

## Wireless Networks and Exposure to Radiofrequency Energy

### What are wireless networks and wireless-enabled devices?

Since the early 2000's, there has been a rapid growth in the number of digital wireless devices that transmit information and link to other devices using radiofrequency (RF) energy. Many of these devices are designed to be used in networks (linked groups of devices) that provide communications over areas that may range from a single household to an entire neighborhood, by transferring information from one device to another throughout the network. Examples include Smart Meters (wireless enabled utility meters) as well as some new systems that provide Internet service to communities by means of arrays of small transmitters mounted on consumers' houses. Other devices provide two-way communication between devices or between computers and devices. Examples include the familiar Wi-Fi and Bluetooth interfaces in computers and smartphones and, increasingly, Wi-Fi enabled home thermostats, bathroom scales, light bulbs, remotely controlled power outlets, and other household appliances.

All of these devices transmit radiofrequency energy, which creates some level of public exposure. In response, some citizens have expressed concerns about the possible health effects of such exposures. RF energy is a form of nonionizing radiation (the photons that carry it have insufficient energy to break chemical bonds and create ions, which is the major cause of tissue damage from ionizing radiation such as X-rays).

**For more information on non-ionizing radiation, click here**

### Wireless Network Technology and Safety

Characteristically, all of the devices considered here transmit signals that consist of streams of brief radiofrequency (RF) pulses. Most of these devices operate at frequencies generally similar to those used by cellular telephones (around 1 gigahertz (GHz)). Many of these devices use the same "unlicensed" frequency bands at 0.9 and 2.4 GHz that are used by other consumer electronic equipment including microwave ovens. The devices typically operate at peak power levels well below 1 watt (and generally at lower levels than transmitted by cellular telephones). Moreover, the devices characteristically transmit energy at very low duty cycle (i.e. they transmit for a small fraction of time), and their average transmitted power is consequently much less than 1 watt.

To be sold in the U.S., devices that transmit RF energy must meet limits for human exposure to RF energy set by the Federal Communications Commission (FCC). These limits are designed to protect against all known hazards of RF energy. For wireless networking devices, as for other RF transmitters, the FCC exposure limits apply to the peak power levels. Depending on the device, the FCC limits may be in terms of peak power density that is incident on the body (for devices that are intended to be used some distance from the body such as Wi-Fi routers) or peak absorbed power in the body (for devices that are intended to be used close to the body, such as tablet computers that are used against the lap). In either case, the FCC limits refer to peak exposure levels while the device is transmitting. Since wireless devices characteristically transmit energy for only a small fraction of the time, typically less than 1%, the average exposure to the user will be far below the peak levels in the FCC limits.

An individual's exposure to RF energy from a wireless devices should be considered in the context of RF exposure from many other sources of RF energy in today's environment. These include radio and TV broadcasting antennas, emergency, police and commercial communications systems, cellular

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telephone base stations, use of cellular telephones by an individual or by nearby individuals, cordless telephones and microwave ovens in the home, laptop computers, and a diverse variety of networking devices including Smart Meters in the home.

The level of exposure from any device falls off rapidly with distance of a person to the transmitting antenna. Consequently, the RF exposure levels in ordinary environments is highly variable, but generally very low compared to exposure limits.

For example an extensive survey of RF field levels in typical environments (office, homes, transportation, outdoors) in five European countries was reported in 2010 by a group of European investigators<sup>1</sup> The highest exposure to RF energy that an average person experiences in ordinary life is from his/her own use of a cellular phone. The study found that the highest average exposure (apart from ones own use of a cellular phone) was from cellular phones used by nearby individuals, followed by exposures from other sources including wireless communications equipment and other RF sources. In all cases, the RF field levels were small fractions of international limits (which are similar to the FCC limits in the U.S.

Levels of exposures to RF energy from Wi-Fi in schools have been studied extensively by several groups. One recent study in Belgium<sup>2</sup> found generally similar overall RF exposure levels in schools, homes, and offices, although the levels varied considerably. The signals measured in that study were from a variety of sources inside the building (Wi-Fi, use of cell phones by occupants) and external sources (e.g. cellular base station, transmitting equipment). All of the levels measured in that study were far below international exposure limits. In schools the largest contribution to the RF exposure level within the buildings was from Wi-Fi; in other environments it was generally from other persons' use of cellular telephones. Nevertheless, all exposure levels were quite similar.

Despite these complexities, the largest overall exposure that an average citizen receives to RF energy is when he/she uses a cellular telephone. Because exposure falls off rapidly with distance from the transmitting antenna, other RF sources will contribute to the background exposure, at a greater or lesser amount depending on the distance from their antenna to an individual. In generally decreasing amounts, this includes RF energy from the cellular telephone used by a bystander, and then RF signals from other wireless devices, including cordless telephones, Wi-Fi, Smart Meters, and other networking technologies, and (at a generally lower level) from RF sources outside the home.

All of these measured exposure levels are a very small fraction of U.S. and international exposure limits. A "backgrounder" published by the World Health Organization in 2006 concluded that "Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects".<sup>3</sup> In the view of CDC, this conclusion remains valid today.

### What you need to know:

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<sup>1</sup> Joseph, Wout, et al. "Comparison of personal radio frequency electromagnetic field exposure in different urban areas across Europe." *Environmental research* 110.7 (2010): 658-663.

<sup>2</sup> Verloock, Leen, et al. "Assessment of Radio Frequency Exposures in Schools, Homes, and Public Places in Belgium." *Health physics* 107.6 (2014): 503-513.

<sup>3</sup> World Health Organization, *Electromagnetic fields and public health. Base stations and wireless technologies.*



- The FCC's present guidelines on RF energy exposure are based upon standards developed by the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). The FCC's guidelines were developed through a comprehensive<sup>4</sup> process that included input from federal agencies and the public. While the guidelines were adopted in 1996, they are similar to major international guidelines that are presently in effect in many other countries.
- Several health agencies have concluded that major international limits, which are broadly similar to present FCC limits, offer sufficient protection against all known hazards of RF energy.
- Wireless communications and networking devices are required to meet FCC guidelines on RF energy exposure. The FCC limits apply to the peak exposure produced by a device while it is transmitting. Because wireless devices characteristically transmit energy for only a small fraction of the time, typically much less than 1%, the average exposure to the user will be far lower than peak values reported to the FCC.
- There remains no convincing evidence that exposure to such fields creates any health hazard. Moreover, exposure levels to the public from wireless networking devices, Wi-Fi, Smart Meters, and other similar devices is generally much lower than exposure to an individual from use of a cellular phone, and it is probably lower than from use of a cellular phone by a bystanding individual (depending on the distances involved). To the extent that RF exposures can be reduced by an individual, it would be by reducing the use of cellular telephones or wireless equipment that is located close to the individual. CDC does not recommend such measures based on present information however.
- CDC recognizes that there is some level of scientific uncertainty about possible biological effects of RF energy. In particular, in 2011 the International Agency for Research on Cancer (IARC, a component of the World Health Organization) classified RF energy as "possibly carcinogenic to humans"<sup>i</sup> In the formal decision process that IARC used, this indicates a level of suspicion and not a conclusion that RF energy probably or actually does cause cancer. Moreover, most of the evidence leading to this classification pertained to long term use of cellular telephones, which is *a different (relatively much higher) exposure than that produced by wireless networking devices*
- CDC will continue to monitor this topic.

**For More Information:**

[Federal Communications Commission \(FCC\)](#)

[CDC- Frequently Asked Questions about Cell Phones and Your Health](#)

[NIH – Cell Phones](#)

[National Cancer Institute – Cell Phones and Cancer Risk](#)

[WHO – Electromagnetic Fields \(EMF\)](#)

[HPS – Micro/Radio Waves, Radar and Powerlines](#)

WHO World Health Organization, Electromagnetic fields and public health. Base stations and wireless technologies. Backgrounder May 2006 (available at <http://www.who.int/peh-emf/publications/facts/fs304/en/>)

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31 May 2011 IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS. [http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208\\_E.pdf](http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf)