Mobile Phones – Health and Safety

By : R.G. Candiah

The mobile phone industry is one of the most buoyant industries in Malaysia. Due to the fast changes in the development of mobile technology, capital expenditure on communication services for the local telcos is expected to grow from the current RM17 billion to RM22 billion by year-end. By 2010, this capital expenditure is expected to grow to RM34 billion.

This growth is expected to continue for the foreseeable future, especially with the introduction of the 3rd Generation (3G) mobile technologies.

With this growth comes the inevitable increase in the number of base station sites, accompanied by public concern for possible impacts of these communication systems.

This feature seeks to address such concerns by providing background information on the operation of mobile communication systems as well as touching on aspects of health and safety.

What is a Cellular System?

Mobile communication networks are divided into geographic areas called cells, each served by a base station (Figure 1). Mobile phones are the user's link to the network. The system is planned to ensure that mobile phones maintain the link with the network as users move from one cell to another.

To communicate with each other, mobile phones and base stations exchange radio signals. The level of these signals is carefully optimised for the network to perform satisfactorily. They are also closely regulated to prevent interference with other radio systems used, for example, by emergency services, taxis as well as radio and television broadcasters.

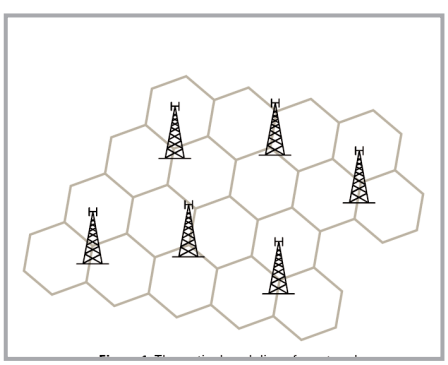

Figure 1 : Theoretical modeling of a network

How a Cellular System Works

Mobile Phones

When a mobile phone is switched on, it responds to specific control signals from nearby base stations. When it has found the nearest base station in the network to which it subscribes, it initiates a connection. The phone will then remain dormant, just occasionally updating with the network, until the user wishes to make a call or a call is received. Mobile phones use automatic power control as a means of reducing the transmitted power to the minimum possible whilst maintaining good call quality. For example, while using a phone the average power output can vary between the minimum levels of about 0.001 watt up to the maximum level which is less than 1 watt. This feature is designed to prolong battery life and possible talk time.

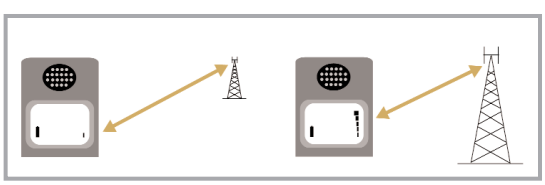

Figure 2 : Signal strength is impacted by a number of factors but proximity to a base station is one of the most important

Another aspect of a mobile network is that as the user is moving while talking, the network needs to be able to pass the call from one base station to another. This process is called a 'handoff' – literally where the network hands over the call from one base station to another, and it is undertaken seamlessly and without the caller being aware of the change.

Base Station Sites

Transmitted power levels from base stations vary considerably depending on the required area or cell that they are providing coverage for.

Typically transmitted power from an outdoor base station may range from a few watts to about 100 watts, while the output power of indoor base stations is even lower. For comparison purposes, 100 watts is equivalent to a standard light bulb used in our homes.

A base station comprises several different components – including an equipment shelter, a tower or mast which provides the necessary height to give better coverage, and the transceivers and antennas which sit on top of the tower or mast – or in some cases are attached to the top of buildings, where the building itself provides sufficient height. The antennas are typically about 15–30 cm in width and up to a few metres in length, depending on the frequency of operation.

These antennas emit Radio Frequency (RF) electromagnetic energy (also called radio waves) in beams that are typically very narrow in the vertical direction (height), but quite broad in the horizontal direction (width). Because of this, the RF energy at ground level directly below the antenna is very low.

To help assure that public exposure to EM radiation remain within established limits, antennas are typically elevated, and where necessary, fences or other means to restrict access are used together with appropriate signage to ensure that only authorised personnel can access the area immediately around a base station. The consequence of these measures is that in areas around base stations that are accessible to the public, the RF levels are typically many times below international safety limits.

There is a common misconception that emissions are stronger directly under antennas which partly explains some of the concerns about antennas placed on schools or on residential buildings.

Whatever the equipment, the radio wave intensity decreases rapidly as it travels away from the antenna. In free space, the intensity decreases to a quarter when the distance is doubled. In reality, the intensity reduces much more quickly than that due to the loss of signal strength (also known as 'attenuation') that is caused by having to pass through obstacles such as trees and buildings.

Some people have asked why base station equipment is not always placed in industrial areas or areas remote from

habitation. There are several reasons: firstly if the equipment is placed too far from the users it not only gives poor communication quality but also causes the phones to increase their output power to sustain the connection, thus decreasing battery life and talk time. Secondly, there are practical limitations to the geographic area that a base station can effectively serve, especially where there are a high numbers of users. In this instance, the base stations need to be closer together to provide increased capacity rather than coverage, forming microcells, and as a result of their proximity to one another, each base station only needs to operate at very low power levels to avoid interfering with others nearby. Therefore a properly designed network will optimise coverage and capacity and operate at only the lowest power levels necessary to provide good communications.

Health Concerns

RF fields are non-ionizing and do not disrupt the molecular structure of biological material. The globally recognised, independent 'International Commission on Non-Ionizing Radiation Protection' (ICNIRP) has released guidelines that provide levels of RF exposure that are regarded as safe for all members of the community.

All established health effects of RF exposure at the frequencies used for mobile communications relate to heating. So called 'non-thermal' effects have been, and continue to be, evaluated. To date, the view of health experts is that the literature on non-thermal effects is inconsistent and its relevance to human health too uncertain for this body of information to be used as a basis for setting limits on human exposure to RF fields.

Studies and Safety Guidelines

The biological effects of radio frequency electromagnetic fields have been studied for more than 50 years with over €200 million spent on research in the last decade alone.

The ICNIRP guidelines have been widely adopted internationally and turned into national safety standards. The guidelines apply to mobile phones as well as base station sites and incorporate wide safety margins to protect against all established health effects of RF exposure. There are no known adverse health effects at exposure levels below these guideline levels.

There are over 1300 peer-reviewed publications in the research database relating to the biological effects of RF fields. Included in these 1300 papers are more than 350 independent, peer-reviewed studies conducted at frequencies used by mobile communications. Over half of these have looked for associations between cancer and radio waves.

Information on the various studies undertaken in this field is available from the World Health Organisation (WHO) website: http://www.who.int/peh-emf/research/database/en/

However, the WHO in 2004 said:
"In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30

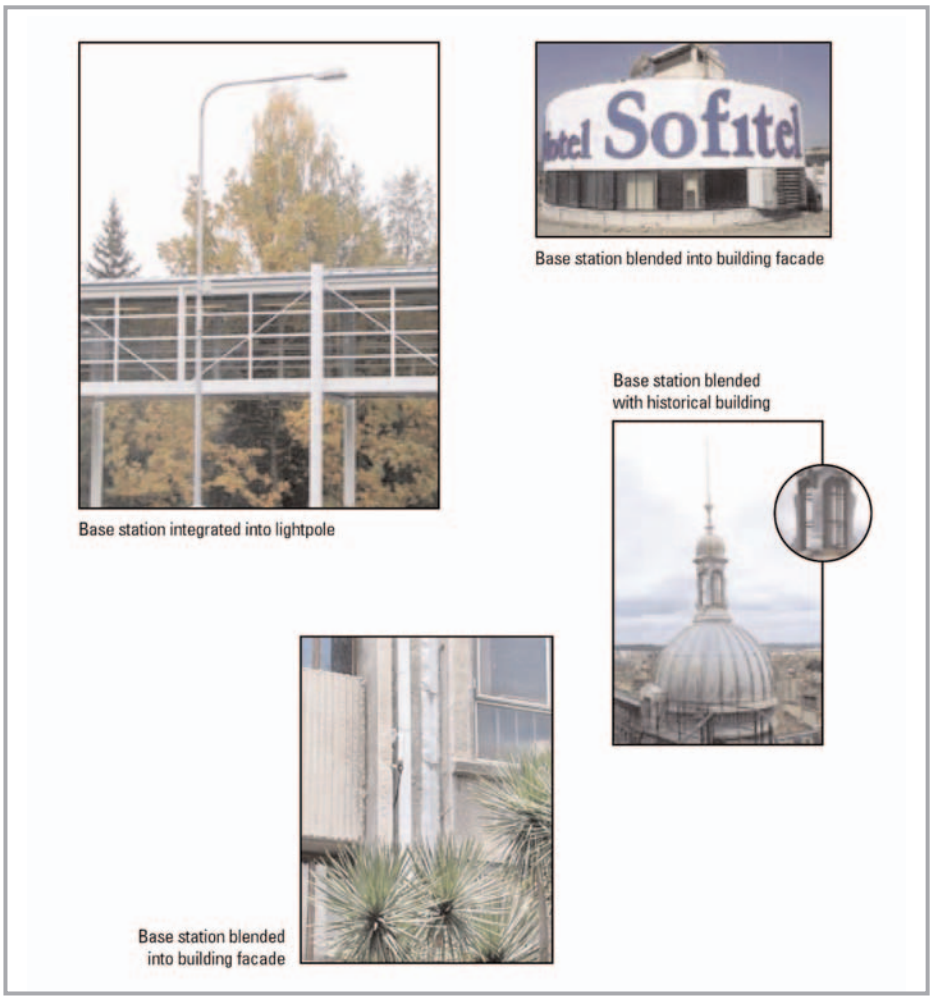

Figure 3 : Examples of reducing the visual impact of base stations

years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields."

Exposure guidelines have been developed by ICNIRP and are based on a careful analysis of the scientific literature (taking into account both thermal and non-thermal effects) and provide protection against all identified hazards of RF exposure with large safety margins.

The views of the industry concerning the health effects of RF exposure from mobile phones and base stations are based upon the conclusions of many expert review panels established by official national and international entities. These panels have reviewed the scientific literature over the past 10 years and have consistently concluded that there is no credible or convincing evidence that RF exposure from mobile phones or base stations operating within ICNIRP exposure limits causes any adverse human health effects.

Compliance with the Standards

Even though today's mobile phones only emit, on average, a maximum of a few hundred milliwatts, they are held in close proximity to the body and, therefore, expose the user to local levels of EMF exposure that are relatively higher than those from base stations.

The concept of Specific Absorption Rate (SAR) was introduced to quantify the amount of energy being absorbed by the body, and to demonstrate compliance with national and international safety standards.

The SAR of a phone is determined by operating the device near a model of the head or body. The model is filled with a liquid that exhibits the electrical properties of body tissues. A SAR probe is operated inside the model and a 3 dimensional measurement takes place to determine the highest SAR and verify that this is below the limit.

With respect to base station sites, the simplest RF propagation model is the 'free-space' model, whereby the intensity decreases to one quarter when the distance is doubled. As mentioned previously though, in reality, it drops much faster than that due to loss of signal strength caused by absorption in trees, buildings and the earth itself.

To measure the RF levels for compliance purposes, one takes the highest transmitted power and the maximum antenna focus, and uses both of these to calculate the RF energy levels at any given distance from an antenna. Generally, due to the height of antenna masts, the antenna focus and other factors, the RF emissions from base station sites are lower than the ICNIRP guidelines. In areas accessible to the public, measurements and calculations have found that the exposure levels to be far below international guidelines, typically by a factor of 500 or more.

Site Design Considerations

During the last decade, the design of mobile communications equipment has matured rapidly, with a general trend to smaller equipment offering equal or greater functionality.

In Malaysia however, the antennas of base stations have tended to remain visible, as radio engineers can achieve optimum performance when antennas are mounted on high ground or the top of buildings, away from physical obstruction (such as other buildings, trees, etc.)

Creative antenna and mast tower design is capable of significantly reducing the visual impact of mobile communications infrastructure equipment. Local state governments need to look into this. Examples of some of these creative solutions are shown in Figure 3.

Community Consultation

Despite the ever increasing use of mobile communications, the placing of communications infrastructure equipment within communities or in a visible rural location has tended to generate strong responses.

Predominately, concerns relate to the landscape being spoiled, nearby property values being negatively affected and speculation that operating the equipment will lead to illness.

In some areas, public feelings have been further heightened by real or perceived lack of consultation and factual information.

When considering the placement of communications infrastructure, it is suggested that:

- Community representatives are invited to view plans and are provided with independent factual information relating to health concerns.
- In areas of visual sensitivity, adoption of visually appealing solutions should be considered. It is important that the public is aware of such installations in order to avoid concerns that the equipment is being 'hidden'.

Sensibly designed equipment deployed after open consultation is more likely to meet the demands of the public, operators and local authorities and minimise unnecessary delays and concerns.

WLAN, Wi-Fi and Health

Wireless Local Area Network (WLAN) seems to have caught on in Malaysia as seen in cafes such as Starbucks and Coffee Beans recently.

WLAN is a flexible data communication system implemented as an extension to, or as an alternative for, a wired network within a building.

WLAN technology is being widely used to provide wireless internet access in public places like airports, hotels, and shopping centres, but it is also increasingly used in the home and office to allow computers to access the internet and network without the need for cabling. To connect and communicate, WLANs use radio waves in the 2.4 and 5 GHz range to transmit and receive data over the air.

Several studies that record the measurements of radio waves used by WLANs have been conducted by some foreign governments and by their respective industries. These studies have measured radio waves from WLANs in places where they are most commonly used, such as schools, bookstores, and office places. All these studies have shown that the radio waves used by WLANs are substantially below the required international safety limits.

When thinking about WLANs, it should be remembered that the products operate using radio waves which are the same radio waves that are a common, though sometimes overlooked, part of our everyday lives. Radio waves provide the benefits and enjoyment of television and radio as well as an increasing range of mobile communications services.

The safety of radio waves has been extensively studied for more than 50 years. This large and growing body of research has been regularly reviewed by numerous independent scientific expert panels, government agencies, standard-setting organisations and health authorities from around the world. These organisations have reached the same general scientific conclusion that there is no established evidence of any adverse health effects from exposure to radio waves when present at or below the recommended limits applied to wireless communications systems.

WLAN products are subject to the same standards that are applied to other radio products used near the human body. The standards themselves are established by independent scientific organisations, such as the International Commission on Non-Ionising Radiation Protection (ICNIRP). These standards have been widely adopted by governments and health agencies around the world, including the World Health Organisation (WHO). The standards establish exposure limits, to which products must comply, and include substantial margins of safety to protect both users and the general public.

Wi-Fi Devices

All Wi-Fi wireless products are required to be evaluated to ensure they conform to the RF emission safety limits adopted by agencies around the world before being placed on the market. These evaluations are done in accordance with the various regulations and guidelines adopted or recommended by regulatory agencies around the world such as the Federal Communications Commission.

The Wi-Fi Alliance (the Wi-Fi Alliance is a global, non-profit industry association of more than 200 member companies devoted to promoting the growth of WLANs) is currently conducting additional studies to confirm, in a variety of settings, that the radio wave exposures to Wi-Fi products consistently fall well below the international exposure limit. ■