ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH
Base Stations and Wireless Technologies

Mobile telephony has rapidly become commonplace in everyday life. At the end of 2005, about 1.6 billion people, or around 20% of the world's population, use a mobile phone to send and receive voice, text messages, pictures and other data. The number of mobile phone users in developing countries is increasing rapidly because the telecommunications infrastructure costs are significantly cheaper than land-line systems. This wireless technology relies on an extensive network of fixed antennas, or base stations, relaying information with radiofrequency (RF) signals. Over 1.4 million base stations exist world wide and the number is increasing significantly with the roll-out of third generation (3 G) technology.

Other wireless networks that allow high speed internet access and services, such as wireless local area networks (WLANs), are also increasingly common in homes, offices, and many public areas (airports, residential areas and schools). As the number of base stations and local wireless networks increases, so does the RF exposure of the population. Recent surveys have shown that the RF exposures from base stations range from 0.002% to 2% of the levels in international guidelines, depending on factors such as how close a person is to the antenna and the surrounding environment. This is lower or comparable to RF exposures from radio or television broadcast transmitters.

There has been concern about possible health consequences of the expansion of wireless technologies. This fact sheet, based on a WHO workshop held in Geneva in June 2005 (WHO, 2005), reviews the scientific evidence on the health effects from continuous low-level human exposure to RF fields produced by base stations and other local wireless networks.

Health concerns

A common concern about base station and local wireless network antennas is that whole body exposure to the RF signals they emit may have long-term health effects. To date, the only acute health effect from RF fields identified in scientific reviews has been related to increases in temperature ($> 1^0$C) from exposure to very high intensities, that are only found in certain industrial facilities. The levels of RF exposure to people from base stations and wireless networks are so low that thermal effects are insignificant.

The strength of RF fields is greatest at its source, and diminishes quickly with distance. Access near base station antennas is restricted where RF signals may exceed international exposure limits. Recent surveys have indicated that the RF exposures from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally 1000s of times below international standards, and are similar or below those

from radio and television broadcasting antennas, which usually operate at a lower frequency.

In fact, for similar RF exposure levels, the body absorbs about 5 times more of the signal from FM radio and television frequencies (around 100 MHz) than from base station frequencies (around 1000 MHz). Reassuringly, radio and television broadcast stations have been in operation for the past 50 or more years without causing any known health consequence.

While most radio technologies have used analog signals, modern wireless telecommunications are using digital transmissions. Whether these increasingly complex digital signals will have different health effects is unknown. However, detailed reviews conducted so far have not revealed any hazard specific to different RF modulations.

Cancer: Media reports of cancer clusters around mobile phone base stations have heightened public concern. It should be noted that geographically, cancers are unevenly distributed among any population. Given the widespread presence of base stations in the environment, it is expected that possible cancer clusters will occur near a base station merely by chance. This does not mean that the base station is the cause, especially since the reported cancers in these clusters are often a collection of different types of cancer with no common characteristics or cause.

Scientific evidence on the distribution of cancer in the population can only be obtained through carefully planned and executed epidemiological studies. Over the past 15 years, about a dozen such studies examining a potential relationship between RF transmitters and cancer have been published. These studies have not provided any evidence that RF exposure from the transmitters increases the risk of cancer. Likewise, animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks.

Other effects: Few studies have investigated general health effects in individuals exposed to RF fields from base stations because of the difficulty in distinguishing their very low signals from other higher strength RF signals in the environment. Most studies have focused on the RF exposures of mobile phone users. Human and animal studies examining brain function and behaviour after chronic exposure to RF fields, such as those generated by mobile phones, have not identified any adverse effects. RF exposures used in these studies are about 1000 times higher than those associated with general public exposure from base stations or local wireless networks. No consistent changes have been seen on sleep or cardiovascular function.

Some individuals have reported that they experience non-specific symptoms upon exposure to RF fields coming from base stations and other EMF devices. As recognized in a recent WHO fact sheet (WHO, 2006), EMF has not been shown to cause such symptoms. Nonetheless, it is important to recognize the plight of people suffering from them.

From all evidence accumulated so far, no adverse short or long term health effects have been shown to occur from the signals produced by base station and local wireless networks.

Protection standards
International exposure guidelines have been developed to provide protection against established effects from RF fields by the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998) and the Institute of Electrical and Electronic Engineers (IEEE, 2005). The ICNIRP guidelines have been adopted by over 30 countries world wide.

National authorities should adopt the international standards to protect their citizens against high levels of RF fields. They should also consider monitoring the exposure levels near wireless network antennas and restrict access to areas where international guideline limits may be exceeded.

Public perception of risk and the need for proactive communication
Some people perceive risks from RF exposure as likely and possibly severe. Several reasons for public fear include media announcements of new and unconfirmed scientific studies, leading to a feeling of uncertainty and a perception that there may be unknown or undiscovered hazards. Other factors are aesthetic concerns and a lack of control or input to the process of determining the location of new base stations. Education programmes as well as effective communications and input by the public and other stakeholders at appropriate stages before installing RF sources will enhance public confidence and acceptability of them. The need for such dialogue has been highlighted in a WHO publication (WHO, 2002).

Conclusions
Considering the very low exposure levels and research results collected to date, there is no scientific evidence that the weak signals people are exposed to from base stations and wireless networks could cause cancer or any other adverse health effects.

WHO Initiatives
WHO, through the International EMF Project, has established a programme to evaluate health effects from exposure to EMF in the range from 0 to 300 GHz and provide advice about any hazards resulting from EMF exposure and any needed mitigation measures. The EMF Project has also developed a research agenda to fill gaps in knowledge, which has amounted to over $250 million spent on EMF research over the past 10 years.

The International Agency for Research on Cancer (IARC), a WHO specialized agency, will conduct an assessment of cancer risk from RF fields by 2006 and the International EMF Project will then conduct an overall health risk assessment for RF fields in 2007-2008.

Further Reading
ICNIRP (1998) http://www.icnirp.org/documents/emfgdl.pdf

IEEE (2006) IEEE C95.1-2005 "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz" (to be published in April 2006)
WHO (2005) http://www.who.int/peh-emf/meetings/base_stations_june05/en/index.html
WHO (2006) http://www.who.int/mediacentre/factsheets/fs296/en/
WHO (2002) http://www.who.int/peh-emf/publications/risk_hand/en/index.html

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