INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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EVUALATION OF ATTENUATION DUE TO ATMOSPHERIC WIND DIRECTION OF 2.4 GHz SIGNAL.

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Accepted Date: 05/03/2015; Published Date: 01/05/2015

Abstract: The estimation of the electromagnetic signal power losses is a very important step in the design of radio systems. The main objective of this study is to find out the effect of atmospheric variations on the RF transmission, as the signal propagates through the atmosphere. Two transceivers (Zigbees) at 2.4 GHz at known distance are used to measure the received signal strength (RSS) and an autonomous weather station (AWS) measures the surface atmospheric parameters. The results are presented in terms of mean signal level, received signal level.

Keywords: Received signal strength (RSS), zigbee transceivers, attenuation, atmospheric parameters.

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How to Cite This Article:

Abhijeet Gaonkar, IJPRET, 2015; Volume 3 (9): 353-361

PAPER-QR CODE

INTRODUCTION

Effect of atmospheric parameters varies in radio frequency band during the propagation of electromagnetic (EM) signal through the surface atmosphere. Radio waves propagating through atmosphere experience different attenuation mechanisms such as absorption, reflection, refraction, scattering, polarization, group delay and fading/scintillation. Radio wave looses its energy mainly due to absorption, cloud and rain attenuation, attenuation due to snow, hail and fog. Atmosphere contains free electrons, ions, and molecules and their interaction with radio waves depend strongly on frequency, so as the frequency increases, the effect of attenuation also increases [12]. The atmospheric gases and rain will both absorb and scatter the radio waves, and consequently degrade the performance of the link. Rain is considered to be the major cause of attenuation at frequencies above 10 GHz and has strong effect on the communication link at 23 GHz. While the atmospheric gaseous absorption plays a significant role under a clear weather, heavy rainfalls can cause several tens of dB loss for a 100-km path through the rain. One of the reasons of attenuation is due to hydrometeors, which are particles of water or ice formed in the atmosphere or at the Earth's surface as a result of condensation or sublimation. Water or ice particles blown from the ground into the atmosphere are also classified as hydrometeors such as clouds, fog, rain, snow, hail, dew, rime, glaze, blowing snow, and blowing spray.

When there are no possibilities to gather data for calculations of the specific attenuation due to surface atmospheric parameters such as winds, humidity, air temperature rain, clouds and fog, and atmospheric refractive index, the values recommended by the International Communication Union's Radio communication sector (ITU-R) can be used. But the recommended values are not always exact. In design of the radio links, the most desirable operating frequencies are below 10 GHz, because in such cases atmospheric absorption and rainfall loss may generally be neglected. However, in most countries, the frequency-band below 10 GHz is highly congested. Accurate prediction of these losses can ensure a reliability of the radio system, decrease in equipment cost, and may be the system can become less injurious to health of people [13]. These attenuation results are useful resources of information for researchers or telecommunication engineers, before implementation any mitigation method as a solution for point to point terrestrial link communication in future.

This study will evaluate the net loss in the transmitted radio frequency signal due to surface atmospheric parameters also it will identify the radio frequency signals that significantly correlates with the surface atmospheric parameters and will generate attenuation coefficient of radio signal at different frequencies due to surface atmospheric parameters. It will also be able to predict weather conditions at a given place.

II.RELATED WORK

Different setups are developed to study atmospheric variations due to different atmospheric parameters in the radio frequency band. Compared to other waves radio waves have high atmospheric attenuation therefore they have a short range and can only be used for terrestrial communication over about a kilometer. Reported studies say in winter absorption density is higher due to increased oxygen density and the signals are highly attenuated. There are also series of experiments are carried out with the support and collaboration of the national oceanic and atmospheric administration, primarily responsible for meteorological instrumentation and scientific research in this field. As frequency increases, crucial changes to link power margins must be examined. There are also several statistical models developed for the atmospheric attenuation calculation. They are mostly regional dependence. Similarities and differences between these models are also found through a comparison study. In this study they have mainly employed ITU (International Telecommunication Union) models for the estimate of microwave power margin losses in the SHF band (3–30 GHz)[16].

In[2,3,5,11] are the studies where an approach as experimental test bed has been set up for frequency in the gigahertz range terrestrial point to point data communication link to study the attenuation due to rain. Also in [17] signal attenuation due to rain and fog at 7.2 GHz is measured for about 12 months in the harmattan weather(Nov-Feb) and Rainy season (June-Sept) and the observed attenuation values due to Harmattan(fog) and rain attenuation was calculated (using Altshuler's model).

In [8] an analysis of the propagation loss measurements taken from the Near Earth Propagation-6 (NEP-6), Panama City, FL, experiment in Aug 2009, where propagation loss was measured at 1768 MHz.

This is the research study where 2.4 GHz Frequency is used for the evaluation of the atmospheric attenuation for variable weather conditions at NIO (Dona Paula Goa) as Most AT(aeronautical telemetry) links operate in the frequency range of 1.4–2.4 GHz so It is important to determine the changes in link power margins as the frequency increases. Also this study will also predict the weather conditions at given place.

III. METHOD

The experimental setup for the study is installed on the terrace of the CSIR-National Institute of Oceanography (CSIR-NIO), Goa (Fig.1). It consist of two Zigbee transceivers acting as transmitter and receiver separated by 60 m. The Zigbees are provided with associated electronics for transmitting and receiving the EM signal strength at regular interval. An AWS is also installed near the receiver unit, which records surface atmospheric data at regular intervals.

Figure1 shows the experimental setup install at the CSIR-NIO terrace with two transceivers and an AWS. Two transceivers are zigbees at frequency 2.4 GHz and an AWS setup which records all the atmospheric parameters such as wind speed, wind direction, air temperature, barometric pressure and relative humidity were recorded using AWS (Autonomous weather station) from NIO Goa.

Fig.1 Experimental setup install at the CSIR-NIO terrace with two transceivers and an AWS.

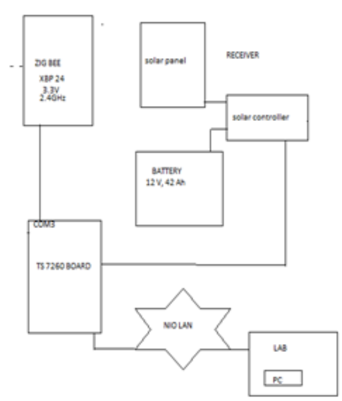
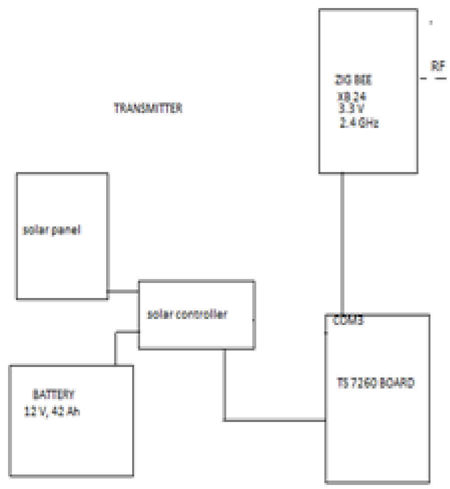


Figure 2: Internal block organization of setup

It consists of a Zigbee which is a low power, low cost wireless communication module which can be used in lot of outdoor and indoor application.

Zigbee is a protocol that stacks above the IEEE802.15.4 physical and MAC layer. The main purpose of Zigbee is to handle the networking, security and data transmission applications. In the present study, the (receiver) is x-Bee (XB24) with channel number 15 used for the reception of code word “nio” from transmitter.



The (transmitter) is X-Bee Pro (XBP24) working at 2.4 GHz at a power level of -18dbm with whip antenna. Both units are provided with TS-7260 board, Linux based PC-104 computer as shown in block diagram of the experimental setup (Fig. 2). TS-7260 computer board connected to Zigbee acting as transmitter is programed to transmit known characters at regular interval. TS-7260 computer board connected to Zigbee acting as receiver is programmed to obtain the received signal strength indicator RSSI from the Zigbee module and record the data along with the time stamp.

The receiver TS-7260 computer is hooked to the local area network (LAN) of the institute, enabling near real-time monitoring of the module.

It allows the data download, monitoring and correction of time and modification of algorithms from the laboratory avoiding the regular visit to the field.

IV. DATA ANALYSIS:

A link of path length 60m was set up on NIO Terrace Goa both the transmitter and receiver operate at a frequency of 2.4 GHz. The received signal levels (RSS) were sampled every 10 seconds. 1 month, data from 25 November 2014 till 31 December 2014 data was collected from receiver and this data is used to investigate the link. The weather information such as wind speed, wind direction, air temperature and relative humidity were recorded using AWS (Autonomous weather station) from NIO Goa. Once per 10 minute, it logs the average values of these parameters over the previous minute to an internal database. The weather station is mounted on NIO Goa terrace near the receiver experimental sites. Table 1 shows the link specifications. Figure 1& 2 shows the block diagram and the actual experimental set-up for measuring purpose. Software codes are written in such a way that transmitter transmits the code letter (nio) to receiver every 10 seconds and after receiving that code word receiver sends a command to receiver zigbee to obtain the received signal strength through ATDB(DB-decibels) command which gives Received signal strength indication (RSSI) is used by wireless networking community to measure signal strength in (dbm). It gives values in HEXADECIMAL then converted to DECIMAL to know the exact power. The table1 below gives the system specifications:

Specifications	Transmitter	Receiver
Transmitted frequency	2.4 GHz	2.4 GHz
Antenna type	Whip antenna	Whip antenna
Antenna gain	1.5 dbi	1.5 dbi
Transmitted power	-6dbm	18dbm
Data rate	250 kbps	250 kbps
Channel number	15	15
Modem type	XB24	XBP24
Path length	60 m	

Table1: System Specifications

V. EXPERIMENTAL RESULTS:

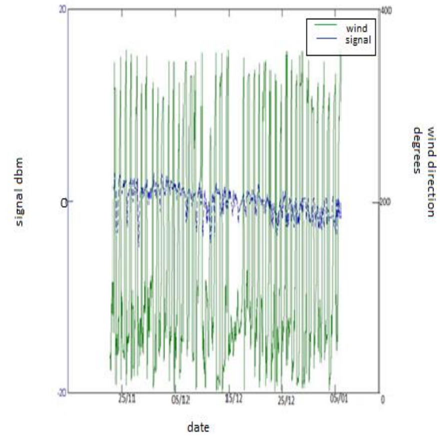


Figure3: mean signal variation between atmospheric wind direction and received signal strength

The figure3 shows the daily variations of the mean signal level for the transmitted signal due to atmospheric wind direction. This work has provided the statistics of wind direction effects on a line-of-sight (LOS) microwave link situated in NIO Goa.

As the signal travels from transmitter to receiver zigbee in variable weather conditions. It is attenuated by different attenuation parameters from the atmosphere but as the direction of wind changes attenuation of signal is observed as more and also when the wind direction changes from northern side to western side that is sea side where humidity content is more. If we neglect six scatter points above and two down from figure 4 the signal strength varies between 92 to 88 dbm for the December data from 1/12/2014 to 15/12/2014.

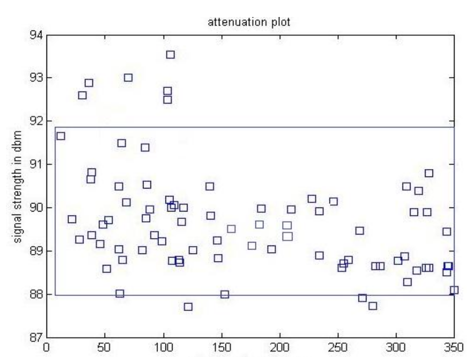


Fig 4: received signal strength v/s wind direction in degrees.

VI. CONCLUSION AND FUTURE WORK:

It was observed 3 dBm to 3.5 dBm attenuation of signal strength during the measurement period. In this paper time dynamics towards seasonal and hourly variations of wind direction were analyzed and presented. However this results are still preliminary and more data need to be collected for accurate results. A method of detecting atmospheric attenuation due to atmospheric wind direction in NIO Goa has been proposed in this paper. Experiment has been performed to collect the received signal strength from receiver zigbee in variable weather conditions in NIO Donapaula Goa. The proposed method also generates absorption data for the frequency of 2.4 GHz. Future work focuses on generation of attenuation coefficient for each transmitted frequency.

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