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TERRAIN MODELING FOR IEEE802.11N NETWORKS

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This paper is intended to outline the communications part of a project to produce a working interface and communications system for a solar car and its support vehicles. Data is gathered from the cars sensors whilst displaying it to the driver in real time it also transmits it to support vehicles. Additionally voice contact is required between the vehicles. Progress information that has been collected must be stored and the appropriate web site updated when conditions permit. Glyndwr University have designed and built a Solar Car that is entered into Solar Challenges [1] typical a challenge is across Australia from Darwen to Adelaide and in 2012 South Africa. The normal configuration for the event is that the Solar Cars run with 2 support vehicles, one running in front and the other following. This convoy can stretch over a distance of 1.5km and the support vehicles require information on the performance of the solar car. Usually the route is over an inhospitable environment that has none of the standard infrastructure communications services found in most places.

Several wireless standards have been investigated including Cellular network, IEEE 802.16 but were found unsuitable for the project due to cost and availability. IEEE 802.11 was selected and is the topic for this paper because it is both easily obtainable and low cost however the range requires further investigation. Since the standard antenna supplied with this type of equipment has limited range it will be necessary to utilize antenna with increased gain.

For an isotropic antenna for transmission and receiving in an open environment the power at the receiving antenna under idealized conditions can be found by Friis Transmission Equation [2]:

$$P_r = \frac{P_t}{4\pi d^2}$$

Where: P_r = Received power, P_t = Transmit power, d = Distance between antenna. For an antenna with gain in the transmit direction the equation becomes:

$$P_r = \frac{P_t}{4\pi d^2} G_t$$

Where: G_t = Transmit antenna gain. As the receiving antenna will have a limited effective area the equation becomes:

$$P_r = \frac{P_t}{4\pi d^2} G_t A_{er}$$

Where A_{er} = Effective area of receiving antenna. The effective area for an antenna can also be expressed as:

$$A_e = \frac{\lambda^2}{4\pi}G$$

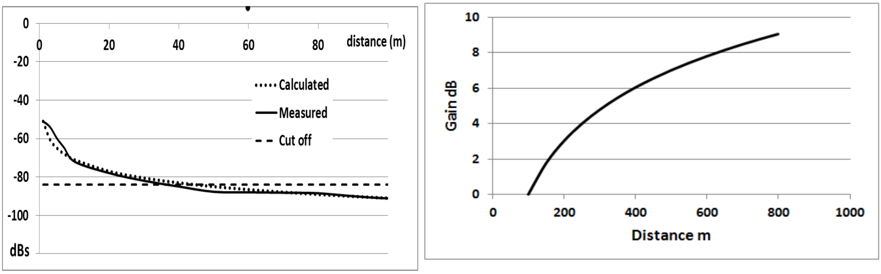
Where: λ = wavelength. Therefore the received power can be expressed as:

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2} \quad (1)$$

Usually the power and gain of an antenna is specified in db which is a log scale and so equation (1) becomes

$$Pr = Pt + Gt + Gr + 20\ \mathrm{Log}_{10}\left(\frac{\lambda}{4\pi d}\right) \quad (2)$$

Typical values for laptops used in this application discussed in this paper are:- Pt = 15dbm, Gt = 2db = Gr since it is symmetrical, λ the wavelength = c/f where f = 2.4 Ghz and c the speed of light. Putting these values in equation (2) for a distance of 50m gives a receive power level of -85.03dbm. Figure 1a shows the graph created from the calculation and compares it with the measurements taken.



a b

Figure 1a - Comparison of Calculated & measured

Figure 1b - Comparison of Gain of antenna against distance

Equation (2) can be re-arranged so that the gain require of the antenna for a given distance can be calculated. This graph is shown in figure 1b

$$2G = Pr - Pt - 20\ \mathrm{Log}_{10}\left(\frac{\lambda}{4\pi d}\right)$$

Normally for wifi networks operating at 2.4 Ghz the issue of operating in a mobile environment is not considered since the distance covered is usually within a radius of 50m however in this application there needs to be an investigation into the effect of motion and environment. There are a number of wireless propagation models but they are all are empirical in nature developed from measurement taken. They have been produced to help understand the cell phones applications since this is a very popular technology that is used in all environments. Unfortunately most of the models developed apply to the frequency range of 150 MHz to 1.5 GHz and do not cover 2.4GHz. Empirical models do not describe the exact behavior of the wireless link due mainly to the problem of specifying accurately the environment under which it is being used. To this end there are a number of different models intended for use in different environments. One of the authoritative works in this area was carried out by

Okamura in Tokyo city [3] and is intended for use in urban areas. This was improved by Hata who added components for predicting the behavior in city outskirts and other rural areas [4]. There are numerous other models but they are based on this initial work. Since these are the most widely used model in radio frequency propagation for predicting the behavior in city outskirts and other rural areas. The Hata model for Suburban Areas is given by:

$$Lsu = Lu - 2\left(Log\frac{f}{28}\right)^2 - 5.4.$$

Where, LSU = Path loss in suburban areas. Unit: decibel (dB), LU = Average Path loss in urban areas. Unit: decibel (dB), f = Frequency of Transmission. Unit: megahertz (MHz). The Hata model for open areas is given by:

$$Lo = Lu - 4.78(Logf)^2 + 18.33\,Log\,f - 40.94$$

Where, Lo = Path loss in open area. Unit: decibel (dB), Lu = Path loss in urban area. Unit: decibel (dB), f = Frequency of transmission. Unit: megahertz (MHz). A Matlab implementation of these models has been produced [5] which provides some idea of the effect of different environments. Since the Okamura-Hata Model is intended for use at lower frequencies and distances over 1km modifications to the Matlab model had to be made before results could be obtained. It is understood that this is not a perfect model however it is a good starting point to gain an understanding of the situation.Fig 2 shows the result of running the Matlab model at 2.4GHz using the values Pt =-15dbm, Pr cut-off = -84, Gt = Gr = 2db at distances up to 0.1km. The results are that the Rural environment provides the longest distance and the larger the size of the Urban area the greater the losses. In Big Cities then the distances could be as short as 20m, however this should not be too much of a problem for this project since the urban areas are very likely to have coverage from other sources.

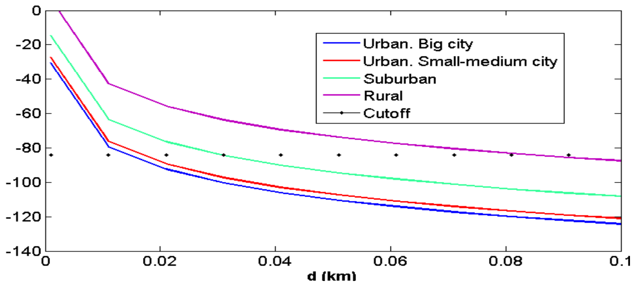


Figure 2 - Okamura-Hata Model

Measured values and the use of the Okamura-Hata Model indicate that distances of around 800m are achievable with antenna gains 8~10 dbm. It is understood that this model requires further investigation to account for frequency discrepancies and a better terrain description.

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SIMULATING PERFORMANCE OF MULTITHREADED PROGRAMS

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Introduction

Performance is an important characteristic of any software system. It depends on various factors, such as parameters of underlying hardware, system's workload, and configuration options of the program. Proper understanding of how these factors affect performance of the system is essential for many tasks, including configuration management, building autonomous data centers, and answering "what-if" questions. Usually this requires building a model of the program that will predict performance of the program in different configurations.

Building performance models of computer programs is hard, but building models of multithreaded programs is even more challenging. Such models require simulating the complex locking behavior of the application and concurrent usage of various computational resources such as the CPU and the disk I/O subsystem. As a result, existing performance models either impose restrictions on the types of programs that can be modeled [1] or require collecting vast amounts of data about the performance of the system in different configurations [2]. Such limitations often make these models impractical.

Our work attempts to overcome these limitations. We have developed a PERSIK (PERformance SImulation Kit) - a simulation framework for modeling performance of multithreaded programs running in various configurations under the established workload [3].

Model definition

For the purpose of simulation we represent computations performed by the program as request processing. We denote a request as some external entity; the