

# Internet of Things: Boon or Bane: A Review

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**Abstract** - Internet of things (IOT) has become the latest buzzword in the industry. With the onset of IOT, the lives of common man are set to become more organized and hassle free. The idea behind this task is to teach machines to read real time data with the help of various sensors and take suitable necessary action accordingly. The sensors may be inbuilt or remotely located. The communication is mostly wirelessly, through Radio Frequency (RF), microwave or Wi-Fi, which ensures hassle free environment. All this convenience comes at a cost, of public health. Although all the latest technologies have made and will be continuously making our lives much easier, but the side effects seem to be far more dangerous to ignore.

**Keywords** - RF, Radiation, Cancer, Wi-Fi, SAR.

## 1. Introduction

Internet of Things may be a hot topic in the industry but it's not a new concept. [1] In the early 2000's, Kevin Ashton laid the groundwork for what became the Internet of Things (IoT) at MIT's AutoID lab. In a 1999 article for the RFID Journal, Ashton wrote: "If we had computers that knew everything there was to know about things—using data they gathered without any help from us -- we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. RFID and sensor technology enable computers to observe identify and understand the world—without the limitations of human-entered data." Following the lines of Ashton's insight, sensors were developed which could read and transmit data wirelessly to machines or computers for further processing or analysis. Different forms of wireless communications are Radio Frequency (RF), Microwave, Wi-Fi, 2G, 3G, 4G, 5G and so on...[2] To fulfill the purpose of IOT, everywhere cloud services are being accessed – things like webmail, social networking and virtual applications – over wireless networks. It is the modern way but wireless is an

energy monster, it is inherently inefficient. Calculations show that, in 2015, the wireless networks used to access cloud services commanded around 90% of the energy needed to power the entire wireless cloud services ecosystem. This is an increase in carbon footprint from 6 mega tonnes of CO<sub>2</sub> in 2012 to up to 30 mega tonnes of CO<sub>2</sub> in 2015, the equivalent of adding 4.9 million cars to the roads.

[3] The quantity used to measure how much RF energy is actually absorbed in a body is called the specific absorption rate (SAR). It is usually expressed in units of watts per kilogram (W/kg) or milliwatts per gram (mW/g). In the case of whole-body exposure, a standing human adult can absorb RF energy at a maximum rate when the frequency of the RF radiation is in the range of about 80 and 100 MHz, meaning that the whole-body SAR is at a maximum under these conditions (resonance). Because of this resonance phenomenon, RF safety standards are generally most restrictive for these frequencies. [3] Biological effects that result from heating of tissue by RF energy are often referred to as "thermal" effects. It has been known for many years that exposure to very high levels of RF radiation can be harmful due to the ability of RF energy to rapidly heat biological tissue.

[4] Wi-Fi emits microwave radiation in the same frequency range as that of microwave oven. Both wireless routers and wireless computers contain transmitters that send information back and forth through the air. Microwave radiation is able to penetrate walls made of wood and concrete. It can also penetrate our bodies. Human and animal bodies significantly perturb the spatial distribution of a low frequency electric field. At low frequencies, the body is a good conductor, and the perturbed field lines external to the body are nearly perpendicular to the body surface. Oscillating charges are induced on the surface of the exposed body and these produce currents inside the body.

In section II, a detailed summary of various side effects of radiations is covered, Section III guidelines pertaining to

radiation around the world and that of India are discussed. Section IV shows the various sources of radiations and warnings given on various products and section V provides possible solutions to the problems.

## 2. Dangers of Radiations

Many researches and surveys for the ill effects of radiations have been carried out since the onset of wireless technologies. Some of which are listed below:

**Cancer:** Research showing that long term heavy cell phone users have an increased risk of brain cancer lead to the WHO IARC [12] classification of this radiation as a Class 2 B carcinogen: a “possible human carcinogen”. A study showed that adults who started using cell or cordless phones as teenagers had a 8 fold higher risk of brain cancer on the side of their head where they held the phone.

**Hearing:** According to a news report in Indian Express, Mumbai, July 18, 2012, a research shows chronic mobile phone usage results in high frequency hearing loss and inner ear damage. Research has also shown significant risk of tumors on the auditory nerve in the brain (acoustic neurons).

**Disruptions to Heart Functioning :** Research done by National Library of Science [18] show increases in heart rate, arrhythmias, dizziness, changes in blood pressure and other disturbances in heart functioning from wireless radiation.

**Headaches:** Research [13] shows children who used cell phones or were exposed prenatally to wireless radiation are at higher risk of developing headaches.

**Infertility:** In 2006, the American Society for Reproductive Medicine [15] reported that use of cell phones by men is associated with semen quality, sperm count, motility, viability and normal morphology and is related to the duration of cell phone use.

**DNA damage:** Wireless radiation can also produce DNA breaks in sperm cells that can mutate and cause cancer. Damage to sperm DNA increases the risk further and can pass on the genetic changes to subsequent generations. Prof. Henry Lai of University of Washington, USA observed [14] single and double stranded breaks in DNA from microwave exposure.

Figure on the left shows an unexposed control bundle of DNA. Middle figure shows DNA breaks after exposure to X-Ray and the right figure shows a comet of DNA with exposure to cell phone radiation.

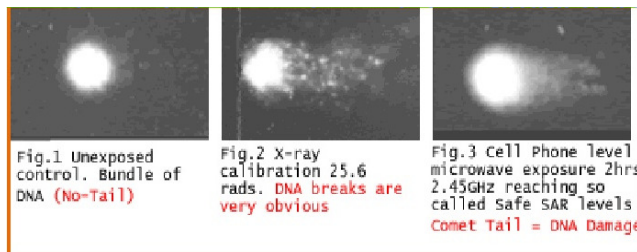


Fig1: DNA breakage due to extended exposure to radiation

**Vision Problems:** Cell phones [13], even when not in use, send signals to the base station almost every minute, so the eyes of the person using the phone for hours, would get these high radiation signals, which can dry the fluid in the eyes over the years due to cumulative effect.

## 3. Around the World

Safety limits are designed to protect the public from a potential harm and are often set well below the point of potential danger to prevent that point of danger from being accidentally reached. Safety Limits are determined in two steps. First, by identifying the amount of exposure to any given agent, above which causes a health effect to be observed. This amount is determined for the most vulnerable members of the population, and considers the effects of both short and long-term exposure. That resulting number is then divided by a safety factor to ensure that the public is never exposed to dangerous levels. The reason for the safety factor is so the regulator will have time to fix the problem before the levels reach a point that can cause harm to the public, if for whatever reason, the safety limit is exceeded. The more uncertain the dividing line between safety and harm is, the larger the safety factor used to protect the public. Various laws and rules are implemented round the world to check the radiation levels from various sources.

### France:

New Legislation and the National Agency for Health, Food and Environmental Safety (ANSES).

- 2013 The French National Assembly passed an amendment banning Wi-Fi from nursery Schools and strongly discouraging Wi-Fi in their schools until its proven “safe for human consumption.”
- 2011 French Cell Phone Statute: Merchants must display SAR Radiation levels for different phone models, all phones must be sold with a headset, cell phone ads aimed at children younger than 14 are banned and phones made for children under 6 are banned.
- 2013 ANSES Report recommends hands free phones, SAR labeling, and “limiting the population's exposure

to radiofrequencies... especially for children and intensive users, and controlling the overall exposure that results from relay antennas.”

- The French National Library along with other libraries in Paris, and a number of universities have removed all Wi-Fi networks.

#### **Belgium:**

Federal Public Health Regulations on March 2013 due to Health Concerns for Children.

- Phones designed for children under 7 years old are prohibited from sale.
- Total Advertising Ban on cell phones aimed at children younger than 14.
- Mandatory Radiation SAR levels must be available for consumers at point of sale.
- Warning label on phones: “Think about your health – use your mobile phone moderately, make your calls wearing an earpiece and choose a set with a lower SAR value.”
- Ghent Municipality: Wireless internet is banned from spaces that cater to children between 0 and three: preschools and daycares to reduce exposure to microwave radiation.

#### **Australia:**

In 2013 the Australian Radiation Protection and Nuclear Safety Agency issued Fact Sheet 14: titled How to Reduce exposure from mobile phones and other wireless devices.

- Reduce the risk from Wi-Fi devices by “keeping them at a distance, for example placing the wireless router away from where people spend time”, and “reducing the amount of time you use them”.

#### **Finland:**

The Radiation and Nuclear Safety Authority issued recommendations for children which include: favoring text messages, parents limiting duration and amount of calls, the use of hands free devices, avoiding calls in a low reception area and keeping the phone away from the body.

- "With children, we have reason to be especially careful, because there is not enough research on children's mobile phone use", according to STUK research director Sisko Salomaa.

#### **Israel:**

The Israeli Ministry Of Education has issued guidelines limiting Wi-Fi and cell phone use in schools.

- Preschool through 2nd grade have banned the use of wireless networks.

- A hard wired direct cable connection is required if the teacher has a computer in the class.
- The Israeli Supreme Court ordered the Israeli government to reply on ceasing Wi-Fi installations
- In third and fourth grade class internet is restricted to 3 hours per week.
- The Education Ministry has instructed all schools to perform radiation tests.
- Israel's Minister of Health Rabi Litzman stated that he supports a ban on Wi-Fi in schools.

#### **Switzerland:**

The Governing Council of Thurgau Canton 2008 “The Governing Council recommends for schools to forgo the use of wireless networks when the structural makeup of a given school building allows for a wired network.”

#### **Germany:**

The German Federal Ministry for Radiation Protection states, “supplementary precautionary measures such as wired cable alternatives are to be preferred to the WLAN system.”

#### **Bavaria:**

The State Ministry of Education and Cultural Affairs: “For precautionary reasons the Federal Office for Radiation Protection recommends for schools that if a wireless network is used to place its components in suitable locations and to prefer the use of wired network solutions whenever possible.” In 2007 Parliament recommended to all schools to not install wireless LAN networks.

**Frankfurt:** “In Frankfurt’s schools there will be no wireless networks in the short or mid term. The Local Education Authority did not wish to conduct a “large scale human experiment,” said Michael Damian, spokesperson of the Head of the School Department Jutta Ebeling.

#### **Austria:**

"The official advice of the Public Health Department of the Salzburg Region is not to use WLAN and DECT in Schools or Kindergartens." Gerd Oberfeld, MD.

- The Austrian Medical Society has issues cell phone safety guidelines stating that cell phones should be used for as short of a time as possible and that children under 16 should not use cell phones at all. The state that wireless LAN leads to high microwave exposure.

#### **United Kingdom:**

The UK National Health Service has specific Recommendations for children and cell phones as “children are thought to be at higher risk of health implications”.

- “Children should only use mobile phones for essential purposes and keep all calls short. “
- For the public they have “recommendations to help lower any potential long term risks” which include keeping calls short, keep phone away from the body on standby mode, only use it when the reception is strong and use a phone with an external antenna.

**India:**

2012 The Ministry of Communications and Information Technology issued EMF guidelines with new Exposure Limits lowered to 1/10 of the ICNIRP level, SAR labeling on phones.

- Official guidelines for cell phone use include: Headsets, Speakerphones, limiting cell use, increasing distance from devices, and choosing landlines.
- 2013: Supreme Court of India upholds a decision of the High Court of the State of Rajasthan to remove all cell towers from the vicinity of schools, colleges, hospitals and playgrounds because of radiation “hazardous to life.”
- The Ministry of Communications and Information Technology has a webpage entitled “ A Journey for EMF” detailing guidelines and current issues with wireless devices and cell towers.

**Italy:**

The Italian Supreme Court ruled a man’s brain tumor was caused by his cell phone use in 2012. The National Institute for Workmen’s Compensation must compensate a worker with head tumor due to cell use. 18

**Russia:**

The Russian National Committee on Non-Ionizing Radiation Protection has repeatedly warned about electromagnetic radiation impacts on children and recommended Wi-Fi not be used in schools.

- Decision of Russian National Committee on Non-Ionizing Radiation Protection 2008, "CHILDREN AND MOBILE PHONES: THE HEALTH OF THE FOLLOWING GENERATIONS IS IN DANGER.”

**Canada:**

Health Canada offers “Practical Advice” on reducing exposure to wireless radiation.

- Recommendations: 1. Limit the length of cell phone calls, 2. Replace cell phone calls with text, use "handsfree" devices and 3. Encourage children under the age of 18 to limit their cell phone usage
- “Health Canada reminds cell phone users that they can take practical measures to reduce RF exposure. The department encourages parents to reduce their

children's RF exposure from cell phones since children are typically more sensitive to a variety of environmental agents...There is a lack of scientific information regarding the potential health impacts of cell phones on children.”

Following the recommendations from International Commission on Non-Ionizing Radiation Protection (ICNIRP), many countries have set limits on radiation exposure for public.

Table 1: EMF Radiation Standards for GSM 900

| Country                                  | Watts/m <sup>2</sup> |
|--|----------------------|
| India (Implemented)                      | 4.5                  |
| India (Proposed)                         | 0.45                 |
| Australia                                | 0.00001              |
| Austria (Salzburg city)                  | 0.001                |
| Belgium (Luxembourg)                     | 0.024                |
| BIO-INITIATIVE REPORT (Outdoor)          | 0.001                |
| BIO-INITIATIVE REPORT (Indoor)           | 0.0001               |
| Canada(Toronto Board of Health proposed) | 0.1                  |
| China                                    | 0.4                  |
| France (Paris)                           | 0.1                  |
| Germany (ECOLOG 1998)                    | 0.09                 |
| Germany (BUND 2007)                      | 0.0001               |
| Italy                                    | 0.1                  |
| New Zealand (Auckland)                   | 0.5                  |
| Poland                                   | 0.1                  |
| Russia                                   | 0.1                  |
| Switzerland                              | 0.042                |
| USA                                      | 3                    |

**4. The Fine Print**

All manufacturers of wireless devices have warnings which describe the minimum distance at which device must be kept away from users in order to not exceed the present legal limits for exposure to wireless radiation. For example, the Federal Communications Commission (FCC) regulates that the exposure limit for laptop computers and tablets is set when devices are tested 20 cm away from the body.

**Blackberry Bold 9930:**

“Keep the BlackBerry device at least 0.59 in. (15 mm) from your body (including the abdomen of pregnant women and the lower abdomen of teenagers) when the BlackBerry device is turned on and connected to the wireless network.”

#### **iPads:**

"To be sure that human exposure to RF energy does not exceed the FCC, IC, and European Union guidelines, always follow these instructions and precautions: Orient the device in portrait mode with the Home button at the bottom of the display, or in landscape mode with the cellular antenna away from your body or other objects."

#### **Samsung 3G Laptop:**

"Usage precautions during 3G connection: Keep safe distance from pregnant women's stomach or from lower stomach of teenagers. Body worn operation: Important safety information regarding radiofrequency radiation (RF) exposure. To ensure compliance with RF exposure guidelines the Notebook PC must be used with a minimum of 20.8 cm antenna separation from the body."

#### **iPhone 4:**

" To be sure that human exposure does not exceed the FCC guidelines, always follow these instructions... keep iPhone at least 15 mm (5/8 inch) away from the body, and only use carrying cases, belt clips, or holders that do not have metal parts and that maintain at least 15 mm (5/8) inch separation between the iPhone and the body." To view the information on your iPhone go to Settings > General > About > Legal > RF Exposure.

#### **Belkin WIFI Router Manual:**

"Caution: Exposure to Radiofrequency Radiation: The device shall be used in such a manner that the potential for human contact normal operation is minimized. This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body."

#### **HP Printer:**

"In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 20 cm (8 inches) during normal operation."

Most people, especially children and young adults, carry and use their wireless devices directly against their bodies. Consumers do not know that using a laptop on your lap, clutching an iPad to your chest or tucking a cell phone in your pocket or bra is potentially unsafe and could result in the user getting radiation exposures that exceed the standard. Since warnings are deep in the legal fine print of manuals and on manufacturer websites, they are often overlooked.

## **5. Antidote**

Solution is to have more numbers of cell towers with lesser transmitted power. When power transmitted is reduced, it will not require power hungry power amplifiers having lower efficiency. Heating effect will also be reduced, so lesser cooling or no cooling will be required; all of these will reduce the power requirement, which can also be met by solar panel.

Thus, high power diesel generators will also be not required; it will reduce the carbon emission and we can earn from carbon credits. In addition, repeaters or signal enhancers or boosters may have to be installed where signal is weak. Care must be taken that maximum power transmitted by these must not exceed 0.1W because of their close proximity to the users. Self certification by the operators must be immediately abolished; measurements must be done by third party, which is independent and trustworthy. Also, radiation measurements must be monitored continuously, so that operators should not increase the transmitted power during the peak period. Very strict penalties must be imposed on those operators, who violate these norms as it causes serious health hazards to innocent people.

## **6. Conclusion**

Although, with onset of IOT, life has become much comfortable with tasks being run on fingertips, the dangers of it in the long run seem to be more frightening. The very main reason, for which the technology is being developed i.e. mankind, is at a greater loss. Wise use of technology is need of the hour.

## **Appendix**

IOT: Internet of Things

RF: Radio Frequency

FCC: Federal Communications Commission

PC: Personal Computer

3G: Third Generation Mobile

WLAN: Wireless Local Area Network

DECT: Digital Enhanced Cordless Telecommunications.

EMF: Electromagnetic Fields

SAR: Specific Absorption Rate

ICNIRP: International Commission for Non-Ionizing Radiation Protection.

WHO: World Health Organization.

IARC: International Agency for Research on Cancer

DNA: DeoxyriboNucleic Acid

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