# Increasing Receiving Level of Microwave Transmitted Signal in Mobile Communication

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ABSTRACT

**This work consists of research carried out for increasing the microwave transmitted signal receiving level. The company Sierra faces some problems, when they install microwave links. Problems occur during initial surveys due to equipment damage and bad performance, signal transmitting problem, transmitted signal receiving problem, installation problem. Data was collected and the most frequent problem was identified. It was the transmitted microwave signal receiving problem. Then this problem was categorized into non-line of site problem and frequency reuse problem. Again it was categorized into six categories: 11 GHz, 13 GHz, 15 GHz, 18 GHz and 23 GHz range. When the same frequency range is used to transmit microwave signals it generates interference. This is a problem for microwave installation.**

**Solutions were implemented to overcome the above barrier. One of them is expanding microwave networks. When expanding microwave network, distance between two towers is reduced. Then non-LOS problem will be reduced. And also many microwave links will be generated to transmit data and this will minimize frequency reuse problem and this will minimize. Fiber optic transmission is another solution for minimizing non-LOS problem and Frequency reuse problem. Data capacity of Fiber optic transmission is higher than the microwave transmission. But fiber installation cost is higher than the microwave installation. Another solution for non-LOS problem is making software to calculate tower height to measure maximum height along link's path. This solution cannot be achieved practically. Therefore the best solution for "Increasing microwave transmitted signal receiving level in mobile communication" is expanding the network.**

## INTRODUCTION

The mobile communication installation company-Sierra, has installed microwave links for another telecom company-Tigo. In this they had to face some problems regarding microwave transmission and receiving. Tigo installs both SDH(Synchronous Digital Hierarchy) and PDH(Plesiochronous Digital Hierarchy) links. SDH is used to travel more data between two towers, because SDH have high data rate than the PDH links. Its cost is higher than the PDH links. Therefore PDH links are used to transmit data which has low capacity. Therefore, we had opportunity to study both SDH and PDH installation process. When installing above microwave links, Sierra faces both none LOS problem and frequency reuse problem.

Sierra always tries to install links without faults. Therefore they try to solve their problems, and help academic studies of trainees.

Study Objectives

- Using collected data to analyze the problem.
- Discovering the root causes for transmitted signal receiving problem in the microwave transmission for mobile communication.
- Finding alternative solutions for the problem.
- Selecting the best solution for the problem between above solutions.

Scope of the study

This study is mainly focused on identifying the root causes of the microwave transmission problems. Therefore this research has tried to examine the process of microwave links: It was then decided to classify those according to the categories which may contain similarities, and effect of each cause was identified to suggest solutions.

In a microwave transmission data travel to ODU (Out Door Unit) from IDU (Indoor Unit), along IF (Intermediate Frequency) cable. That signal frequency is intermediate frequency. Then intermediate frequency is converted into radio frequency and emits signal to the free space by using ODU. This microwave signal is sent targeting another microwave antenna. This is called point to point propagation. Sometimes transmitted signal cannot receive from relevant point. Normally a voltmeter is used to align antennas. Changing antenna direction finds effective position and then log to the AWY software and again aligns to get planned performance. When links have some barrier both above readings are not correct. This research aimed to find causes for following questions.

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- Which is the major cause for losing data, while transmitting signals from one antenna to another

While transmitting microwave signal from one antenna to another data may be lost due to;

- Barriers between the antennas: Those barriers may be huge buildings, high trees.
- Frequency reuse: Distance between two towers is constant. When we allocate frequency for a link the distance between two towers is considered. If we use another link for the towers which are already having the link, same frequency range should be used. Due to that both of these links may overlap[1].

These are the factors which causes the loss of data while transmitting data from one tower to another tower. Considering past faults about microwave, we could understand that most of it is transmitted signal receiving problem. And also that faults generate extra high work load. Extra works generate unnecessary cost for the organization. This is not good for organization development.

Workers do not like working with those faults. Their time is wasted. Then customers are not happy with our service and build bad image about the service provider.

Above mentioned faults generate extra workload. By solving above problems company can get more benefits. Faults generate extra workload to the company If extra workload is reduced company can reduce extra cost. That cost can be invested for development of the organization. Those faults are disturbances for customer. So that creates bad image towards company that provides service. Therefore they influence to reduce issue contracts. And also time is saved and that time can be allocated for another work. Technicians do not like to work with faults. Because of it, work gets very confused. So company cannot get efficient and effective work from Technicians. When the number of faults increase customers do not get satisfaction from the company. Then it will damage the reputation of the organization.

## LITERATURE

- **Radio propagation at microwave frequencies for line-of-sight microcellular Mobile and personal communications**

A propagation experiment has been designed and conducted at 900 MHz and 11 GHz to characterize microcell channels using various antennas at two distinct frequencies. This research was done by Rustako,A.J.,Jr Amitay,N. Owens,G.J. RomanR.S., (Feb 1991 ) [1]. It was found that propagation in rural areas was dominated by interference between the direct, line-of-sight ray and a specula roadway reflected ray. In urban areas, the addition of four secular wall-reflected rays adequately represents microcell propagation. The dependence of mean power falloff, measured mean power and calculated power on distance was determined. The λ/2 scale micro variations of the received power are reduced compared to the variations in present cellular radio systems. For urban sites using Omni directional base and mobile antennas, the RMS delay spread due to road- and wall-reflected rays was obtained from a six-ray model. Using a 20-dB horn for the mobile antenna can reduce this delay spread

**A simple transmit diversity technique for wireless communications**

This research presents a simple two-branch transmit diversity scheme. Using two transmit antennas and one receive antenna the scheme provides the same diversity order as maximal-ratio receiver combining (MRRC) with one transmit antenna, and two receive antennas. It is also shown that the scheme may easily be generalized to two transmit antennas and M receive antennas to provide a diversity order of 2M. The new scheme does not require any bandwidth expansion or any feedback from the receiver to the transmitter and its computation complexity is similar to MRRC. This research was done by Alamouti,S.M, Redmond, WA ( Oct 1998 ) [2]

- **Selective fading on LOS microwave links: classical and spread-spectrum Measurement techniques**

A survey has been presented of techniques for measuring selective fading on line-of-sight (LOS) microwave links, particularly over a wide band. Classical pulse methods, including pulse compression, as well as the much used frequency-sweep approach are covered. Methods utilizing both frequency-hopping and direct-sequence spread-spectrum transmissions are also discussed. An analysis of this latter method (used by the US National Bureau of Standards and by the authors) is included and a relationship is established between the true channel transmittance and that estimated by this approach. The advantages and disadvantages of the various schemes are outlined with the aim of assisting an experimenter in the choice of technique in a given experimental context. This research was done by Hewitt,A. Vilar,E. Dept. of Electr. & Electron. Eng., Portsmouth Polytech.[3]

- **Comparison between the performance of QPSK, SQPSK, QPR, and SQPR systems over microwave LOS channels**

This research studies the effectiveness of adaptive equalizers used with QPSK, SQPSK, QPR, and SQPR modems over frequency selective microwave LOS channels. A power series model is employed to represent the channel model, giving special attention to the channels with a null in the pass band. The effect of staggering the symbols on the performance of modems with and without an adaptive

equalizer is provided. With a deep null in the pass band of the channel, the performance of QPR modems is slightly worse than SQPR modems, while QPSK systems significantly outperform SQPSK systems. The general conclusion that a decision feedback equalizer is required for a robust performance by each modem is reached. This research done by Pahlavan,K. , Andover, MA, USA, [4]

## METHODOLOGY

Both kinds of primary and secondary data were used to solve this research problem. Primary data which was collected during two months were not enough. Because of that to increase accuracy of the research most of data were collected as secondary data. To get Primary data print screen and surveys were used.

When transmit microwave signal, it has power. Then it can be received at the other end. Receiving signal should have desired power. When we transmit and receive signals we should measure its power. Normally Voltmeter and AWY software are used to measure power of signal. Both of them use AWY software to measure accurate power. Those values were used to identify faults of site.

- Print screen: above mentioned transmitting and receiving power values are displayed on the AWY Software. Then it should be saved and it is called print screens.

- Faulty reports: those data used only to get secondary data. And also they are prepared using print Screen.

Collected primary and secondary data were categorized into five categories. Then for each problem the frequency of occurring these problems were obtained. Then percentage of occurring these factors was also calculated. The most important problem was selected as the problem with the highest percentage value. Above problems were categorized into two categories. By using secondary data the numbers of times that a fault occurs in each category for selected range of different frequencies was obtained. Then pie charts have been drawn to represent each percentage value for each category of the problem to represent graphically. Then each problem was described according to these charts.

Once obtained a count of frequencies for any variable, frequency distribution tables were constructed. Those frequencies were obtained by doing production study or time study more than three times. Therefore frequencies are summarized by the percentage frequencies. An average is a convenient way of describing a data set by means of a single value. It involves calculating the arithmetic mean value.

A percentage is a statistic which summarizes the data by describing the proportion or part in every 100.

## DATA COLLECTION & ANALYZING

First all problems in microwave installation was identified. Then categorized all the problems into five groups considering their behavior.

- Problems occurred during initial Survey

  Before installing microwave link, usually many surveys are done. Tower mounting places, height of tower, antenna height, cable length, position for microwave rack, are the details investigated by the surveys. Tower mounting place is very important while selecting the place. That place should have ability to transmit signals effectively under normal conditions. If the selected place is lower in height then tower height should be increased. So above described causes which are identified during the previous survey are the causes to fault microwave link.

- Equipment damage and bad performance.

  All the equipments and instruments are brought and transported from France. When transporting the equipment those are exchanged at many places and at many times. Therefore at that exchange time, there may be damages occurred in those equipments. And also equipment can show bad performance.

- Signal transmitting problem.

  Before receiving the signal, signal should be transmitted with relevant power. If we can't send it with effective power, there may be transmitting problems affecting the signal.

- Transmitted signal receiving problem.

  If power of Transmitting signal is accurate, signal should have the ability to receive the signal at the point which is far away from the transmitting point under relevant power. Receiving level should keep -30dBm to get maximum performance. This value can vary with 5dBm. According to above described values, link status can be identified.

- Installation problem.

  Microwave installation process has some intermediate positions. Every point should be connected properly. If not difficult to install links.

Above described faults were identified by measuring transmitted and received signal power by using AWY software. Then identified the states. Then the most common problem among above mentioned categories was identified. Then that problem was selected to analyze and find solution. After that this

problem was divided into two. One of it is none Line-Of-Site and other one is frequency reuse.

So faulty sites are allocated to above two methods and frequency level. Frequencies depend on distance between two towers, thus categorize faults according to used frequencies. Most of collected data were primary data. Others are secondary data. Primary data collected from site by logging to the AWY software. Secondary data collected by using prepared faulty reports. Considering those transmitting and receiving power identified states of faulty or success. Then record data according to above category.

All the faults were identified using primary and secondary data. Then the problems were categorized into five and the respective numbers of faults were stated in table 1

| Category | No of Faulty Sites | Percentage of fault category (%) |
|---|---|---|
| Problems occurred during initial Survey | 5 | 15.15 |
| Equipment damage and bad performance | 3 | 9.09 |
| Signal transmitting problem. | 8 | 24.24 |
| Transmitted signal receiving problem | 14 | 42.42 |
| Installation problem | 3 | 9.09 |

**Table 1: Fault percentage for every category**

For the purpose of analysis, as shown in following table 2, the problem was divided into two categories, namely, none LOS and frequency reuse. From LOS category maximum number of fault sites has occurred while using 7GHz frequency range. There have been two fault sites each in ranges of 11GHz and 23GHz respectively. There is only one fault site reported in 13GHz frequency range whereas no fault sites reported in both 15GHz and 18GHz frequency ranges.

| Problem | Frequency | Number of Faulty Sites |
|---|---|---|
| LOS | 7 GHz | 4 |
| | 11GHz | 2 |
| | 13 GHz | 1 |
| | 15GHz | 0 |
| | 18GHz | 0 |
| | 23GHz | 2 |
| Frequency reuse | 7 GHz | 3 |
| | 11GHz | 1 |
| | 13 GHz | 0 |
| | 15GHz | 1 |
| | 18GHz | 0 |
| | 23GHz | 0 |

**Table 2 : Classification of Fault with frequency range**

## RESULTS AND DISCUSSION

Among all the categories main problem is the transmitted signal receiving problem. Transmitting signal receiving problem occurs because of no-LOS and frequency reuse. Non-LOS is the most common problem

When the link comes across barriers it is called non-LOS as shown in figure 1. Path of Microwave link is not visible. And also highest positions along the link are not visible and can't measure accurately. Different height trees, buildings are barriers that come across the link. When signals are transmitted across far distance, there are many variations in position along the link. Therefore for high distances probability of occurrence of non-LOS is high

**Figure 1: Non-Line-of-Sight Obstruction**

Frequency reuse is another problem that is faced in microwave propagation. When installing more links between two towers, same frequency range is used because. Because, interference can occur among existing microwave links.

Another problem in microwave installation is initial survey errors. Before deciding places for tower, should consider about so many things. So by doing surveys hope to minimize errors. Place to mount tower, should be the highest place. If used lowest place for tower, tower height should be increased more. And also that place should have the ability to transmit microwave signals in normal condition without disturbance.

Every equipment and materials are transported from France. When, equipments and materials are transported to site, they have to be exchanged it in many places. So there is the risk to damage equipment. And also equipment can show low performance. This is a manufacturing problem. When install and maintain the microwave link above both faults can be occurring.

Signal transmitting problem is another problem to be faced in microwave transmission. Signals are emitted to ionosphere by using ODU. If ODU does not work properly transmission process can stop. Signals come from IDU to ODU through IF cable like intermediate frequency. Sometimes cable show low performance. Due to that reasons signal transmitting problems can occur.

➢ Fiber optic cable to install backbone link.

Fiber optic cable can be laid along the backbone link. When data traveling is done using microwave, have maximum data rate. If high data rate is needed to transmit data than the above limit, should use more links. So again comes installation problems and frequency reuse problems. For installing more links there should be enough space both in the tower and the cabin. After installing more microwave links, should face interference problem and aligning problem. Normally data rate of microwave channels are 2Mbps for PDH and 126Mbps for SDH. But fiber optic transmission has more capacity and it is about 50 Gbps. Data rate is one of the most important factor, when working with future technology. So fiber link is more suitable for data transmission along the busy path.

➢ A suitable Software to decide tower height

It is suggested to make software to calculate tower height observing accurate height of the land positions and considering all objects. Normally they use manual method to decide tower height. So human errors can be occur. And also manually accurate height can't be calculated. So making software is required for calculating accurate maximum height.

➢ Signals transmission along short path by expanding microwave network.

When using long paths to transmit signals, non-LOS problem occurs. So tower constructing place should be decided to reduce link distance. According to propagation of microwave signal, when reducing distance between two towers, can reduce accuracy of non-LOS problem. When transmit signals in short path, many number of paths can be selected to transmit signals, because there are many towers for links.

Fiber optic transmission is a good solution to transmit data. Capacity of fiber transmission is higher than the microwave transmission. But fiber optic installation cost is higher than the microwave transmission

Developing software can reduce faults in non-LOS problem. But difficult to find variables like, accurate height (including objects) of the position practically

Therefore the best solution is expanding the microwave network.

Data collection part of the research had some limitations. During the training period we could not collect enough data. Because of it fewer faults occurred during the latter period. So secondary data had to be used.

Resources are wasted for above faults and revenue is reduced because occurring these faults cannot be calculated and analyzed. This is also a limitation.

Decision to make software to calculate the tower height: Measuring maximum height for the position of land along the microwave link. But practically it is very difficult to measure the accurate height of positions. Some places have huge buildings. Existing method can't calculate this height.

Some important factor cannot be measured. Effects to the human body and environment cannot be measured. This is also a limitation for analyzing the problem.

Time was also a limitation factor for this research. Some solutions are not implemented into the process, because of lack of time. Six months are not sufficient enough to implement the suggested solutions. In fast research it should select the best option comparing microwave transmission and fiber optic transmission. Factors such as data rate, data capacity, installation cost, maintenance cost, and income should be considered with future needs. In future definitely data capacity should increase. Effect for both human body and environment is higher than the fiber optic transmission. This effect cannot be measured and calculated mathematically. But those effects should be considered however, before selecting the best solution.

## CONCLUSION

In the six month industrial training programme at Sierra, I got the chance to use the academic knowledge acquired through years, to suggest solution, to some real telecommunication problems. During these six months, I was able to work with the employees of all of the departments in the corporation, who shared their knowledge with me as well. Other than the academic aspect of the training, many things on general administration which will be important for me when starting my carrier could be learnt. Every one cooperated, & offered the best to enable the interested undergraduate to enhance their skills and provide a better foundation which will enable an undergraduate to face the people in the industry without any hesitation.

The main objective of the research was to increase the transmitted signal receiving level. By solving above problem, company can get more benefits. Faults generate extra workload to the company. If extra work load is reduced, company can reduce extra cost. That cost can be invested for development of the organization. These faults are disturbances for customers and create a bad image towards the company that provides service. They influence to reduce contracts. And also we can save time. That time can be allocated for another work. Technicians do not like to work with fault because that work was very confused. Therefore we can't get efficient and effective work from technicians. When increasing number of faults, customers do not have satisfaction with the company. Therefore it will be a damage to the reputation of the company.

Decreasing the transmitted microwave signals receiving level was one of the problem they are faced. First, problem was identified. Then the solutions were found. Laying Fiber optic cable to install backbone link, decide to make suitable Software to decide tower height and Signals transmit along short path expanding the network, are the founded solutions. Fiber cable can use to transmit data one point to another.

Fiber transmission is high capacity. But limitation of this solution is installation cost. Fiber installation cost is very high. Suitable Software should be made to decide tower height, considering higher objects between two towers like trees. This solution is difficult to reach in practically. Network expanding is another solution. Using this solution, LOS problem can be reduced.

When we consider about above solutions, network expanding is the best solution.

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