On Measurement of Electro Magnetic Radiations in IET DAVV Campus

Raksha Upadhyay
Department of Electronics and TeleCommunication, IET DAVV, Indore, INDIA

ABSTRACT
Radiofrequency (RF) fields are part of the electromagnetic (EM) spectrum. The EM spectrum is divided into ionizing and non-ionizing bands, and depending upon them it finds variety of applications in communication. Measurement of electromagnetic field is critically important as all the application can enhance their utility, if its radiation and spectrum is well known. In this paper we have shown two different case studies, in one of which optimization of the location of access point is proposed to enhance the signal strength of WiFi in fixed scenario. It also focuses on increasing the number of access points. In other case, we have measurement of the radiation of mobile unit and shown that radiation emitted by mobile unit is inversely proportional to antenna power.

Keywords—Radiofrequency (RF), Electromagnetic (EM), Access Point, WiFi and Antenna Power.

I. INTRODUCTION
Electromagnetic Field (EMF) waves are used to transmit signals from a source to the desired destination. The EMF propagates at the speed of light in free space (300,000km/s) so it can be modulated, transmitted and received while conveying the necessary information [1]. The signal may be in form of voice, data or video. This electromagnetic wave consists of an electric field perpendicular to the magnetic field and both are perpendicular to the direction of propagation. The wave length of the wave depends on the operating frequency [2]. Different types of electromagnetic waves have different frequencies. Each of these frequencies has its own properties and characteristics which make it distinguished from others. The Electromagnetic radiation may be classified as ionizing and non-ionizing radiation. Ionizing radiation has enough energy to remove bound electrons from the orbit of an atom such that it becomes an ionized atom which may cause health hazard [3]. On the other hand, the non-ionizing radiation does not have the sufficient energy to ionize (change) the atoms. For example, the human eye can easily perceive the light whereas the EM with very high frequency, like X-ray, may ionize material and break down molecules. However, this radioactive radiation should not be confused with radio wave frequency (RF). The radio waves used in mobile telephones and cellular communications are also electromagnetic waves like visible light and X-ray and they also propagate in the same speed of light [2] [3]. The RF used for mobile communication can be in the range 450-2200 MHz which is considered as part of the microwave (MW) range. It is also shows the range of non-ionizing and ionizing ranges of frequency and the applications of each one as well as the energy associated with each one. Obviously, the wave energy is directly proportional to the wave frequency [4]. In the last decade, the Indian telecom has witnessed phenomenal growth due to mobile wireless applications.

The popularity of the cell phone and WLAN devices has resulted in increase in electromagnetic radiations. So the paper presents a case study on measurement of strength of electromagnetic radiations in IET-DAVV Indore campus for the safe usage of mobile phones and for selecting optimum position of access points.

II. LITERATURE
A cell phone transmits 1 to 2 Watt of power in the frequency range of 824 - 849 MHz (CDMA); 890 - 915 MHz (GSM 900) and 1710 – 1780 MHz (GSM1800). Cell tower antennas; transmit in the frequency range of 869 - 894 MHz (CDMA), 935 - 960 MHz (GSM900) and 1810 – 1880 MHz (GSM1800), radiate substantial power. In addition to cellular system, wireless local area network of (Wi-Fi) devices, operating in 2.4 GHz & 5 GHz range, are an increasingly common technology employing radio frequency energy for communication. Wi-Fi devices may operate at different power levels, depending on the band and operating characteristics. Maximum conducted power...
(into the antenna) and maximum equivalent isotropic ally radiated power (e.i.r.p.) must not exceed 1 watt and 4 watts, respectively. These standards are mentioned below:

### 2.1 WiFi, 802.11 Standards:

Wi-Fi, an acronym for "Wireless Fidelity", is a set of product compatibility standards for Wireless Local Area Networks (WLAN) based on the IEEE 802.11 specifications. Wi-Fi was intended to be used for mobile devices and LANs, but is now often used for Internet access. It enables a person with a wireless-enabled computer or personal digital assistant (PDA) to connect to the Internet when in proximity of an access point. Wi-Fi allows to connect to the internet from virtually anywhere at speeds of up to 54Mbps. The computers and handsets enabled with this technology use radio technologies based on the IEEE 802.11 standard to send and receive data anywhere within the range of a base station [5].

### Table 1: Showing Different Version of WiFi [3]

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Frequency</th>
<th>Signal</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legacy</td>
<td>2.4 GHz</td>
<td>FHSS</td>
<td>2 Mbps</td>
</tr>
<tr>
<td>802.11a</td>
<td>5 GHz</td>
<td>OFDM</td>
<td>54 Mbps</td>
</tr>
<tr>
<td>802.11b</td>
<td>2.4 GHz</td>
<td>HR-DSSS</td>
<td>11 Mbps</td>
</tr>
<tr>
<td>802.11g</td>
<td>2.4 GHz</td>
<td>OFDM</td>
<td>54 Mbps</td>
</tr>
<tr>
<td>802.11n</td>
<td>2.4 GHz</td>
<td>OFDM</td>
<td>600 Mbps</td>
</tr>
<tr>
<td>802.11ac</td>
<td>5 GHz</td>
<td>OAM</td>
<td>1.3 Gbps</td>
</tr>
</tbody>
</table>

### 2.2 GSM:

Mobile Phone which works on GSM network baseband part (Layer 1) and protocol stack running on CPU differs, which will be based on GSM standard [8]. For CDMA Mobile phone the same Layer 1 and protocol stack will be based on CDMA standard and so on for LTE, HSPA standard based mobile phones. Mobile phone provides connectivity with laptop/other devices using WLAN, Bluetooth and GPS. All these features are based on specific standard specifications designed. GSM Mobile phone is in use earlier days for only voice applications [3].

### 2.3 Specific Absorption Rate (SAR):

SAR is a measure of the rate at which energy is absorbed by the human body when exposed to a radio frequency (RF) electromagnetic field; although, it can also refer to absorption of other forms of energy by tissue, including ultrasound [9]. It is defined as the power absorbed per mass of tissue and has units of watts per kilogram (W/kg).

SAR is usually averaged either over the whole body, or over a small sample volume (typically 1 g or 10 g of tissue). The value cited is then the maximum level measured in the body part studied over the stated volume or mass [2]. Due to recent public concerns related to the proliferation of telecommunication services, measurement of RF exposure has been an essential need.

### III. CASE STUDY I: OPTIMIZING LOCATION OF ACCESS POINT

#### 3.1 Objective of Study:

In this work we aimed to optimize the Wi-Fi access point’s location and in our campus, IET, DAVV, Indore. Also analyze the effect of increasing access points on signal strength. Using measurement device we have measured Wi-Fi signal Strength at various locations in different blocks. Currently one router is installed in a block serving as sole Wireless Access Point (WAN). We found that the location of the router is not optimum along with that a single access point is not sufficient to cover the whole block, hence we have proposed that the location of Wi-Fi access points needs to be changed along with increasing the number of access point.

#### 3.2 Steps of Implementation:

- Select a RF meter/device of your choice.
- Make sure you are not holding or wearing any wireless devices like other smart phones, Bluetooth devices. These devices are emitting RF radiation that might interfere with the reading of the meter.
- If you are using a smart phone to capture a video or photos of the measurement, please make sure it is in flight mode.
- Make sure you are not wearing or holding any rings or metal items that might interfere with the meter's reading.
- Hold the device in an upright position (vertical axis) without having your hand block the antenna/RF sensor of the meter.

#### 3.3 Summary:

After Deep analysis of the measurements of Wi-Fi radiation intensity at different points it is revealed that the presence of one access point or router is not enough to provide Wi-Fi strength to every region. Therefore, it is advised to increase the number of router at a point such that the regions, which are not covered by the initial router, are properly covered and each user is availed with signal at corner regions.

### IV. CASE STUDY II: MEASUREMENT OF MOBILE RADIATION

#### 4.1 Objective of Study:

This study we focus on electromagnetic energy radiated from the typical mobile phones. Measurements and analysis of power density emitted by a mobile phones was carried out during ringing (incoming & outgoing) and calling (incoming and outgoing) under at different physical locations of the college. The mobile phones used for this project were from various service providers. The main objective of this project is to analyze the guidelines for limiting EMF exposure that will provide protection against...
known adverse health effects. An adverse health effect causes detectable impairment of the health of the exposed individual or of his or her offspring; a biological effect, on the other hand, may or may not result in an adverse health effect.

4.2 Summary:

The radiated power from mobile phones is inversely proportional to the signal strength. And the radiated power from mobile phones also depends on the physical location of the mobile. If the phone is in an open area radiated power is comparatively less. If the phone is inside basement or closed room with thick and multiple walls the radiated power from the mobile is very high, even good quality phones emit high radiations. The radiated power from the phone is highest in first 3 rings, after that radiated power reduces depending on the physical location of the phone.

V. CONCLUSION

Case studies reveal the importance of measurement of Electromagnetic Radiation. Case shows that as we increase the number of access point, signal strength also increases. And optimum placement of access point in the define geography, increase the availability of access signal all the geographically separated users. In the other case, when radiation of mobile phones is evaluated, it has been shown that as the strength of signal from antenna decreases, mobile unit try harder to connect to it and under that process it radiate more power.

VI. ACKNOWLEDGEMENT

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REFERENCES