

Preface

Hello! Do you recognize me? I am the cell phone, sometimes also called the palm phone or mobile phone. Many of you have grown familiar with using me; but have you ever given a thought to what I am, and how I became so intimately involved in your world of communications? The story of my invention sounds almost like a fairy tale to today's new generation. I was invented in the USA, in the eighties of the twentieth century. The history of my advent is crowded with momentous events (see Chap. 1). The scientific community believes that I came into being due to light experiments, which in turn led to the development of electromagnetic theory, followed by radio wave propagation and then to my being developed as a major communication device. I communicate through Radio frequency (RF), which is the rate of oscillation in the range of around 800 MHz–5.6 GHz. This brings us to the salient concept of the this book entitled “Radio Frequency Propagation Made Easy”.

Radio frequency propagation made easy is a booklet that brings you up-to-date in key concepts, underlying principles and practical applications of wireless communications. This book has seven chapters comprising various aspects of radio wave propagation and its attributes. The contents of these chapters are briefly presented below:

In Chap. 1:

- We have traced the historical background and have shown that the modern wireless communication system is due to a series of light experiments.
- The mechanism and the underlying principle of electromagnetic radiation were presented with illustrations.
- The key concepts, underlying principles and construction of array antennas were provided.
- This material was very lucidly and simply presented, so as to be easy for readers to grasp.

In Chap. 2:

- We have derived the free-space path loss formula and have shown that it is *proportional* to the square of the distance.
- Free space pathloss is also proportional to the square of the *frequency*.

- It is shown that free space pathloss exhibits an equation of a straight line, having a pathloss slope of 2.
- We have defined the Effective Radiated Power (ERP) and the Received Signal Level (RSL) and have shown that RSL exhibits an equation of a straight line having a slope of -2 .

In Chap. 3:

- We have examined the Fresnel Zone Effects and various anomalies of RF propagation and have shown that there exists a free space propagation medium in multipath environments.
- We have presented a two ray model for outdoor deployment and have shown that these propagation models also exhibit equation of straight line within the Fresnel zone break point.
- We have also presented a two ray model for indoor deployment and a multiray propagation model
- For tunnels and subways and have shown that these propagation models also exhibit equation of straight line within the Fresnel zone break point.
- These findings indicate that cellular network based on Fresnel zone break point as the cell radii is an effective solution to reduce power and save energy.

In Chap. 4:

- We have presented a general overview of various empirical prediction models and have shown that these propagation models also exhibit equation of straight line within the Fresnel zone break point.
- Although these predictions and measurement techniques are the foundation of today's cellular services, they suffer from inaccuracies due to user defined clutter factors. These clutter factors arise due to numerous RF barriers which vary from place to place. It is practically impossible to accommodate all these factors accurately. Cell site location is also a challenging engineering task because of regulations and restrictions imposed on some locations. Therefore cell sites have to be relocated from the predicted location, requiring best judgment of RF engineers. Thus we came to the conclusion that propagation prediction is a combination of science, engineering and art. An experienced RF engineer, willing to compromise between theory and practice, is expected to accomplish the most.

In Chap. 5:

- We have reviewed Statistical Analysis and showed that it is an important exercise to design and implement cellular base stations with reliability.
- Presented regression analysis and showed that random data such as Received Signal Level (RSL) can be predicted with confidence.
- Drive Test, Live air data collection & Data analysis techniques were presented.
- A computer aided prediction technique was presented as a student project.

In Chap. 6:

- We have discussed radio Frequency coverage and provided the concept of cell
- Rationalized the use of hexagonal cell geometry and calculated cell radius
- Provided the concept of OMNI and Sectorized cells
- Provided the concept of Cell cluster
- Presented $N=7$ frequency reuse plan and carrier to interference ratio (C/I)
- Presented $N=3$ frequency reuse plan and carrier to interference ratio (C/I)
- Discussed the benefit of antenna down tilt and calculated the down tilt angle

In Chap. 7:

- We have discussed Global RF & CO₂ Pollution connected to wireless communications.
- The classical Electron Spin Resonance (ESR) is presented to show that there is a possible
- public health issues due to RF absorption.
- It has also been argued that cell phone technology may contribute to global CO₂ pollution, expected to rise due to high speed data communication.
- With this in mind, we have presented a technique to design energy efficient green cellular technology, comprising Micro, Pico and Femto cells.

My readers, in this book I've tried to present radio frequency propagation facts for you in easy language. If this book pleases you while it teaches, I shall be amply rewarded.

<http://www.springer.com/978-3-319-11393-7>

Radio Frequency Propagation Made Easy

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2015, XI, 103 p. 73 illus., 48 illus. in color., Softcover

ISBN: 978-3-319-11393-7