

STUDY OF SAFETY AND HEALTH ASPECTS OF BASE STATIONS AND  
MOBILE PHONES

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*To those who closed to my heart:*

*My late father, Allahyarham Lias bin Sahak.*

*My dearest mother, Ijon binti Latip*

*My beloved family especially my cousins Alina bt Ali, Halmi and Safinah, all my*

*lecturers and my friends*

*To my beloved one and my loving sister, Norhany.*

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## ABSTRACT

The wide use of mobile phones and also the increasing number of base stations have inevitably raised the question of whether there are any implications for human health. This project focused on study of safety and health aspects of mobile phones and base stations. Much attention is paid to the effect of mobile phones rather than base stations. There are four conditions taking into consideration for this project. First, mobile phone held next to human head, second, loudspeaker and third Bluetooth conditions. Last and fourth condition is focused on base stations effects on human health. For the assessment purpose, Finite Difference Time Domain (FDTD) is used in order to find the Specific Absorption Rate (SAR) rating or values of four conditions that have been mentioned. International Commission on Non-Ionizing Radiation Protection (ICNIRP) has been stated the limits of SAR which is 4W/kg. When the limits is exceed, it produces human health effects where it can caused reverse cell membrane polarity, alter brain waves and brain chemistry and damage DNA. This leads to cancer and memory loss. However, both mobile phone and base stations are designed with low power and operate at high frequency where the value of SAR is low than the limits that stated by ICNIRP. Other temporary biological effects produce by mobile and base stations are heating, headache, fuzziness, fatigue and nausea. As a conclusion, there is still no convinced evidence that mobile phone and base stations caused human adverse health effect and shorten human life span.

## ABSTRAK

Penggunaan telefon bimbit secara meluas dan pertambahan bilangan pencawang telefon telah menimbulkan persoalan samada terdapatnya implikasi kepada kesihatan manusia atau tidak. Oleh itu, projek ini memfokuskan kajian terhadap aspek keselamatan dan kesihatan yang disebabkan oleh telefon bimbit dan pencawangnya. Pemerhatian bagi kajian ini lebih tertumpu kepada kesan telefon bimbit terhadap manusia berbanding dengan pencawangnya. Kajian ini meliputi empat bahagian. Bahagian pertama ialah situasi dimana telefon bimbit berada disebelah kepala manusia, bahagian kedua ialah situasi apabila pembesar suara digunakan dan bahagian ketiga pula adalah situasi *Bluetooth*. Manakala, bahagian yang terakhir pula memfokuskan kepada kesan pencawang terhadap kesihatan manusia. Bagi tujuan penyelidikan, "Finite Difference Time Domain" (FDTD) digunakan untuk mencari nilai Tahap Serapan Tentu (SAR) bagi empat keadaan yang telah dinyatakan. Pertubuhan Perlindungan Radiasi Bukan Berion Antarabangsa (ICNIRP) telah menggariskan had SAR iaitu 4W/kg. Apabila nilai SAR melebihi had yang telah ditetapkan, ianya akan memberikan kesan terhadap kesihatan manusia seperti keadaan di mana pembalikan polariti sel membran, perubahan terhadap gelombang dan kimia otak dan merosakkan struktur DNA. Keadaan ini boleh menyebabkan penyakit kanser dan kehilangan memori. Namun, penghasilan telefon bimbit dan pencawangnya telah dicipta dengan nilai kuasa yang rendah dan beroperasi pada nilai frekuensi yang tinggi. Penciptaan teknologi ini menghasilkan nilai SAR yang lebih rendah daripada nilai yang telah dinyatakan oleh ICNIRP. Di samping itu, kesan biologikal yang disebabkan oleh telefon bimbit dan pencawangnya adalah pemanasan, pening kepala, penat dan mual. Melalui hasil kajian dapat dirumuskan bahawa tiada bukti kukuh yang menyatakan bahawa telefon bimbit dan pencawangnya boleh memberi kesan kepada kesihatan dan memendekkan jangka hayat manusia

## TABLE OF CONTENTS

| CHAPTER  | TITLE                        | PAGE |
|----------|------------------------------|------|
|          | <b>DECLARATION</b>           | ii   |
|          | <b>DEDICATION</b>            | iii  |
|          | <b>ACKNOWLEDGEMENT</b>       | iv   |
|          | <b>ABSTRACT</b>              | v    |
|          | <b>ABSTRAK</b>               | vi   |
|          | <b>TABLE OF CONTENTS</b>     | vii  |
|          | <b>LIST OF TABLES</b>        | xi   |
|          | <b>LIST OF FIGURES</b>       | xiii |
|          | <b>LIST OF ABBREVIATIONS</b> | xvi  |
|          | <b>LIST OF SYMBOLS</b>       | xix  |
|          | <b>LIST OF APPENDIX</b>      | xx   |
| <b>1</b> | <b>INTRODUCTION</b>          | 1    |
|          | 1.1 Introduction             | 1    |
|          | 1.2 Objectives               | 2    |
|          | 1.3 Scopes of project        | 2    |
|          | 1.4 Problem statement        | 3    |
|          | 1.5 Project Outlines         | 3    |

|          |  |          |
|----------|--|----------|
| <b>2</b> | <b>LITERATURE REVIEW</b>                           | <b>4</b> |
| 2.1      | Basic concept of EMF                               | 4        |
| 2.2      | Quantity and units                                 | 4        |
| 2.3      | Radio Frequency (RF)                               | 6        |
| 2.4      | Base restriction and reference level               | 7        |
| 2.5      | Mobile Phone                                       | 8        |
| 2.6      | Base Station                                       | 10       |
| 2.7      | Second Generation Mobile Communication (2G)        |          |
| 2.7.1    | Global System for Mobile Communication             | 13       |
| 2.7.2    | General Packet radio Service                       | 13       |
| 2.7.3    | Enhanced Digital GSM Evolution                     | 13       |
| 2.7.4    | Code Division Multiple Access                      | 14       |
| 2.8      | Third Generation Mobile Communication (3G)         |          |
| 2.8.1    | Wideband Code Division Multiple Access             | 14       |
| 2.8.2    | Code Division Multiple Access 2000                 | 14       |
| 2.8.3    | High Speed Packet Data Access                      | 14       |
| 2.9.     | Other Wireless Communication Technologies          |          |
| 2.9.1    | Wireless Local Area Network                        | 15       |
| 2.9.2    | Wimax  | 15       |
| 2.10     | Short Range devices                                |          |
| 2.10.1   | Bluetooth  | 16       |
| 2.10.2   | Ultra Wideband Technology                          | 16       |
| 2.10.3   | RFID   | 16       |
| 2.11     | Interaction mechanism                              | 17       |
| 2.11.1   | Coupling to low frequency electric fields          | 17       |
| 2.11.2   | Coupling to low frequency magnetic fields          | 17       |
| 2.11.3   | Absorption of energy from electromagnetic<br>field | 18       |
| 2.12     | Biological effect                                  | 18       |
| 2.13     | Health effect                                      | 18       |

|          |   |           |
|----------|---|-----------|
| 2.13.1   | Potential Health Effects  | 19        |
| 2.13.2   | Adverse Health Effects  | 19        |
| 2.13.3   | Thermal and Non-thermal Effects   | 19        |
| 2.14     | Summary of Practiced and Experienced in other countries<br>and International Recommendation | 20        |
| 2.15     | Situation in Malaysia   | 21        |
| 2.16     | Reviews of the International Organizations on Health<br>effect of RF exposure               | 23        |
| <b>3</b> | <b>TECHNICAL BACKGROUND</b>   | <b>25</b> |
| 3.1      | Introduction  | 25        |
| 3.2      | Zeland  | 27        |
| 3.3      | Fidelity  | 28        |
| 3.4      | Fidelity workshop structure construction and auto modeling                                  | 33        |
| 3.5      | Specific Absorption Rate (SAR)  | 34        |
| 3.5.1    | SAR assessment  | 36        |
| <b>4</b> | <b>ALGORITHM AND IMPLEMENTATION</b>   | <b>38</b> |
| 4.1      | Introduction  | 38        |
| 4.2      | Yee Algorithm   | 39        |
| 4.3      | Material FDTD   | 42        |
| 4.3.1    | PEC and PMC   | 42        |
| 4.3.2    | Frequency-dependent   | 43        |
| 4.3.3    | Modeling material object  | 44        |
| 4.3.4    | Staircase approximation   | 45        |
| 4.3.5    | Packed coefficient  | 46        |
| 4.4      | Absorbing Boundary Condition (ABC)  | 47        |



|          |   |           |
|----------|---|-----------|
| 4.5      | The Human Head model                                    | 48        |
| 4.6      | The Mobile Phone model                                  | 48        |
| 4.7      | The Base Station model                                  | 49        |
| 4.8      | Implementation by FDTD                                  | 49        |
| 4.8.1    | Design a project on Fidelity                            | 50        |
| <b>5</b> | <b>RESULT AND DISCUSSION</b>                            | <b>57</b> |
| 5.1      | Introduction  | 57        |
| 5.2      | Mobile phone with monopole antenna modeling             | 58        |
| 5.3      | The comparison of the results from GSM 900 and GSM 1800 | 61        |
| 5.4      | Loudspeaker condition                                   | 65        |
| 5.5      | Bluetooth condition                                     | 66        |
| 5.6      | Base Station condition                                  | 70        |
| <b>6</b> | <b>CONCLUSION</b>                                       | <b>75</b> |
| 6.1      | Conclusion  | 75        |
| 6.2      | Future Works  | 77        |
|          | <b>REFERENCES</b>                                       | <b>78</b> |
|          | Appendix A  | 81 - 97   |

## LIST OF TABLES

| <b>TABLE NO.</b> | <b>TITLE</b>   | <b>PAGE</b> |
|------------------|--|-------------|
| 2.1              | Typical base stations locations  | 11          |
| 2.2              | Summary of exposure limit for various countries  | 20          |
| 4.1              | Dielectric properties of brain tissue  | 48          |
| 4.2              | Dielectric properties of metal   | 48          |
| 5.1              | Total absorbed power and SAR values for<br>external antenna for GSM 900 and GSM 1800                             | 63          |
| 5.2              | Total absorbed power and SAR values for<br>internal antenna for GSM 900 and GSM 1800                             | 63          |
| 5.3              | Total absorbed power and SAR values for<br>Loudspeaker with external antenna for<br>GSM 900 and GSM 1800         | 66          |
| 5.4              | Total absorbed power and SAR values for<br>Loudspeaker with internal antenna for<br>GSM 900 and GSM 1800         | 66          |
| 5.5              | Class of Bluetooth with input power and range cover  | 67          |
| 5.6              | Total absorbed power and SAR values for<br>Bluetooth condition   | 68          |
| 5.7              | Total absorbed power and SAR values for<br>bluetooth with external antenna for<br>GSM 900 and GSM 1800 (class 2) | 69          |
| 5.8              | Total absorbed power and SAR values for  | 69          |

|      |  |    |
|------|--|----|
|      | bluetooth with internal antenna for<br>GSM 900 and GSM 1800 (class 2)        |    |
| 5.9  | Total absorbed power and SAR values for<br>Base station condition (GSM 900)  | 71 |
| 5.10 | Total absorbed power and SAR values for<br>Base station condition (GSM 1800) | 72 |

## LIST OF FIGURES

| FIGURE NO. | TITLE  | PAGE |
|------------|--|------|
| 2.1        | Electromagnetic Spectrum   | 5    |
| 2.2        | Base station   | 9    |
| 3.1        | Flow chart   | 26   |
| 3.2        | A plastic-coated cellular handset modeled on Fidelity  | 28   |
| 3.3        | The poynting vector and near field display on a<br>microstrip to coaxial transition  | 29   |
| 3.4        | 3D SAR display in a lossy dielectric block 9 mm next<br>to a monopole handset antenna. Antenna input power is<br>0.6W at 0.835GHz.Total absorbed power is 0.52W (86%).<br>SAR volume of 16.4 W/kg is detected at the<br>dielectric surface | 30   |
| 3.5        | (a) Time signals of 116000 steps for regular simulation<br>(b) Time signals of 5600 steps with convergence<br>acceleration   | 31   |
| 3.6        | The rotated head model on Fidelity   | 32   |
| 3.7        | Fidelity User Interface  | 34   |
| 4.1        | The location of the field components in a single cell<br>(Yee cell)  | 40   |
| 4.2        | The location of an electric field component<br>and the efficient permittivity in the E cell case   | 45   |
| 4.3        | The location of an electric field component  | 45   |

|      |   |    |
|------|---|----|
|      | and the efficient permittivity in the H cell case                               |    |
| 4.4  | Staircase approximation of two equicentric spheres with different radii         | 46 |
| 4.5  | Flow chart that shows step to create the mobile Phone and human head modeling   | 50 |
| 4.6  | Properties of project wizard  | 52 |
| 4.7  | Dielectric database for mobile phone  | 53 |
| 4.8  | Dielectric database for brain tissue  | 53 |
| 4.9  | Layout and boundaries for mobile phone  | 54 |
| 4.10 | Layout and boundaries for human head and mobile phone                           | 54 |
| 4.11 | Basic parameter for construction of human head and mobile phone                 | 55 |
| 4.12 | Object template list  | 55 |
| 4.13 | Simulation setup  | 56 |
| 4.14 | SAR display parameter   | 56 |
| 5.1  | Mesh view of generic phone  | 58 |
| 5.2  | Outline view of generic phone   | 58 |
| 5.3  | S-parameter of mobile phone   | 59 |
| 5.4  | Real time graph of the mobile phone   | 59 |
| 5.5  | 3-D view of radiation pattern of mobile phone GSM 900                           | 60 |
| 5.6  | 3-D view of radiation pattern of mobile phone GSM 1800                          | 61 |
| 5.7  | Human head and mobile phone with external monopole antenna                      | 62 |
| 5.7  | Human head and mobile phone with internal monopole antenna                      | 62 |
| 5.8  | 3-D view of radiation pattern of mobile phone placed next to human head, 900MHz | 64 |

|      |   |    |
|------|---|----|
| 5.9  | 3-D view of radiation pattern of mobile phone placed next to human head,1800MHz | 64 |
| 5.10 | Human head and mobile phone loudspeaker with external monopole antenna          | 65 |
| 5.11 | Human head and mobile phone loudspeaker with external monopole antenna          | 66 |
| 5.13 | Bluetooth model with human head   | 68 |
| 5.14 | Base station away 150m from human head model                                    | 70 |
| 5.15 | Base station away 550m from human head model                                    | 71 |
| 5.16 | Base station away 1000m from human head model                                   | 71 |

## LIST OF ABBREVIATIONS

|        |   |  |
|--------|---|--|
| 2G     | - | Second Generation Mobile Communication   |
| 3G     | - | Third Generation of Wireless Technology  |
| 4G     | - | Fourth Generation Mobile Communication   |
| AMPS   | - | American Mobile Phone System   |
| AFFSSE | - | French Agency for Environmental Health Safety                                    |
| AP     | - | Access Point   |
| BSC    | - | Base station controllers   |
| BSS    | - | Base station subsystems  |
| BTS    | - | Base transceiver stations  |
| BWA    | - | Broadband Wireless Access  |
| CDMA   | - | Code Division Multiple Access  |
| EIRP   | - | Effective Isotropically Radiated Power   |
| EMF    | - | Electromagnetic Field  |
| EMI    | - | Electromagnetic Interference   |
| FDA    | - | Food and Drug Administration   |
| FDTD   | - | Finite Difference Time Domain  |
| GHZ    | - | Gigahertz  |
| GPRS   | - | General Packet Radio Service   |
| GSM    | - | Global System for Mobile Communication   |
| HPA    | - | Health Protection Agency (formerly known as National Radiology Protection Board) |
| HSDPA  | - | High speed Downlink Packet Access  |
| HSPDA  | - | High speed Packet Data Access  |
| HSUPA  | - | High speed Uplink Data Access  |

|                    |   |   |
|--------------------|---|---|
| Hz                 | - | Hertz   |
| I                  | - | Electric current  |
| ICNIRP             | - | International Commission on Non-Ionizing radiation Protection |
| IEEE               | - | Institute of Electrical and Electronics Engineers, Inc        |
| IEGMP              | - | International Expert Group on Mobile Phones                   |
| IP                 | - | Internet Protocol   |
| ITU                | - | International Telecommunication Union                         |
| kHz                | - | kilohertz   |
| MAC                | - | Medium Access Control   |
| MCMC               | - | Malaysian Communications and Multimedia Commission            |
| MHz                | - | Megahertz   |
| MNA                | - | Malaysia Nuclear Agency                                       |
| MoH                | - | Ministry of Health Malaysia                                   |
| MoM                | - | Method of Moments   |
| MSC                | - | Mobile Switching Center                                       |
| NIR                | - | Non-Ionization Radiation                                      |
| NMT                | - | Nordic Mobile Telephone                                       |
| NRPB               | - | National Radiological Protection Board                        |
| PCS                | - | Personal Communication System                                 |
| RF                 | - | Radio Frequency   |
| RFID               | - | Radio Frequency Identification Device                         |
| rms                | - | root mean square  |
| SAR                | - | Specific Absorption Rate                                      |
| SAR <sub>av</sub>  | - | Average SAR   |
| SAR <sub>max</sub> | - | Maximum SAR   |
| UHF                | - | Ultra High Frequency  |
| UMTS               | - | Universal Mobile telecommunications System                    |
| UV                 | - | Ultraviolet   |
| UWB                | - | Ultra Wideband  |
| VHF                | - | Very High Frequency   |



|       |   |   |
|-------|---|---|
| WCDMA | - | Wide band Code Division Multiple Access     |
| WHO   | - | World Health Organization                   |
| Wi-Fi | - | Wireless Fidelity                           |
| Wimax | - | World Interoperability for Microwave Access |
| WLAN  | - | Wireless Local Area Network                 |

**LIST OF SYMBOLS**

|            |   |                                  |
|------------|---|----------------------------------|
| $E$        | - | Electric Field                   |
| $H$        | - | Magnetic Field                   |
| $\sigma$   | - | Conductivity                     |
| $\rho$     | - | Mass Density                     |
| $\xi_r$    | - | Relative Permittivity            |
| $c$        | - | Specific heat capacity of tissue |
| $\Delta t$ | - | Change of temperature            |
| $D$        | - | Rectangular volume               |

**LIST OF APPENDICES**

| <b>APPENDIX</b> | <b>TITLE</b>   | <b>PAGE</b> |
|-----------------|--|-------------|
| <b>A</b>        | Fidelity's manual of basics guidelines to use Fidelity | 81          |

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Introduction**

The use of mobile phone has increased exponentially in the recent years and has become the ubiquitous element in daily life. With this growth comes the inevitable increase in the number of base station sites. By the quick introduction of mobile telecommunications devices and technologies, especially among the general public, so there has been a focus on the health problems associated with Radio Frequency (RF) exposure from base stations and mobile phone. In addition, concerns persist that chronic exposure to pulsed and amplitude modulated RF fields may cause specific health effects.

There have been numerous studies on health effects of chronic exposure to the RF fields from base stations and mobile phone. The first extensive review has focused on the radiation exposure from base station and mobile phone based on epidemiological and experimental studies on health effect. This was done by the Independent Expert Group on Mobile Phone (IEGMP), in the year 2000 and known as Steward Report [1].

After IEGMP, National Radiological Protection Board (NRPB) or currently known as Health Protection Agency (HPA) published a report that provide advice to address public concerns about mobile phone technology. This published in year of 2004 [2]. Then, in February 2005, French Agency for Environmental Health Safety (AFSSE)

published a document in the specified field of non-ionization radiation used by mobile telephony system [3].

In Malaysia, public concern on health effect that provide by widespread use of mobile phone stated in the 1990's. Continuous research and review of related documents are needed to ensure that the data or information is not outdated. Electromagnetic energy or frequency of exposure level will always increases with advancing technology. Thus, even small health consequences from electromagnetic frequency exposure could pose a major public health impact.

## **1.2 Objectives**

The objectives of the project are:

- 1) to study on the mobile phone and base station technology, also the basic concept of electromagnetic energy.
- 2) to study on human health effect that associated to electromagnetic radiation produce by mobile phones and base stations.
- 3) to do simulation in order to investigate the effect of mobile phones and base stations on human head.

## **1.3 Scopes of Project**

The scope of this study is listed below:

- 1) Gathered information on mobile phones and base stations technology.
- 2) Differentiate between ionization and non-ionization radiation of electromagnetic energy.

- 3) Searching historical data that done by other countries.
- 4) Finite Different Time Domain (FDTD) method is used to model mutual effects of mobile phones and base stations on human head in term of human health effect.

#### **1.4 Problem Statement**

Study on the health effect that brought by mobile phones and base stations is done due to provide the standard and guidelines for limiting electromagnetic exposure on the radio frequency use. It is also to determine the safety distance of electromagnetic of a base station antenna.

#### **1.5 Project Outlines**

Chapter 1 provides the introduction of the project where the background, objectives and scopes of project are presented. Then, the literature review of the project which include the fundamental theories and concept of electromagnetic field (EM), specific absorption rate (SAR), cellular systems and the appropriate literature are all described in Chapter 2. For Chapter 3, the technical background is explained. This part emphasized on Zeland simulator. Proceed with Chapter 4 that justify on the algorithm and implementation of the project. Result and discussion come up in Chapter 5 followed by conclusion in Chapter 6. The conclusion will be summarized all the finding of the project besides the suggestion for further work.

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