

Your low EMF Home Articles

Your low EMF Home set of articles is separated into 9 sections, each of which can be individually downloaded. It is a 'work in progress' incorporating new information whenever time permits.

Section 5

WiFi general and WiFi technical

1. House wiring and EMFs; introduction; what are normal EMFs? Choosing a consumer unit; electric Fields; cables; demand switches; external 'faults' in the supply that can cause high magnetic fields; Wiring in homes - SAGE report July 2007
2. Dirty electricity (DE) – What is dirty electricity? What effect does it have? What sort of levels are you likely to have? What you can do if you have high levels of DE; DE coming into the house; DE generated within the house; dLAN caution
3. Lighting and EMFs; Bulbs, incandescent, energy-saving, fluorescent, halogen, full-spectrum light, daylight, light emitting diode (LED); anglepoise lamps and other metal framed lamps, halogen desk lamps, bedside/bedhead lights, spotlights, standard lamps and table lamps, nightlights; light wiring; light switches, dimmer switches; Physiological effects of blue and red lights; circadian rhythms, melatonin, light and illness, timing of blue lights, timing of red/amber lights
4. Smart meters – What is it all about? Smart Grid; Remote reading meters; Smart meters; Wide Area Network (WAN) technologies; Home Area Network (HAN); RF exposures from Smart Meters; Experiences of smart meters in other countries; Solar storms may affect smart meters
5. WiFi general – cancer; diabetes; DNA; electrical hypersensitivity; eyes; heart; heat shock proteins; immune system defects; neurodegenerative diseases; neurological effects; plant effects; reproductive effects; skin effects and WiFi technical – WiMAX; Wireless Myths 1) We've been exposed to this radiation for years, it must be safe 2) People only got affected when the scare stories started, it must be psychosomatic 3) Being on a phone for 20 minutes is equivalent to 1 year in a WiFi classroom 4) The WHO factsheet says there is no cause for concern, and they should know; Technical Information for Different Protocols
6. Underfloor heating
7. Microwaves, windows & Pilkington K glass – the glass; frames; ventilation

8. Intermediate frequency sources – CFLs; solar-power invertors; a result of DE; electronic article surveillance systems

9. References – 131 References

WiFi

In 2008, Solihull Council (amongst others) declared that WiFi is *“beneficial and safe”*. This they maintain and the Health Protection Agency comments *“There is no consistent evidence to date that exposure to RF signals from WiFi and wLANs adversely affect the health of the general population”* and *“On the basis of current scientific information, exposures from WiFi equipment satisfy international guidelines. There is no consistent evidence of health effects from RF exposures below guideline levels and no reason why schools and others should not use WiFi equipment.”* The World Health Organisation also says *“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.”*

Manchester boasts *“We’re now the UK’s on-street (and tram) capital of WiFi; the biggest on-street WiFi network in the UK”*. There are 260 ‘connected’ roads and 200 public buildings.

International guidelines on limiting the adverse health effects of RF, such as those of ICNIRP, allow for time-averaging of exposure. However, WiFi signals consist of intermittent bursts of RF energy that will exceed the average. Exposure was broadly similar in a study by Khalid ([2011](#)) in both primary and secondary schools. The maximum time-averaged field from a laptop would be about 0.3 V/m at a distance of 0.5 metres.

A new European Commission study has found that people are flocking to use WiFi Internet and the trend is set to continue. 71% of all EU wireless data traffic in 2012 was delivered to smartphones and tablets using WiFi, possibly rising to 78% by 2016. The results show how the cheaper cost of using WiFi hotspots is changing consumers' behaviour.

The most commonly reported adverse effects to low-level RF electromagnetic signals are headaches, concentration difficulties, learning and memory problems, chronic fatigue, depression and behavioural problems. These symptoms are present in many ADHD cases. Since 1997 there has been a four-fold rise in children diagnosed with ADHD – indeed the National Institute for Clinical Excellence now estimates that as many as 5% of children have this problem.

Warille ([2016](#)) concluded from their review that children's unique vulnerabilities make them more sensitive to EMFs emitted by electronics and wireless device compared to adults. Some experimental research shows a neurological impact and exposure may lead to cognitive and behavioural impairments. Because of the proliferation of wireless devices, public awareness of these dangers now is important to safeguard children's future healthy brain development.

The British Educational Communications and Technology Agency (BECTA), which had government funding withdrawn in March 2011, which advised schools on the installation of technology, said “while secure wireless networks can complement an institution's wired network, they should not replace it. A school must have a full properly wired Ethernet and/or Gigabit network and that wLAN (WiFi) Access Points may then be used to complement it.

The insertion of cochlear implants makes moderate localised differences in SAR levels near the implant (Parazzini [2011](#)).

Sangun (2015) found that exposure to 2450 MHz EMF, particularly in the prenatal period, resulted in postnatal growth restriction and delayed puberty in female Wistar rats. Increased total oxidant status and oxidative stress index values in the brain and ovary tissues were indicative of chronic stress induced by EMF. Çelik (2015) found that Wi-Fi increased oxidative stress in both foetal and newborn brain and liver. Holovská (2015) found that exposure of rats to a pulsed 2.45 GHz electromagnetic field could have adverse effects on the liver.

Çiftçi (2015) found alterations in the elemental composition of the teeth, especially affecting such oxidative stress-related elements as copper, zinc, and iron, suggesting that short-term prenatal and postnatal exposure to Wi-Fi-induced EMR may cause an imbalance in the oxidative stress condition in the teeth of growing rats. However, no effect of WiFi was found in a study of rats exposed in utero and postnatally (Aït-Aïssa 2012).

WiFi exposure induced calcium influx increase; epilepsy is involved in calcium efflux (Ghazizadeh & Naziroğlu 2014). Both the use of WiFi and the incidence of epilepsy is increasing, this may be coincidental.

Magda Havas, a researcher at Trent University in Canada, says that some schools have seen an increase in cancer diagnoses in the years since WiFi has been introduced.

Wi-Fi HaLow is intended for uses in areas such as smart home, connected car, and digital healthcare, as well as industrial, retail, agriculture, and smart city. Up to 30 km is claimed for clear line-of-sight. It is part of Imec's R & D programme developing the future internet-of-things (IoT), with sensor systems that are aware of us, our perspective and our environment and react exactly as we need or want, assisting us in an unobtrusive way.

WiFi Alliance says: *"Wi-Fi HaLow extends Wi-Fi into the 900 MHz band, enabling the low power connectivity necessary for applications including sensor and wearables. Wi-Fi HaLow's range is nearly twice that of today's Wi-Fi, and will not only be capable of transmitting signals further, but also providing a more robust connection in challenging environments where the ability to more easily penetrate walls or other barriers is an important consideration."*

Antibiotic sensitivity

The findings of Taheri (2015) show a statistically significant rise in the sensitivity of *Klebsiella pneumoniae* to different antibiotics after 4.5 hours of exposure to 2.4 GHz Wi-Fi radiation, followed by a fall after 8 hours of exposure. These observations can be interpreted by the concept of non-linearity in the responses of *Klebsiella pneumoniae* to different antibiotics after exposure to electromagnetic radiofrequency radiation. As in this study a minimum level of effect was needed for the induction of adaptive response, these results also confirm the validity of the so-called "window theory".

Cancer

2450 MHz radiation causes structural changes in the frontal cortex, brain stem and cerebellum and impairs the oxidative stress and inflammatory cytokine system. This deterioration can cause disease including loss of function of these areas and cancer (Eser 2013).

Diabetes

WiFi exposure at 2.45 GHz (1h/day during 21 consecutive days) induced a diabetes-like status through alteration of oxidative response (Salah [2013](#)). Olive leaves extract was able to correct glucose metabolism disorder by minimizing oxidative stress induced by RF in rat tissues.

Papageorgiou ([2011](#)) found that WiFi exposure exerted gender-related alterations on neural activity.

DNA

DNA damaging effects of 2.45 MHz radiation were found in rat brains (Paulraj & Behari [2006](#), Deshmukh [2013](#)). Kesari ([2010](#)) found that chronic exposure to 2.45 GHz radiation may cause significant damage to brain, which may be an indication of possible tumour promotion.

Electrical Hypersensitivity (EHS)

Two students and one teacher developed symptoms of EHS in schools using Wi-Fi. The increasing exposure to RF-EMF in schools is of great concern and needs better attention. Longer-term health effects are unknown. Parents, teachers, and school boards have the responsibility to protect children from unnecessary exposure (Hedendahl [2015](#)).

Eyes

Akar ([2013](#)) reported that exposure to 2.45 GHz MW radiation might cause alterations in the rat cornea.

Heart

2.45-GHz electromagnetic radiation caused oxidative stress in the heart of rats exposed for an hour a day for a month (Türker [2011](#)). Saili ([2015](#)) found that exposure to WIFI affects heart rhythm, blood pressure, and catecholamines efficacy on cardiovascular system, indicating that radiofrequency can act directly and/or indirectly on the cardiovascular system.

Heat shock proteins

Electromagnetic fields (EMFs) can act as inducers or mediators of stress response through the production of heat shock proteins (HSPs) that modulate immune response and thymus functions. In a study by Misa-Agustiño ([2015](#)), cellular stress levels in rat thymus after exposure of the rats to a 2.45 GHz radio frequency (RF) were examined; the RF exposure caused changes in the endothelial permeability and vascularization of the thymus.

Immune system defects

The levels of antibodies (IgA, IgG and IgM) were higher on day 7 after exposure to 2450 MHz fields compared to those on day 14 after the exposure (Grigor'ev [2010](#)).

Kidney damage

Chronic pre- and post-natal exposure to WiFi may cause chronic kidney damage (Kuybulu [2016](#)); the authors felt that staying away from WiFi sources especially in pregnancy and early childhood may reduce the negative effects of kidney exposure.

Neurodegenerative diseases

A study by Dasdag ([2015](#)) concluded that long-term exposure of 2.4 GHz RF from WiFi equipment may lead to adverse effects such as neurodegenerative diseases originating from the alteration of some miRNA expression.

Neurological effects

Jorge-Mora ([2010](#)) found dark neurons, chromatin condensation, heat shock proteins and nucleus fragmentation after exposure to 2.45 GHz radiation.

Plant effects

High frequency nonionizing electromagnetic fields (HF-EMF) that are increasingly present in the environment constitute a genuine environmental stimulus able to evoke specific responses in plants that share many similarities with those observed after a stressful treatment. In a study by Vian ([2016](#)) numerous metabolic activities were affected by low power (i.e., nonthermal) HF-EMF exposure.

Reproductive effects

Long-term exposure of 2.4 GHz RF emitted from Wi-Fi affects some of the reproductive parameters of male rats. Dasdag ([2014](#)) suggests that Wi-Fi users avoid long-term exposure of RF emissions from Wi-Fi equipment. Nazıroğlu ([2013](#)) found indications that oxidative stress from exposure to Wi-Fi and mobile phone-induced EMR is a significant mechanism affecting female and male (Saygin [2015](#)) reproductive systems. Wireless (2.45 GHz) EMR was found to cause oxidative damage in testis by increasing the levels of lipid peroxidation and iron level and decreasing vitamin A and E levels (Özorak [2013](#), Oksay [2014](#)).

DNA damage was found in the testes of rats exposed to Wi-Fi Internet access devices (Atasoy [2013](#), Akdag [2016](#)). The authors believe that their findings raise questions about the safety of radiofrequency exposure from Wi-Fi Internet access devices for growing organisms of reproductive age, with a potential effect on both fertility and the integrity of germ cells. Shahin ([2013](#)) concluded that a low level of MW irradiation-induced oxidative stress suppressed implantation, and could lead to deformity of the embryo in those that survive. They also suggested that MW radiation-induced oxidative stress by increasing ROS production in the body may lead to DNA strand breakage in the brain cells and implantation failure/resorption or abnormal pregnancy in mice. 2.45 GHz radiation was found to increase DNA damage in rat brain tissue and plasma (Gürler 2014). Yüksel ([2015](#)) suggests that Wi-Fi-induced EMR may be one cause of increased oxidative uterine injury in growing rats and decreased hormone levels in maternal rats.

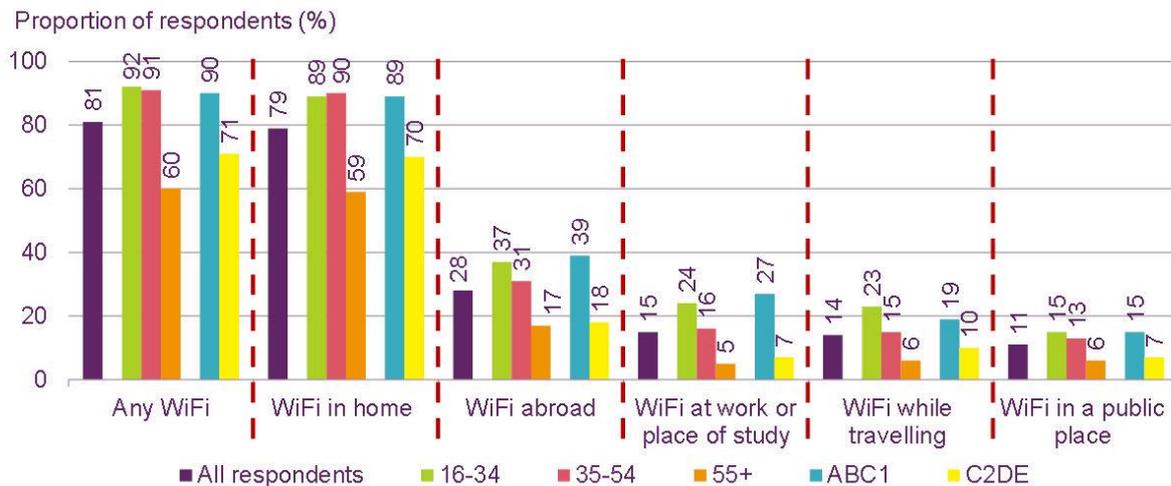
Avendano ([2012](#)) found changes in movement and vitality of human spermatozoa and DNA fragmentation in in vitro samples of sperm exposed for 4 hours to a wireless internet-connected laptop.

Margaritis (2013) found that RF EMFs, including WiFi, had statistically significant effects on *Drosophila* flies regarding fecundity and cell death.

Skin effects

Exposure to 2.45-GHz electromagnetic radiation caused significant changes in antioxidant enzymes in skin tissues (Ceyhan 2012).

Figure 5.19 WiFi access in different locations, by age and socio-economic group



Source: Kantar Media Omnibus

Base: Q.A All adults 16+ in UK (N=2,026), Q.A2 All with internet access at work or place of study (N=349), Q.A3 All adults 16+ in UK (N=2,026)

Question: Q.A Which of the following do you currently ever use, if at all? Q.A2 Which of the following ways do you access internet in your work or place of study? / Q.A3 Do you ever use any of the following to connect to the internet when you are abroad?

I also attach a graph from this extract that shows about 80% of UK adults regularly use WiFi. 90% use WiFi in their homes and in the 16 - 54 age group (parents and children) and in the ABC1 social groups. If you use it at home - why worry about its use in school? At present, on these figures, we only have about a 1 in 10 chance of people voting to exclude WiFi from schools.

That is one big reason why it is so difficult to make progress with SSITA aims.

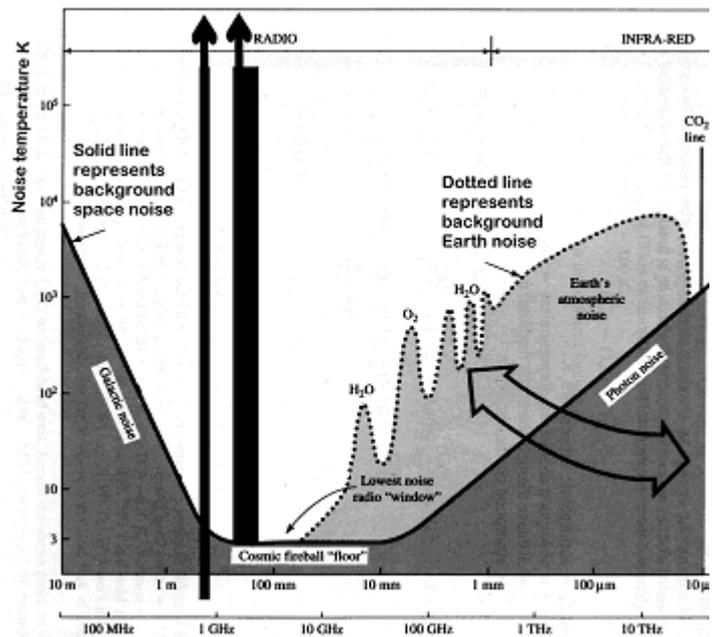
Most people really don't think WiFi (or mobile phone use) can cause any health problems - or they don't care.

Wireless Local Area Networks (WLANs) and Microwave Radiation (more technical)

Wireless Local Area Networks, also known as WLANs or (incorrectly) WiFi, are one of the more common forms of networking personal computer systems. Most internet routers that people use to connect to the internet come with WLAN capabilities, as do all new laptops. Many cafes, shops and other public areas offer free or paid "Wireless Internet" through WLANs. WLANs operate at

similar frequencies to mobile phones & mobile phone masts, and as such they have attracted some similar concerns about the potential health risks of being exposed to the microwave frequency electromagnetic fields (EMFs) that they produce.

We find the NRPB and other scientific advisers giving inaccurate information about the levels of natural electromagnetic background radiation to which the general population is exposed, and the mix of man-made radiation recently added to it. One local authority education advisor said that this "natural background radiation" has absolutely nothing to do with the "radiation" involved in wireless LANs. He is correct as far as ionising background radiation is concerned - but completely misses the point as regards natural background radiation in the microwave bands. In fact he goes on to state that "There is simply no such thing as background radiation in the 2.4 GHz region of the EMF spectrum".



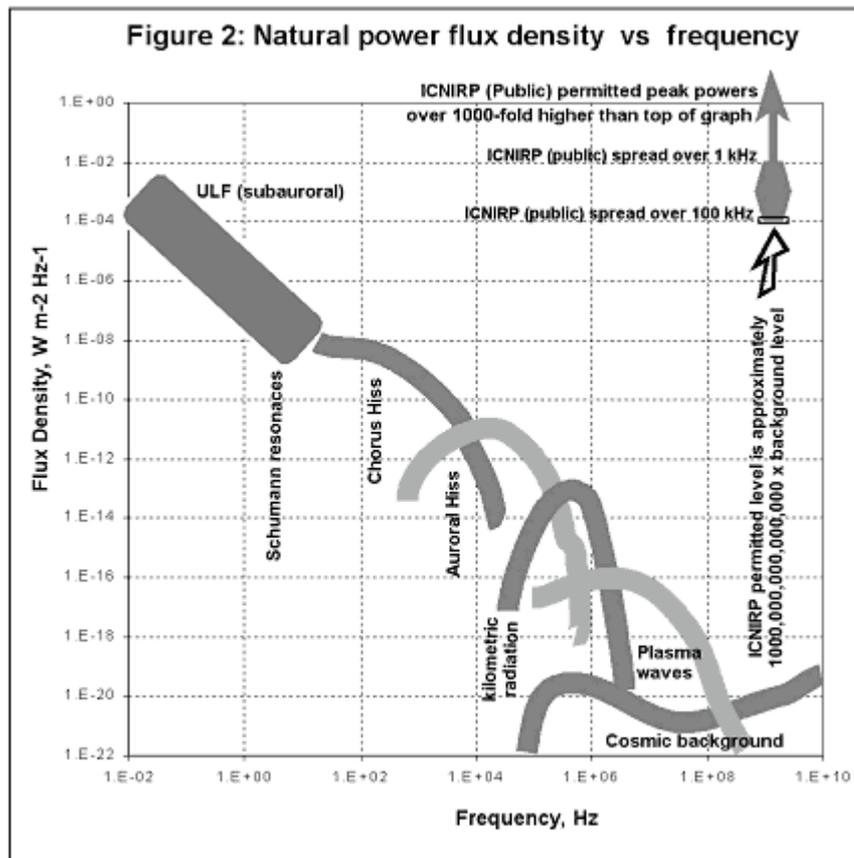
The graph above shows the natural background levels of signals in the radiofrequency spectrum from about 50 MHz to over 10 terahertz in the infra-red frequency band (approaching visible light). [1]

The two black vertical lines show the mobile phone bands and the WLAN frequency (2.4 GHz) is towards the right of the thicker line. This is in the part of the radiofrequency spectrum which has the lowest levels of natural radiofrequency noise.

Levels inside a room with a WLAN system will be off the top of the scale of this graph.

Another comment made by the experts in the advisory bodies is that the power levels in a WLAN system are too low to cause any ill-health effects. We know that nuclear (ionising) radiation is particularly powerful when used in weaponry and as X-rays. It is now believed that there may be *no safe level* of ionising radiation and that even very small levels may create serious health problems.

Current exposure guidelines for non-ionising radiation are only designed to protect the human being from gross heating effects. They are not meant to reflect any concerns about long-term chronic exposure to low levels of amplitude modulated microwaves. The concerns we have are mainly concerned with pulsing interference with the body's own signals rather than the simplistic concept of power levels often referred to. However, if for a moment we consider the power issues, the graph below shows the relationship between currently permitted levels and natural background electromagnetic power-flux densities. Note that both axes are logarithmic in order to cover a wide range. The column on the right is the relevant one and goes from 100 MHz to 10 GHz in frequency. Note that the permitted levels are over 1,000,000,000,000 times the natural flux density in the frequency band.



The maximum natural thermal background level at 2400 MHz is somewhere around $10\ \mu V/m$ (microvolts/metre), otherwise expressed as $20\ dB\mu V/m$.

The "man-made electromog" level is usually below $100\ \mu V/m$, ($40\ dB\mu V/m$), with even very strong broadcast TV (c.500 MHz) and FM radio (c.100 MHz) signals normally not exceeding $0.1\ V/m$ ($100\ dB\mu V/m$) (usually very much lower) unless you are close to a large broadcast transmission mast where they still rarely exceed about $1\ volt/metre$ ($120\ dB\mu V/m$) - and these (older type) signals do not 'pulse' in the way WLAN signals do.

The maximum levels in public places from a cellular telephone base station mast are usually between 100 and $120\ dB\mu V/m$ (0.1 to $1.0\ V/m$), with average levels between 90 and $110\ dB\mu V/m$. (0.03 to $0.3\ V/m$).

In fact, we are not worried about the flux density, *per se*. We, and many other leading bioelectromagnetic scientists, are concerned about pulsing signals interfering with our body's normal internal electrical and electro-chemical signalling systems. This is a somewhat similar process to the interference often heard on a radio, etc, from a mobile phone handset. It is an (biological, living organisms) electromagnetic compatibility (EMC) issue.

There are many scientific papers on the bio-electromagnetic-compatibility issues. Those by Professor Ross Adey [2] and Dr Gerard Hyland [3,4] are probably among the better ones. In our experience of over 35 years in the radio and electronics industries and in monitoring scientific research in these areas we are convinced that the main problem is likely to be the regular, pulsing, amplitude modulation of the signals.

There is now considerable man-made background radio-frequency noise in this part of the spectrum that can be measured with the appropriate equipment. We predict that the levels in the corridors and classrooms of a school with a WLAN system in place will exceed this range - exposing the children to relatively high levels of 'pulsing' microwaves all day, every day. It may be contained, more or less, in one room if the system is fairly small, such as for example, in a science laboratory.

The total amount of power that the WLANs emit is indeed negligible if we were to only consider thermal issues. We are concerned about the pulsing and WLAN systems do pulse (defined here as sudden changes in amplitude with time).

If you are concerned by these fields, suitable meters are available to measure these fields, such as the Acoustimeter sold and hired by EMFields. This enables a decision as to whether it is worth a more complex investigation being embarked upon. Such further investigation needs to be carried out with care - because WLANs are frequency agile, each sequential burst is transmitted on a different frequency and so the overall emission patterns can be missed on a normal spectrum analyser scan. Also, the sensing antenna needs to be small in order to pick up the hot spots. High and low levels can be found close to each other - at about a quarter of the wavelength intervals, which at 2.4 GHz is at $(12.5 \text{ cm})/4$ - i.e. they can be as close as 3 cm apart.

We have heard the inaccurate statement that "*When the computer is not doing this sending or receiving files (the vast majority of the time), there is simply no EMR being transmitted; there is no low-level, tick-over, background transmission.*" This is simply not true, and may be based on ignorance or a deliberate attempt to mislead.

The IEEE 802.11 Specification requires the master node to **continuously** transmit a control signal burst every 625 microseconds (i.e. at a burst-pulse rate of 1600 Hz). When large uploads or downloads of information are being transferred these can extend over 5 time slots (dropping the burst rate to 320 Hz).

When computers with WLANs are turned on in the presence of an active control node they synchronise and log on to the network and regularly send handshake signals to the control node. The control node transmits a pulsing signal continuously to synchronise the system and set the timing for communication with the networked computers.

WLAN access points in the 2.4 GHz band also produce RF noise in the 200 KHz to about 3.5 MHz region as pseudo random noise bursts at different frequencies that occur with the data bursts on the WLAN output. To test this, take the power of the access points, and the radio interference disappears. It is a real RF interference problem. The noise falls off fairly rapidly from the WLAN access points, by about 25 metres it is at a very low level.

That this is correct can easily be checked when the network is up and actively running, by using an Acoustimeter microwave monitor, available from EMFields.

Again, advisers have made misleading statements that WLANs "*are only allowed to transmit at 0.035 watts*" (35 milliwatts, mW). Class 1 devices are permitted to transmit up to 100 mW and Class 2 devices up to 2.5 mW. It maybe that particular models have this power limitation, but the permitted level is almost three times higher. It is similar to that from a digital cordless telephone - devices that we also believe cause adverse health reactions in some people.

The whole area of sensitive people is one which is fiercely debated and children and adults who are affected (often with headaches, tiredness, behavioural disorders, concentration problems and

memory loss, rashes, and general ME/CFS symptoms) are today usually diagnosed as having a psychiatric problem. This is well documented in a (2003) book 'Skewed' by Martin Walker [ISBN 0-9519646-4-X]. It is hardly surprising since mobile radio technology nets the Government over £20bn annually in tax revenue, and produces about 2% of Britain's GDP. In a recession, the government cannot afford to risk losing this revenue.

The symptoms bear a close resemblance to those in a study of a Latvian pulsed radio location station which emits 24 short VHF pulses of 154 - 162 MHz each second. In a study of 966 children aged 9-18 years old, motor function, memory and attention were significantly worse in the exposed group. Children living in front of the station had less developed memory and attention, their reaction time was slower and their neuromuscular endurance was decreased. The RMS field levels at their houses were low, typically only 1V/m, and a maximum level of 6V/m or $10\mu\text{W}/\text{cm}^2$ [5]. These are similar levels to those that the children in the classes with WLANs will be exposed to. In a study near the Latvian radio station, differences in micronuclei levels in peripheral erythrocytes were found to be statistically significant in the exposed and control groups. This is possible evidence of genetic changes caused by non-thermal levels of pulsed radio-frequency radiation. [6]

A study by Verloock [7] measured office exposure to WLAN networks, both with and without a wireless sensor lab environment (WiLab). The average background exposure to WLAN without the WiLab was 0.12 V/m, with the WiLab switched on, it increased to 1.9 V/m. This level could produce adverse health symptoms in workers who are electrosensitive.

In a US Defense Intelligence Agency document [8] among many concerning admissions we find the following: "*Histological examination of the cerebral cortex of rats exposed to UHF at 5 to 15 $\mu\text{W}/\text{cm}^2$ revealed the onset of sclerosis and the formation of vacuoles in some cells*". Also: "*37 persons occupationally exposed to a microwave field at 10 $\mu\text{W}/\text{cm}^2$ over periods of two to eight years were studied; symptoms of asthenic and autonomic vascular disturbances, endocrine shifts, and abnormal EEGs were observed in half the patients*". What does that mean? It means that at exposure levels in the order of those that people will be exposed to from WLANs, brain damage at cellular and functional levels had been found and reported over 20 years ago.

Reports linking RF energy with asthenias had been reported by Charlotte Silverman back in 1973, and again in 1980, as what she called "radio wave sickness". [9]

There are other ways of networking computers - with wires, fibre-optic cables and infra-red communication adaptors. These may be slightly more expensive or less convenient than the currently promoted wireless LANs - but what is the true cost to the long term health of the population, especially children? We believe that the current fast roll-out of WLAN technology, especially in schools and public places, is unwise, unnecessary and irresponsible.

We conclude that, as the WLANs are likely to be used in schools, both staff and parents should be made aware that a minority of children may experience adverse symptoms and that, if reported, these should be taken seriously and that the possibility of the WLAN system playing a provocative role should be recognised.

Alasdair Philips, BSc(Eng), DAge, MIAge, Technical Director of Powerwatch

[1] Electromagnetics with Applications, p.336, Eds Kraus & Fleisch, McGraw-Hill, 5th Ed. 1999, ISBN 0-07116429-4

[2] Adey R 1999 - *Cell and Molecular Bioeffects of Mobile Phone Fields*, in Review of Radio Science, 1996-1999, (R.Stone & S. Ueno, eds, Oxford University Press 1999, pp. 845-872)

- [3] **Hyland, Gerard**, 2000 - *The Physics and Biology of Mobile Telephony*, The Lancet V. 356:1833-6
- [4] **Hyland, Gerard**, Dec 2003 - The inadequacy of the ICNIRP Guidelines governing human exposure to the microwave emissions from base stations (circulated document). Available on the Powerwatch website.
- [5] The Science of the Total Environment 180, Elsevier, 1996, pp 87-93
- [6] The Science of the Total Environment 180, Elsevier, 1996, pp 81-86
- [7] **Verloock L et al** 2010 - *Procedure for assessment of general public exposure from WLAN in offices and in wireless sensor network testbed* Health Phys 98(4):628-38
- [8] DST 1801S-074-76, 1976, facsimile in 'Remote Viewing' by Tim Rifat, 1999, ISBN 0 7126 7908 1, pp405-434
- [9] Silverman, Charlotte - Am.J.Epi, 1973, & Proc IEEE v79, pp78-84 1980

WiMAX

WiMAX is very different from WiFi in technicalities. While WiFi is designed as a LAN (Local Area Network), WiMAX is designed as a MAN (Metropolitan Area Network). The most obvious difference is the range. While WiFi is in the hundreds of metres, WiMAX is theoretically designed for up to 30 miles! However, this is only a theoretical range, and it is expected for most base stations to have a range of between 4 and 10 miles. To achieve such ranges, the power levels have to be much higher, reportedly going up to 40W. Also, frequencies are different, to avoid clashes with WiFi. WiMAX is designed for 2-66 GHz, But so far designated frequencies are all below 10 GHz. The frequencies that have been licensed for frequent use so far are 2.3 GHz, 2.5 GHz, 3.5 GHz, 3.6 GHz, 4.9 GHz and 5.8 GHz. The European fixed WiMAX frequency seems to be 3.5 GHz.

Wireless Myths

Following the high press coverage on health effects from WiFi in early 2007, we found a number of arguments for and against the likelihood of risk. Whilst there is a case to be made on both sides (i.e. strong evidence of health effects from highly similar exposure to base stations against lack of any solid biological mechanism or actual research into WiFi itself) there is also a lot of "techie" misinformation that needs addressing:

Myth 1: We've been exposed to this radiation for years, it must be safe

From the Sun

There have been quite a few comments standard cosmic background radiation has enough microwave radiation in it for us to be affected even before the appearance of TV and radio, let alone mobile phones. The background microwave radiation (by which we refer to frequencies ranging from 300 MHz to 30 GHz) from the Sun is almost non-existent, millionths of what can be found in your local wireless café. So even if the signals themselves were the same, this claim is nonsense.

Background on Radiation Frequencies

It is accepted that X-rays can cause health problems via known mechanisms (e.g. DNA strand breaks). It is also generally accepted that visible light does not cause much harm (with the possible exception of eye-damage if the intensity is too great) during the daytime (caveat here as night-time visible light may cause health problems such as breast cancer indirectly by melatonin suppression). As any physicist could tell you, whilst both naturally occurring forms of radiation, they consist of very different wavelengths and are not comparable.

From Radio and TV

FM Radio transmissions are at about 100 MHz, considerably lower than the 900 MHz, 1800 MHz & 2100 MHz of mobile phone communications. Moreover, and we believe this is of critical importance, radio transmissions are continuous wave transmissions, and do not rely on pulsed signals to transmit data. Likewise, whilst the transmission frequency of TV is much closer (approximately 450 to 850 MHz), this is again close to continuous wave, and does not have anything like the amplitude modulation that mobile phone carriers do.

With the advent of digital radio & TV (pulsed), people are beginning to report health effects similar to those reported by residents near to mobile phone base stations.

This is crucial, not because it guarantees that there must therefore be a risk, but because it highlights that this exposure is new. We are now being surrounded and bombarded by radiation that is unlike anything we have been exposed to previously. It may be safe, it may not be, but we cannot use the argument that it has been around for years as this is not the case.

Myth 2: People only got affected when the scare stories started, it must be psychosomatic

Again, this is a quickly dispelled myth (often also referred to as a 'nocebo' effect -- basically a negative 'placebo' effect). There is an increasing amount of evidence from scientific studies (including animal, bird and insect studies which rule out the nocebo effect) that putting it all down to a psychological response is getting a harder stance to take, see the articles on Radiofrequency EMFs health risks. There are other articles (all free of charge) available on the Powerwatch website that look at the scientific debate.

Myth 3: Being on a phone for 20 minutes is equivalent to 1 year in a WiFi classroom

This statement, very unhelpfully publicised by Mike Clark, senior spokesperson for the Health Protection Agency, is both factually incorrect and highly misleading.

Whilst Mike Clark is right that a mobile phone, working on full power and with you talking continuously (not listening) can technically expose you up to about 50% of the SAR limits. In normal use, with a good number of signal strength bars showing on the display (say 75% signal level), the phone will be working at somewhere between one-thousandth and one-twentieth of this level. Let's average this at about one fiftieth as a reasonable level for the phone to be operating at most of the time. Then, if you are talking 50% of the time, this would reduce the transmitted pulses (using DTX) by another factor of 2. So, a typical exposure would not be 50% of the SAR limit but more like 0.5% of the SAR limit which we should assume to be 0.5% of the ICNIRP limit (for a typical call).

Now we come to a slightly different exposure regime in the classroom in that you are not holding the WLAN card to your head. 2.4 GHz WLANs (most common in the UK) operate at 0.1 watts output power (5-6 GHz ones can use up to 20 times this). So we have one WLAN node in the classroom (0.1 W) and, say, 20 laptops all at 0.1 W. However, they are only transmitting much power when actually transferring files. So, let's say that we have the equivalent of one laptop operating absolutely continuously (actually the combined output of 20 may well be more than this). So we have 0.2 W. Let's say that we are on average 1 metre from the antennas. This seems reasonable based on the fact that there are 20 in the room. So $E = \text{sq.root}(30 \cdot 0.2) / 1 = 2.5 \text{ V/m}$ equivalent continuous. Now the ICNIRP guidance at 2.4 GHz is 61.5 V/m. So the signal strength is 1/25th of what is allowed. Power is proportional to signal strength squared so that would be 1/625th of the ICNIRP power level.

So, we have a mobile phone call next to head typically 0.5% (1/200th) of the ICNIRP guidance. We also have being in a 20 PC WLAN classroom being something in the order of 0.2% (or 1/625th) of ICNIRP guidance, about a 3-fold difference.

Therefore 20 minutes on a mobile phone running at typical power levels would be equivalent to about 1 hour in a classroom with 20 WLAN PCs, approximately two standard lessons.

There are other differences. In the phone call situation, almost all the energy goes into the user's head and hand. In a classroom situation the whole body absorbs this lower level of power, so the "total body burden" if we were to compare it with ionising radiation (for example), would actually be very similar.

We have no idea how Mike Clark can feel justified in claiming this completely unsubstantiated and unsupportable statistic.

Addendum:

The above calculations are based on absorbed power levels, which is based on the idea that the only thing that microwaves do is heat you. As we are looking at non-thermal effects we believe that signal strength is likely to be a more appropriate metric (measured in volts per metre). This has the advantage of not being averaged over time, and we can therefore tell the difference between exposure from a continuous wave signal and one where the signal consists of a number of short pulses with gaps.

Myth 4: The WHO factsheet says there is no cause for concern, and they should know

Whilst it would be great if this was true, it also appears that they have become quite the bureaucracy when it comes to actually keeping on top of the science. The wonderful factsheet that keeps getting quoted as evidence that there is no problem can be found [here](#), and was last updated in June 2000! They have not taken into account any of Hardell's work showing an increase in brain cancer from mobile phone usage, the INTERPHONE studies, nor did they assess any of the papers shown in the rebuttal of myth 2 (which, incidentally, is just the tip of the iceberg anyway). This factsheet is so hopelessly out of date with regards to the current state of science on this issue that it should now be simply ignored.

Technical Information for Different Protocols

Applicable protocols	Frequency Range	Power Limitation	Speed
802.11b and 802.11g	2.4 - 2.4835 GHz	100mW eirp	54 mbps (20Mbps MAC Real-world) and 11Mbps
802.11a (h)	5.15-5.35 GHz	200mW eirp.	Can provide up to 54Mbps (20 Mbps Real-world)
802.11a (h)	5.47 - 5.725 GHz	1W eirp	up to 54Mbps (20 Mbps Real-world)
802.11n	5 - 47 GHz??	Unknown	100Mbps
WiMax	2-66 GHz, most likely 2.3 GHz, 2.5 GHz, 3.5 GHz 3.6 GHz, 4.9 GHz, 5.8 GHz	Reportedly up to 40w	Up to 75Mbps (45Mbps Real-world)
MIMO (multiple input, multiple output)	Varies	Varies	