International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 6, June - 2014

Improved Microwave System for Modern Communication

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Abstract— In order to improve the rate of signal losses in communication, the need for an improved microwave communication comes into play. Microwave communication has actually replaced other forms of communication because of its high band width, effective and low-cost installation, manipulation and maintenance. The other forms of communication exist but none has effective line of sight (LOS) compared to microwave which can travel over rough terrain and unfriendly climatic conditions. Although other sources of transmission require large expanse of land area, microwave communication requires only limited amount of space. Site size is mainly governed by the antenna cable requirements. In this work, several challenges as well as recommendation are outlined.

Key words*: *microwave, line of sight, propagation, wave signaland attenuation.

I. INTRODUCTION

Wireless communication has a key role to play in the modern society. We live in the information age, an age of constant change, driven by our growing dependence on computer, cellular phones, pagers, fax machines, email internet. This demand for real time information exchange is made by an increasing mobile work face. Almost everyone is using such systems everyday. Microwave technology is being used in several ways. Typical examples include mobile phones, wireless internet connectivity, television and radio broadcast. Hence the need to understand the principles of how microwave behave in different situations becomes an important part of design of a communication system.

Microwave communication system is a communication system that utilizes the radio frequency band spanning 2 to 80 GHz. It is also an electromagnetic wave with wavelength between that of infrared light and radio wave. Microwaves are electromagnetic radiation of frequencies from several hundred MHZ to several hundred GHz.Because microwaves are electromagnetic, they possess the qualities of both electric and magnetic fields, which are at right angles to the direction of propagation (travel) of the wave. This is said to be a transverse wave [1][2][3].

Wireless technologies are targeted for certain needs which include:

- Bypass of physical barriers
- Remote data entry
- Mobile application
- Worldwide connectivity for voice, video and data communication
- Satellite communication
- Inexpensive set up

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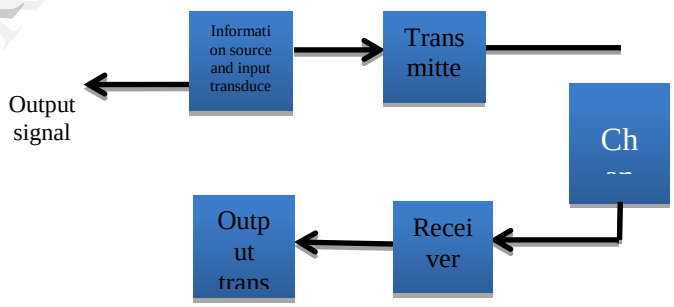

Fig1: Functional block diagram of a communication system

II WHY THE NEED FOR A MICROWAVE SYSTEM

There are several technologies used in transmission of signals. These include radio and wireless broadband, fiber optics, cables, satellite, microwave, etc. The need for improved microwave communication is due to the fact that the frequency spectrum which is usually assigned for radio communication is getting crowded,therefore more frequency spectrum is required to carry wide bandwidth video and digital information. Microwaves also have ultrahigh (UHF) super high (SHF) and extremely high frequencies (EHF) which have great bandwidth than the coaxial cables or fiber optics and because of these extremely high frequencies, there is no need for physical transmission [4].

Generally speaking, microwave communication is less affected by natural calamities, less prone to accidental damage.The possibility of linking microwave towers across mountains and rivers are much more economically feasible.

Also, the availability of single point installation, maintenance and security are possible.
Microwave antennas can have very high directivity that is, the directive gain as high as 50dB can be easily achieved using possible reflectors. Also, the external noise from the atmosphere or its environs is very insignificant. Apart from having wide band width, it can also accommodate large number of channels [1][2][6].

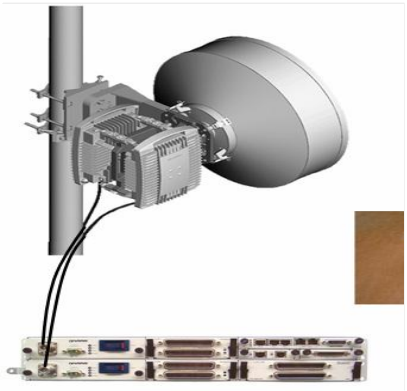

Fig 2: Typical Microwave Antenna

III MATERIALS AND METHOD (DESIGN)

Microwave communication system involves a line of sight (LOS) design which consists of one or more hubs. Each hub is designed so that it can be integrated into a whole wide communication network. The circuitry consists of filters, mixers, amplifiers, oscillators, matching networks and antennas. The necessary tools for the analysis and design of the micro wave circuit device require an understanding of network theory, impedance, matching transmission lines as well as filter designs. Due to the methodical, lengthy and systematic process involved in the design of improved microwave system, calculations are made to attain optimum results which are fading and fading margin calculations, frequency planning and interference calculations, loss and attenuation calculation, quantity and availability calculation to mention but a few [5].
Several redesigning process is usually carried out before reliability is done. In doing this, one must take into account the site size, communication capacity/bandwidth. The range which is usually 50 to 1560 km distance depends on the height of the receiving and sending microwave devices mounted on the tower.

IV PROPAGATION

There are several factors that affect the performance and design of wireless network. The term propagation refers to the various ways by which electromagnetic wave (EM) travels from the transmitting antenna to the receiving antenna [3]. This is also the means of transferring energy or information from one point (transmitter) to another point (receiver).
In microwave communication system, the propagation of the modulated signal is accomplished by converting the electrically modulated signal into electromagnetic field and to radiate the electromagnetic energy in desired directions [5]. We can further enumerate the propagation of waves with the following terms:

- **Ground wave:** These are waves which occur with higher power, low frequency transmission and they travel over and near the surface of the earth. They often suffer frequency-dependent attenuation due to absorption into the ground [7].
- **Sky wave propagation:** Sky wave propagation usually results from the atmosphere. The atmosphere consists of several layers of charged particles. This is noticed especially during the day, due to the heating of the lower atmosphere by the sun causing the formation of the lower layers at the altitude below 2MHz. Also, during the night hours, the electron density in the lower layers of the ionosphere drops sharply and the frequency absorption that occurs during the time is significantly reduced [4][7].

V. LINE OF SIGHT

Perfect line of sight is the basic requirement for microwave communication. The must be a direct path between the transmitter and the receiver. The clearance above the ground should be at least 60% of the radius of the first Fresnel zone to achieve free space propagation. The Fresnel zone are areas of constructive and destructive interface created when electromagnetic wave propagation in free space is reflected or diffracted as the wave intersects obstacles [1]. The transmitting and receiving antennas are generally mounted on high towers to avoid obstruction from buildings, hills, etc. there are instances when obstruction becomes inevitable due to hilly terrain or severe weather conditions in the path of propagation. This causes the signals to be reflected from the ground to the receiving antenna. These obstructions cause various delays in signal arrival at the receiver and also constitute multipath propagation [4].

VI. CHALLENGES

In improving the microwave system, caution must be taken to ascertain maximization and effective signal transmission. The challenges often experienced in microwave communication include:

1. **Loss/Attenuation Calculation**: This usually arises from fog or moving objects crossing signal path, poor equipment installation and poor antenna alignment.
2. **Ground Reflection**: In this instance, the refraction properties are constantly changing. This adversely affects the reflection loss. Usually, the ground reflection. Usually, the ground reflection on the earth surface gives rise to multipath propagation.
3. **Vegetation Attenuation**:When considering a good plan site, it is also advisable to obtain a provision based on five (5) years vegetation growth.
4. **Propagation Losses**:This is due to earth's atmosphere and terrain. Also, the losses encountered due to equipment failure either from transmitter or

receiver output antenna is known as *Branching Losses*.

There are conditions when the losses are caused primarily due to water and oxygen in the atmosphere. This is often seen in the radio relay region. When this condition occurs, it is known as *Gas Absorption*. Apart from considering all the losses mentioned above, there are also situations where the radio continuously experiences errors at a specified bit rate. When this occurs, the process is called *Receiver Sensitivity Threshold*. To avoid such continuous errors, it is advisable to add the antenna gain to each end of the system gain and this is actualized by subtracting the free space radio signal.
In summary, it is worthy of note that the longer the link, the higher the loss.

V. RECOMMENDATION

To avoid occasional ground reflection, it is advised to shield the path against the indirect ray. There are times when due to attenuation, all frequencies are equally affected. Therefore, it is recommended to always choose vertical polarization on water paths at frequencies above 3GHz with high power microwave transmitter. Also, modern path length must be reduced in areas where rain outages are severe.

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