.Saveeda et al. 2013).

The aim of performing the experiment is to see the effect of seasonal variations, buildings, trees, area(urban or rural) and traffic hours on PL values. To achieve the goal the Urban and Rural area of Nagpur city have been chosen. The city is located in the exact center of the Indian peninsula and having area of 217 km^2. The measurement has been carried out by considering BTS and different measurement points coming under the 2km range of source BTS.

The six months of continuous reading of 4 hrs a day has been recorded and being analyzed.

2. STUDY AREA AND MATERIALS AND METHODS

The measurement has been performed continuously for six months in the Urban and Rural area of the Nagpur city. First identifying the source BTS. The source BTS have been identified and its operating frequency has been measured using a spectrum analyzer. After that, the measurement locations have been chosen. These locations are chosen in such way that the buildings and trees will cover up during measurement. Considering attenuation factors seasonal variations, buildings, trees, area(urban or rural) and traffic hours during measurement and finally the path loss have been calculated for the Urban and Rural area at each measurement points.

Figure 1.1: Urban area pointing source BTS and measurement locations

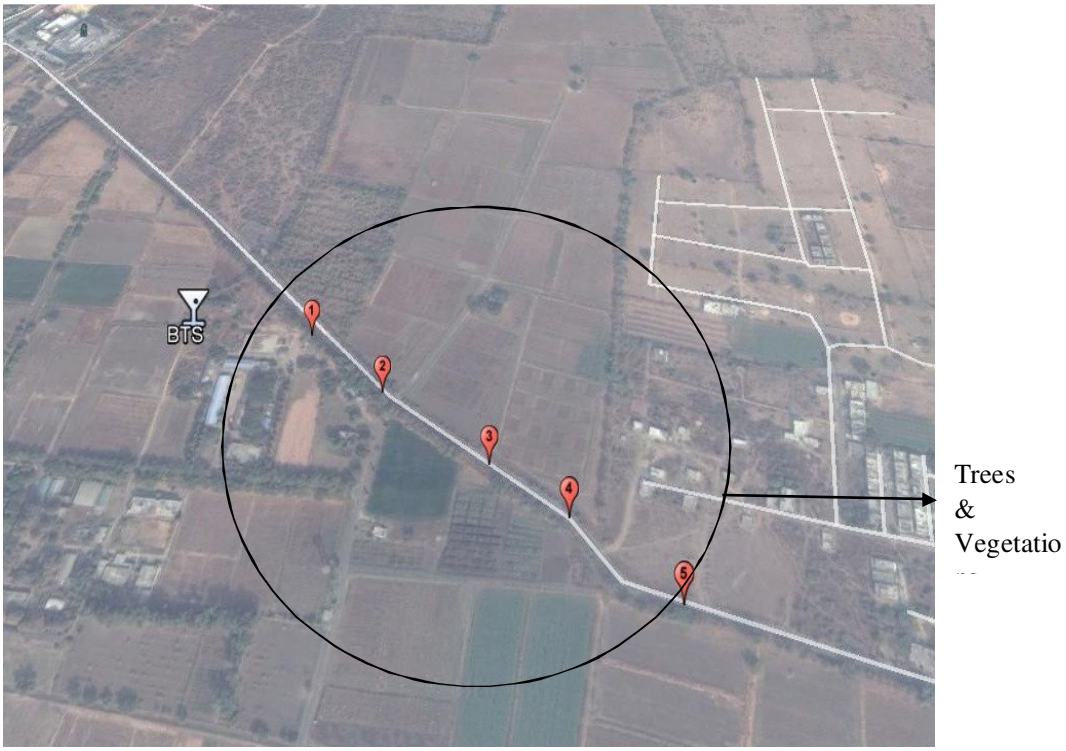

Figure 1.2 : Rural area pointing source BTS and measurement locations

Figure 1.1 shows the Urban area with eight measurements points, the first 1 to 4 pinpointed locations cover up before and after building measurement and next 5 to 8 pinpointed locations cover up before and after trees measurement. Figure 1.2 shows the Rural area with five measurement points, the all five pinpointed locations cover up before and after trees and sparse vegetation measurement. The number of regular height buildings in Rural area is quite lesser.

Density of trees	79.91 m
Density of buildings	88.88 m

The materials being used for carrying out the experiment were spectrum analyzer USBSA44B, GPS Navigator, Equinox EQ- 172 temperature and humidity datalogger.

The spectrum analyzer captures the signal strength at a particular frequency at different measurement points. The device is used to measure the range of frequencies from 1Hz to 4.4GHz. No external power supply is needed.The operating frequency being measured through spectrum analyzer comes out 950 MHz for the Urban area and 958 MHz for Rural area. At each spot, the readings were taken for 2 to 3 min to get stable and accurate signal strength data. The readings were taken three times morning, afternoon and evening a day for the Urban area to see the traffic hour effects while for Rural area one time reading has been recorded as the traffic hour is stable in Rural area as compared to the Urban one. So three times continuous six-month readings have been recorded. To measure the temperature and humidity for time-dependent study the device is known as Temperature and humidity data logger being used. The GPS navigator was used to get the latitude and longitude of the particular place. All the data being simulated on MATLAB and conclusion have been drawn by data obtained from MATLAB curve.

3. RESULTS

The readings have been recorded continuously for 4 hrs a day up to six months from December to May. To analyze the *seasonal variations* the two seasons(winter and summer) readings have been recorded. The averaged winter and summer values are plotted on the same plot as shown in figure 1.3. The PL in summer is more than the PL in winter season as UV rays are responsible for the increase in PL. The UV rays from sun is a type of Electromagnetic waves when it is intense it can disturb the atmosphere in the layer where GPS and communication signals travel [NASA]. The difference of PL between summer and winter seasons is of 3dB to 4dB.

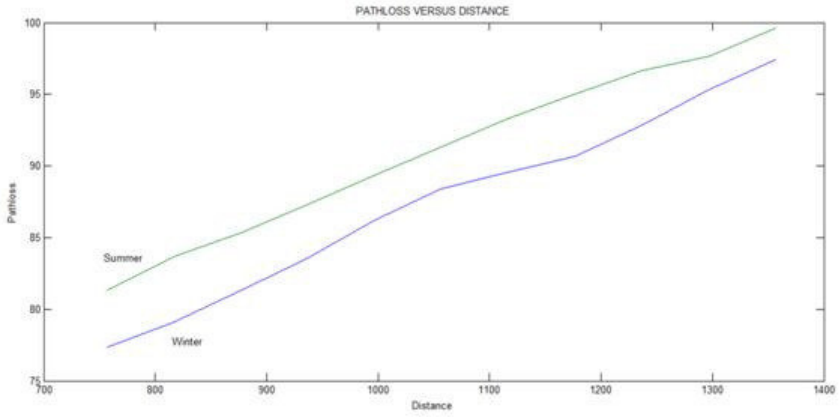

Figure 1.3. Seasonal variation plot(Winter Vs Summer)

To calculate the amount of attenuation factors due to *buildings*, the experiment was performed in the urban area as it comprises of regular height buildings. The measurement has been recorded before buildings and after buildings and the difference have been calculated

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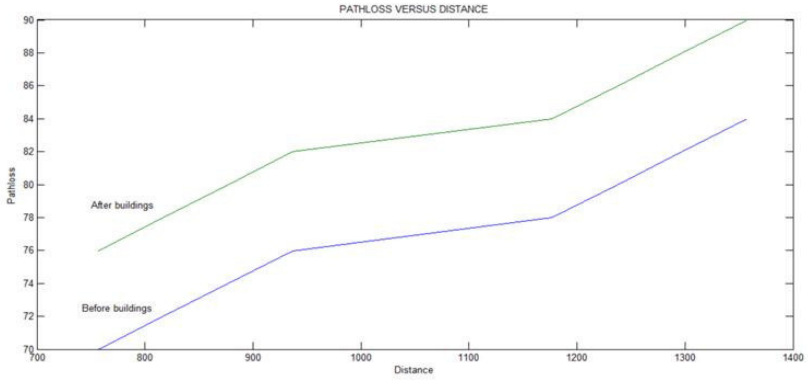

Figure 1.4. PL measured before and after buildings plot

Figure 1.4 shows the PL measured before and after buildings. The PL is increasing with distance. The curve shows that before building the PL is quite less as compared to the PL value calculated after building. The difference in PL values is of 5dB to 6dB.

The *trees* also affect the value of PL. The urban as well as rural areas are comprises of trees and vegetations. Similarly here also the measurement have been recorded before and after trees and difference have been calculated.

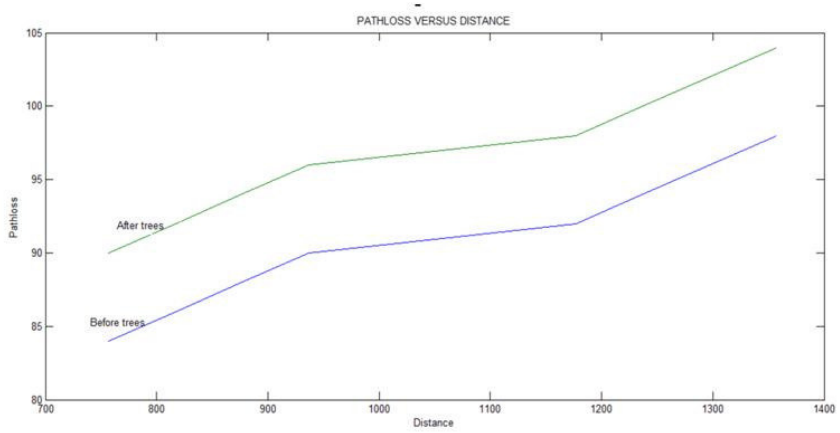

Figure 1.5 PL measured before and after trees plot

The PL measured before and after trees to see the effect of trees on PL value as shown in figure 1.5. The difference in the values of PL before and after trees is of 6dB to 7dB. The difference is large that's the region the signal strength is poor in forest area as trees attenuate the signals.

In most of the times, the PL also depends on measurement areas, like an experiment is going on in *the urban area or rural area*. In most often cases it has been observed that PL in the urban area is more than the PL in rural areas and the coverage of BTS in the urban area is smaller than the rural ones. Figure 1.6 depicts the Urban versus Rural area plot. From the simulation, it is clear that PL is more in the Urban area as compared to Rural area. The Urban area is comprised of more attenuation factors like buildings and trees while Rural area is having fewer attenuation factors like trees and vegetation. The difference in PL values of the Urban and Rural area are quite high that is between 16dB to 19dB.

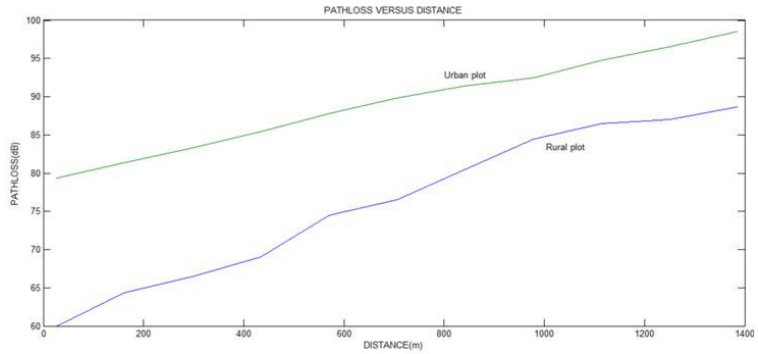

Figure 1.6. Urban versus Rural area plot

To study the effect of traffic hours the three times morning, afternoon and evening time measurement have been performing. This method of data collection has been done for winter as well as summer seasons.

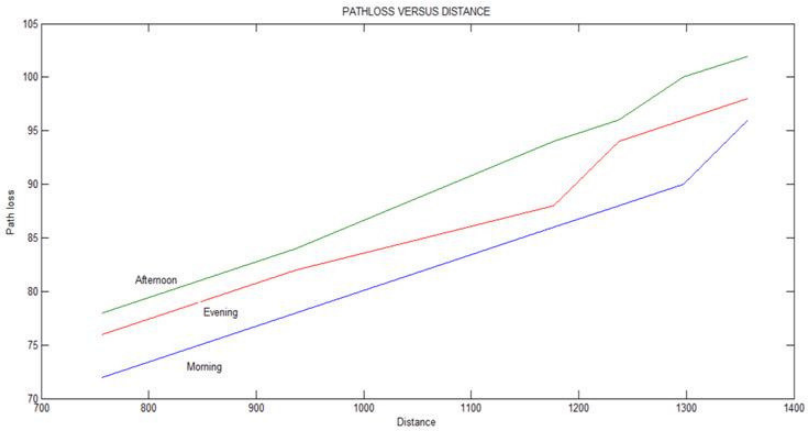

Figure 1.7.Morning, Afternoon and Evening plot(Winter)

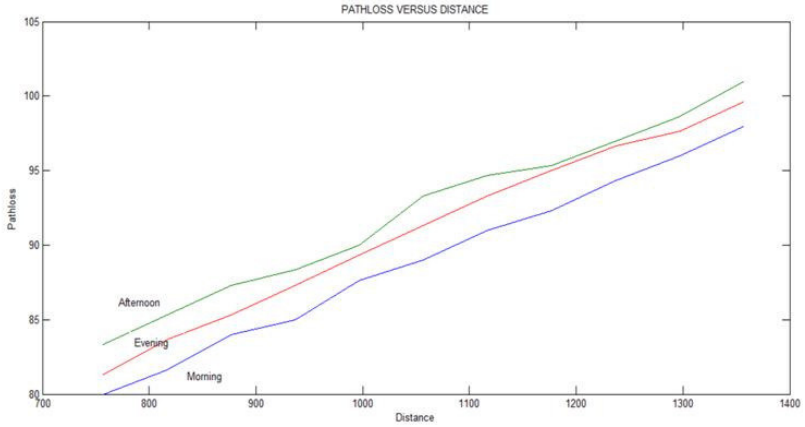

Figure 1.8.Morning, Afternoon and Evening plot(Summer)

Figure 1.7 and 1.8 depicts the morning, afternoon and evening plot of winter and summer seasons respectively . From both of the figure it is clear that the PL very less during morning hours as this is low traffic hours and PL is more during afternoon as it is heavy traffic hours. Thus traffic hours affect the value of PL with the difference of 7dB to 8dB.

4. Conclusions

The measurement has been performed, and data have been collected and is simulated in MATLAB. The PL values have been calculated by keeping all the attenuation factors in mind. For seasonal variations study, it shows that PL values get affected by UV rays and thus PL increases in summer by 3 to 4dB as compared to winter season. The building materials also affect the PL values by 5 to 6dB. Trees, foliage also affect the PL values by 6 to 7dB. The large difference is seen on PL values of the Urban and Rural area. The PL calculated at Urban area was quite high, and the difference was of 16 to 19dB. From time-dependent study it is clear that PL is less during morning hours as traffic hours is quite less as compared to afternoon period and the PL difference is of 7 to 8dB. Thus the PL has been calculated for each attenuation factors mentioned and being plotted.

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