ABSTRACT BOOK

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Mobile phone base stations and epidemiology

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There is currently a high level of concern in many countries that exposure to radiowaves from mobile phone base stations may be hazardous to health. Local initiatives and mass media sometimes gain significant attention by questioning the basis of protection guidelines and by claiming that radiowaves are not only associated with thermal effects but also with chronic diseases including cancer. In view of people's concerns, there is pressure on scientists and government to conduct research on possible effects from radiowaves emitted from mobile phone base stations. Epidemiologic studies, if well-designed, can contribute significantly to the clarification of this issue.
When doing such studies, epidemiologists need to define an exposure metric that can reliably discriminate between exposed and unexposed groups of people. The design of an exposure metric depends on the type of the study, i.e., whether it is a cross-sectional, a retrospective or a prospective study, whereas the type of the study is mainly a consequence of the outcomes of interest. An exposure metric is always an exposure estimation, sometimes even a rather crude one, and an estimation has always uncertainties. The quality of an exposure estimation is best reflected by its sensitivity (the proportion of truly exposed subjects that are classified as exposed by applying the exposure measure) and specificity (the proportion of truly unexposed subjects that are classified as unexposed). For rare exposures, a very high specificity is more important than a high sensitivity, because even a small proportion of false positives can lead to severe bias of the risk estimates. Using statistical simulations, epidemiologists can demonstrate which nature and which magnitude of error in the exposure measure is still tolerable.
Theoretically, potential exposure measures include measurements of the electromagnetic field strength, calculations of the electromagnetic field strength based on computer simulations, and classifications based on characteristics of the mobile phone base station. The advantages and disadvantages of each exposure metric will be discussed in the light of different study designs.
To date, regarding radiowave exposure, epidemiologic research has focused rather on electromagnetic fields emitted from the mobile phone itself than the comparably low exposures from mobile phone base stations. In these studies, particularly the brain cancer studies, exposure was estimated based on questionnaire data on mobile phone use patterns or based on subscriber data from network operators. Some ecological studies have been conducted involving environmental levels of radiowaves, however, only few of them comprised study populations that were large enough to allow meaningful conclusions. Studies in Australia, Great Britain and Italy investigated cancer rates in the vicinities of radio or TV broadcast towers, and some results were suggestive regarding a small increase in the risk of leukemia. However, due to a number of methodological concerns, no clear picture emerged from these studies. In this presentation, a brief summary of these studies will be given.

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May epidemiological studies be used to study health effects related to RF fields from base stations? Methodological considerations and reported studies as bases for discussion.

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Some few epidemiological studies investigating health effects of RF exposure from base stations have been accomplished so far. These studies have focused on subjectively reported symptoms and on cognitive performance. Cross-sectional surveys have been used. In general, this method may be useful to raise questions about an association, rather than to test hypotheses. In order to test hypotheses, case-control studies or cohort studies may be relevant. The choice of method also depends on the nature of the endpoint and of the exposure, for instance whether the exposure/health effect is rare or common, and whether the effect is acute or delayed relative to the time of exposure.

In this presentation methodological aspects of epidemiological studies will be discussed using the reported studies as examples. First, brief summaries focusing on the methods of the studies will be given.

In France Santini et al. (2002) obtained information from 530 people responding to a questionnaire about non-specific heath symptoms and about the distance to base station. Respondents living various distances (less than 300 meters) from base stations were compared with a reference group living more that 300 meters from base stations. A Spanish study conducted by Navarro et al. (2002), used the same list of symptoms that was used in France. The 89 respondents included in the study were grouped according to measured electric field in the bedroom. The questionnaire also included question about the time of exposure, the use of mobile phone, and presence of other sources of electromagnetic fields.

In Austria Hutter et al. (2002) investigated symptoms, sleep quality and cognitive performance of 336 people living in the proximity of base stations. The subjects were told that the investigation was about environmental health problems. Tests and questions, presented by the use of computers, proceeded RF emission measurements in the subject's bedrooms. Also information about air quality and noise was sampled. Age, sex, the subjective rating of health consequence of base stations, and the use mobile phone were included in the analysis as potential confounding factors.

Some of the aspects that need to be considered from a methodological point of view are statistical power, bias, confounding and the exposure assessment. With respect to the exposure, here it will just be mentioned that the distance to a base station can not be regarded as a relevant surrogate for the RF exposure since the correlation between distance and indoor exposure level is low (Schutz and Mann, 2000).

When the significance level is determined (usually $\alpha = 0.05$), the statistical power depends on different factors. Among these the difference in health effect between the exposed group of people and the reference group, and the number of people in the groups that are compared, may be controlled by the design of the study. The challenge will be to identify at least a group of people that is sufficiently strongly exposed to maximise the effect of the exposure (if there is an effect) and a group with a low exposure level as a reference group. Furthermore the number of people within each group should be sufficiently high. In Austria, the number of subjects in each of the three exposure groups varied from about 90 to 150, while in the Spanish study almost all subjects fell within the lowest exposed group leaving just a few subjects in each of the three groups with higher exposure levels. Using three or more categories with different exposure levels or doses is preferable if possible. Then a potential dose – response association may be revealed. The number people that is required in each group to obtain a sufficient statistical power should be estimated when planning the study.

Avoiding bias is essential for the interpretation of the results. Bias may for instance be caused by a low participation or response rate if selected people that do not participate differ from the participants with respect to the statistical relation between exposure and health condition. Efforts to

increase the percentage of participants are important, and if there is a low participation rate, a non-participation analysis may be useful to estimate the impact of the non-participants. The Austrian report describes in details the selection procedure. The Spanish study lacks information about how many who were not included due to neurological and psychological records.

Information bias may in particular be a problem when the subjects are aware of the exposure under consideration. An exposed person may tend to over-report symptoms compared to one that is not exposed. The subjects of the Austrian study were not informed about the reason for the investigation at the stage of the test and response to the questionnaire. However, the report does not state whether the persons who presented the tests and questionnaires knew whether the house was located in the presumably most intensely exposed area or not. A double blind design should be used to avoid possible unconscious influences. Any bias has to be avoided by a careful design of the study.

Confounding may occur when a factor is associated with the exposure and with the health effect independently of the influence of the exposure. The authors of the Austrian study included various factors as covariates in the statistical analysis to adjust for potential confounding effects. Concern about negative health implications of the base station was statistically related to some symptoms. The crude analysis suggested a statistically significant relation between base station RF exposure and sleep quality, but this relation did not remain when adjusting for the effect of *concern about base station*. This implies that taking into account concerns for health effects and possibly other potential confounding factors, is crucial. Otherwise the results may be misinterpreted.

What about exposure from other RF radiation sources, including the use of mobile phones? If the RF radiation from base stations causes negative health effects, a health implication of the radiation from other sources can not be ruled out. Thus, the study should be designed so that signals from radio and television transmitters are as weak as possible in the area of the study population, or the field strengths from these sources should be measured and treated as potential confounding factors. Also RF exposure at working places should be taken into account. The use of mobile phones was recorded in the Austrian and Spanish studies, and in Austria it was treated as a potential confounding factor. It should also be considered whether the amount of mobile phone use should be included in the analysis since epidemiological studies concerning non-specific health effects suggest a statistical correlation between minutes of use per day and frequency of symptoms (Sandström et al. 2001).

These methodological considerations are important, but are just a few of those that are needed when deciding whether or how an epidemiological study should be accomplished.

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Epidemiological Studies on Mobile Phone base Stations and Health
Possible Biological Outcomes and Study Designs

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One of the main questions considering an epidemiological study on mobile phone base stations and health is the possible biological or medical outcome. A health questionnaire survey has been conducted in Switzerland among persons, who complained about symptoms of ill health that they ascribed to exposure to electromagnetic fields (EMF). In 394 analysed answers, 74% complainants related their symptoms “for sure” to mobile phone basic stations. Mostly counted symptoms (multiple quotations allowed) were: sleep disorder (60%) and headache (40 %) followed by less pronounced and less specific symptoms like dizziness, nervousness/distress or concentration difficulties. About 20% complained about tinnitus. The symptoms appeared within a very short period of time after entering the “exposure area” and they declined slightly slower. Thus, in order to prove the causality of these symptoms with EMF, a study should be conducted that allows an investigation of acute effects under well defined exposure conditions – an experimental laboratory study or an “experimental field study”. The study should concentrate on hypersensitive persons. A closer investigation of the Swiss survey or a dedicated pilot study might be useful to investigate whether sleep disturbances or headaches ascribed to EMF have somewhat differentiated pattern than the ones ascribed or associated to other causes, for example noise.

Are epidemiological studies on possible health impact from base stations useful?

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Epidemiological studies alone are not capable to prove causal relationships. They can be useful tools in identifying possible health hazards provided sufficient reliability can be achieved in qualitative and quantitative exposure classification. From a scientific point of view at present there is insufficient basis for performing epidemiological studies of the health impact of mobile telecommunication basestations. A number of limitations would not allow to resolve small risk factors, should they exist, nor would it be possible to demonstrate the absence of a health risk.

If for political reasons such studies would be considered as a tool in the risk communication process, there is a high probability of such an approach being counterproductive in communicating risk to the public. If there is a health risk from mobile telecommunication systems (MTCS), it should first be seen in epidemiological studies of handset use.

There is, however, a need to develop better tools for exposure metrics and to monitor the mobile telecommunication systems exposure situation in Europe. More work is also required on the study of weak field effects and the development of biology- and health- related assessment methods for the complex exposure situations that are already being encountered today and are expected to become even more common in the future.

Reliability of the Exposure Assessment Next to Base Stations

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INTRODUCTION: The introduction of the digital GSM 900 / DCS 1800 systems in the 1990s led to an important deployment of mobile phones. Latest developments in mobile communications, e.g. UMTS, will intensify this process. Today about 1 billion people are using mobile telephones world-wide, about 360 million people of them in Europe. The frequent use of mobile phones has triggered an important deployment of base stations. The number of base stations in a country depends on several factors as the number of network providers, the number of users and the topography. In Austria more than 16,500 GSM base stations are in operation and in France there are about 30,000. Such base stations are often situated close to dwellings or houses and have become the reason for concerns of parts of the population in recent years. The requirements of international and national laws, regulations, guidelines and standards on the one hand and scientific needs on the other hand make the development of measurement procedures adequate to assess exposure in the complex vicinity of base stations necessary.

PROBLEMS: The exposure levels of the general public in the accessible environment of base stations depend on several physical phenomena as reflection, diffraction, multi - path propagation and diffusion. This leads to the situation that the electromagnetic field levels in typical environments of base stations vary both in space and time. Recently performed investigations by the company Seibersdorf research show that the power density levels of one BCCH channel of GSM base stations can vary up to two order of magnitudes within restricted areas (about 1 m³). The next table gives some results of these preliminary investigations .

Scenario	Distance (m)	Smax (mW/m²)	Smin (mW/m²)	Savg (mW/m²)	Ratio between Smax and Smin
GSM 900, no direct view	200	0.000048	0.0000003	0.0000051	173
GSM 900, direct view	60	0.3774	0.01194	0.08825	32
DCS 1800, no direct view	2500	0.0009	0.00003	0.00019	31
GSM 900, direct view	12	17.7618	0.06051	2.42606	294

Table 1: Maximum, minimum, averaged power density and ratio between maximum and minimum of the signal of the respective BCCH channel. In the first column “scenario” the respective frequency band and the conditions of view (line of sight or no line of sight from the measurement location to the base station) are given. In the second column information on the distance between measurement location and base station is given.

Apart from the considerable variations in space also variations in time have to be taken into account. The variations in time are typically in the same order of magnitude as the variations in space. These important variations show that the selection of an adequate exposure assessment protocol is crucial.

DISCUSSIONS: The requirements of the R&TTE directive make it imperative to judge exposure of the general public using reliable assessment procedures. Based on the mandate M 305 of the European Commission, the Technical Committee TC 106x of CENELEC is currently in the process of developing standards including procedures to assess exposure in the environment of base stations. In the frame of the ongoing work laws of field distributions are derived to make reliable and reproducible exposure assessment possible. First preliminary results indicate that the type of field distribution depends strongly on the exposure scenario. Several aspects like indoor versus outdoor exposure and line of sight conditions from the examined area to the base station seem to have an impact on the type of distribution, e.g. LogNormal and Rayleigh distributions and need to be considered while deriving laws of field distribution. The possibility to perform epidemiological studies

to examine imaginable adverse or annoying effects of the electromagnetic emissions of mobile communication base stations is nowadays very controversially discussed. Currently discussions on the design of a feasibility study for such epidemiological studies are ongoing between several international and national institutions and organisations.

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Compliance verifcation versus exposure assessment: different endpoints for exposure measurements

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Measurements of the exposure to electromagnetic fields around base stations have until now mainly been executed to check the compliance of the base station with the exposure limits. To assure that the exposure limits are never exceeded, the exposure is assessed considering the worst-case situation. However, the worst-case exposure is not a good measure for the actual exposure. An intermediate approach between exposure assessment for compliance verification and exposure assessment for a specific individual with a personal dosimeter, is the assessment of the average exposure at a location. Several techniques for the exposure assessment for compliance verification can be reused or extended, but since the endpoint is different, the measurement procedure has to be adapted to obtain a good estimate of the actual exposure.

The developed procedure will be strongly dependent on the exposure metric that has to be assessed. Although there is no consensus yet about which exposure metric has to be used, there are some views that also the evolution in time of the SAR should be included. For compliance verification, it is sufficient to compare the measured electromagnetic fields with the reference levels. However, since these reference levels have been derived from the worst-case exposure situation, also the angle of incidence of the electromagnetic waves and their polarisation should be assessed to be able to estimate the actual whole-body SAR.

The detector of the measurement devices should also be chosen in function of the actual exposure assessment (e.g. RMS in stead of peak detector). To assess the short-term time variation of the exposure (due to the variation of the emitted power at the base station), different site categories may be defined. The evolution of the exposure in time can then be extrapolated from a momentary measurement and the typical variation of the emitted power for the particular site category. Prediction of the long-term future exposure is almost infeasible since it depends on many uncontrollable parameters, while estimation of the historical exposure is very difficult due to the lack of information about the electromagnetic sources present in the past.

Because the assessment of the actual exposure is no longer focussed on one source, measurements should be made in more positions, and the choice of the positions should be aimed to obtain a good sample of the exposure at the location. Averaging should not only be done locally (i.e. around the measurement position), but also over the whole area under consideration.

Simulations are a good alternative for actual exposure assessment, provided that enough information about all the present sources is available. Moreover, some gaps remain between the predicted exposure levels outdoors and the indoor exposure.

Many techniques developed for the compliance verification of base stations can be re-used for the exposure assessment around base stations. On the other hand, since the objectives of exposure assessment are quite different from the goals of compliance verification, the measurement procedure has to be reconsidered, leading to more time- and cost-intensive measurement campaigns.

Exposure to Electromagnetic Radiation from GSM and UMTS Base Station Antennas

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This paper discusses existing processes for measurement of GSM and UMTS signal strength on different scenarios, regarding base stations compliance evaluation with radiation exposure limits. Recommendations to minimise exposure from base station antennas radiation are also established. Propagation models are used and their importance to base stations security evaluation is analysed. A measurement campaign to collect real data from base stations in Lisbon area is described. A specific measurement protocol was developed. Radiation reference levels established by international bodies were never exceeded on the analysed base stations. The worst-case detected was 13.58 dB below security limits established by CENELEC and adopted by the European Union Council. Nevertheless, in general, the measured situations were at least 22.4 dB below the limits. Scenarios where the difference between measurements and limits is lower are exposure on buildings rooftops with base stations and indoor installations.

National EMF measurement programm in Germany

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RegTP's National EMF programme measures field strengths at selected locations to document the effectiveness of its site certification procedure.The field strength levels at over 3,600 sites were measured and compared with the limits in place to protect persons exposed to RF radiation.

In the 1999-2000 and current 2003 measurement series limits of the European Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) were applied.

The National EMF measurement programme has been drawn up so as to allow half of the locations to be chosen by the environment ministries of the federal states.
The focus is on busy streets and squares, and other public places such as schools, nurseries and hospitals.
The measurements were made by staff from the Reg TP's regional offices, following a uniform procedure. The magnetic field strength was measured on frequencies up to 30 MHz and the electric field strength on frequencies above 30 MHz. The field strength levels measured were summed up according to the Requirements of the Council Recommendation and expressed as a fraction of the limit.

It was found that the field strength levels measured at one site are not generally representative: each level is both time-sensitive and subject to local conditions. Hence past attempts to record and present field strength levels in cartographic form seem inappropriate.
Field strength levels **are time-sensitive** because not all theoretically possible electric, magnetic and electromagnetic fields are present all the time.
Field strength levels **vary with location** because the electric, magnetic and electromagnetic fields depend considerably on the on-site conditions.

Conclusions

Due to the limiting effect of the site certification procedure to the field strengths at each transmitter site it was found that none of the levels measured at any of the sites exceeded the limits.
Detailed results are available on the Reg TP's web site at www.regtp.de.

Selective measurements of particular signal sources (i.e. Measurement of the exposure from mobile base stations only) do not allow to draw conclusions on the compliance with the European Council Recommendation. Compliance can only be shown, when the field strengths of all relevant signals are summed up according to the requirements of the Council Recommendation.

The measurements carried out in Taucha show that the contribution of Mobile Base Stations to the overall exposure is very small. This tendency can be found in most test locations in Germany.

In order to be able to compare results it is crucial that a uniform measurement procedure is used. RegTP successfully uses the national Test Instruction RegTP MA 09/EMF/3 which is based on ECC Recommendation (02)04.

Electromagnetic Field Measurement Campaign in an Urban Environment. Exposure Levels in the City of Carthagene.

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In the last few years, society have witnessed the installation of an ever increasing number of radio base stations as a necessity for handling new capabilities and services to the large number of users. This rapid development of wireless networks, however, has induced a marked mistrust attitude into people who fear possible biological effects of electromagnetic emissions from mobile communications base stations. While there are guidelines on the limitation of human exposure to electromagnetic fields (EMF), there are no standard measurement procedures to evaluate compliance with the limits on exposure in the vicinity of a base station. The measurement procedure has to be practical in view of the large number of base stations that have to be assessed and rigorous to guarantee that the limits on exposure are not exceeded in any accessible location within the coverage area of a base station.

In that sense, this paper presents some results obtained during a rigorous measurement campaign developed over the main cities at the Mediterranean coastline of Spain, exactly in the provinces of Valence, Alacant, Castellón, Balearic Islands and the Region of Murcia. The specific results detailed in this paper as an example of the campaign correspond with base stations located in the city of Carthagene, an historical and middle size city in the south-east coastline of Spain. Procedure followed to get the exposure level have been clearly defined and can be found in references, and was partially adopted, with minor changes, by Spanish Ministry of Science and Technology through the *Colegio Oficial de Ingenieros de Telecomunicación (COIT)*. The procedure has been conducted over 1200 different base stations, and has been included in a short term mission for base station compliance testing all throughout Europe.

Electric field levels obtained over the whole campaign are well bellow the decision levels and therefore, below the reference levels established by the Council Recommendation. The narrow-band stage has only been employed for a deeper insight knowledge, and only in a reduced number of cases the reference volume, were reference levels could be surpassed by means of theoretical calculations, was overlapping the zone where people can usually stay, which made the operator amend the installation to avoid such situations.

Results of a Measurement Programme Concerning Mobile Phone Base Station Emissions in North Rhine-Westphalia

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This paper summarises the results of a measurement study, performed by IMST GmbH and financed by the Ministry of Environment and Nature Conservation, Agriculture and Consumer Protection, North Rhine-Westphalia. The measurements were performed on 87 measurement places around 24 base stations. The here described study differs from similar measurement campaigns in the following points:

- The emissions were investigated *systematically*,
- Most of the measurement places were not outside, but *inside buildings*, and
- Starting from the results, a *categorisation* of the base stations was discussed.

On some sites, RF emissions emanating from cordless telephones, broadcast and TV towers as well as other sources were measured additionally to compare the base station emission with.

The measurements were performed with a combination of broadband isotropic field probe and frequency selective spectrum analyser equipment. Special attention was laid on an accurate maximum finding procedure in indoor sites due to the locally rapidly varying electric fields there. All temporary measured values were extrapolated to the maximal operational state of the base station.

Although all measurement places were in direct vicinity of the base stations the results show, that all measured fields are well below the ICNIRP limits. The Swiss "Installation Limit Value (ILT)" was exceeded at only one place, although a few sites reached the ILT nearly. As an interesting point it was discovered, that the radiation directly below the base station antenna is not always extremely low, but may reach values in the ILT region as well. This seems to be contradictory to the so called "umbrella effect". A 24 hours instantaneous measurement impressively shows the dependence of the time varying traffic on the emissions.

Finally it was tried to divide base station installations into different categories, depending on morphographical as well as technical parameters. The idea was to look for possibilities of predicting the radiated fields in surrounding sites just before the installation of the station. Although the categorisation was done carefully, the results showed that the radiated fields in similar sites around stations of the same category were completely different, suggesting that the variety of existing base station installations is too large for an easy categorisation.

Basic Requirement of a Personal dosimeter

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The increasing number of radio base station has induced questions about possible health effect. As it has been analysed by many measurement campaigns (such as in France by the ANFR[1]) the exposure induce by mobile base station is weak and well below the sanitary limits. In spite of these statements, the public concern about these antenna still exist and the introduction of new system such as UMTS as well as WIFI will reinforce questions. Dealing with the analysis of possible correlation between exposure and disease the weak chain is often the exposure assessment. This question is at the centre of the feasibility of an epidemiological study asked by many people. Many studies have been done to estimate at a given place the electric (E) field associated with an electromagnetic (EM) field. In situ measurement protocol have been established at national level, studies are still on going and European Standardisation Bodies such as CENELEC will output harmonised methods. On the other hand, since people are moving between apartment, their job, restaurant and other social activities, these approaches are not suitable to determine the E field strength distribution of the EM field which people are exposed during the day. To estimate the exposure there is two ways. The first approach consists in measurement at the location where the person spend a significant time, these measurement can be done using the existing isotropic and frequency selective systems. This approach is quite heavy and should modify the be behaviour of the person under test (P.U.T). The alternative approach is a personal dosimeter, wearing by the P.U.T and able to record the exposure versus time. In this presentation will analysed the basic requirements of such system. The main specifications can be classified in few categories: frequency, sensibility, isotropy and bulk..

The volume is an important parameter to avoid any interference with the behaviour of P.U.T. The analysis of medical equipment (eg heart monitoring) having the same objective of monitoring shows that a box of 15cm*10cm*4cm, able to be worn, is acceptable without any discomfort if the weight is less than 700 grams.

The second important feature is linked with the frequency analysis. Measurement campaign have shown that the main exposure contributors are FM, TV, PMR, Cellular network and WIFI. The system has to be able to record specifically the exposure induced by these sources. Dealing with GSM and UMTS, at the place where people leaves, the emissions of handsets should be equivalent or higher than those of base station. Since the objective is to answer to people having concern about base station the GSM and UMTS the uplink and downlink have to be measured and recorded separately.

The isotropy and sensitivity are the last important parameters. The objective is not to carry out measurement in the vicinity of base station therefore the sensibility of the system has to be compatible with the exposure encountered in the location where people are leaving. The measurement campaigns have shown that the incident field are below few volt per meter. On the other hand the objective is not record emission below few tenth of volt per meter. Therefore the range [0.1v/m 3v/m] seems to be a reasonable target value. The isotropy is the last parameter, the presence of the person has a large influence on the pattern of the probe. Therefore the isotropy is limited.

This short overview show the challenge of an integrated dosimeter. Since the accuracy will be limited such system seems to be of interest if the if the objective is to create classes of exposure The main problem is to estimate the global uncertainty of such integrated system.

The presentation will analyse theses questions. Specifications as well as feasibility will be discussed according to the objective.

Dosimetric emission measurements as an indicator of exposure of people in the vicinity of mobile phone base stations

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In recent months, the following question has been discussed: can the subjectively observed adverse health effects of people living in the vicinity of mobile phone stations be objectified through epidemiological studies.

These studies, among others, are only of significance when the exposure rates of individuals being investigated can be sufficiently, accurately and reliably determined during the course of the investigation. What is called for here is a wearable HF dosimeter which can be used to measure and record individual HF-field exposures over a 24 hour period. To date, this type of device has only been available on the market for low frequency magnetic fields.

Within the framework of this article the essential technical characteristics of such a HF dosimeter will be specified. Two possible device concepts (narrowband measurements with a spectrum analyser module or a wideband senor with frequency selective filters) will be comparatively presented.

As far as it is possible the electromagnetic fields having an effect should be recorded as direction independent, at the same time the effects on the human body have to be minimised. Moreover the beginnings of a possible solution for a suitable antenna concept will be presented.

Considerably less effort is required when determining emissions, if measurements for people are not recorded on a 24-hour basis in their daily living environments but only for the extent of the exposure in individual rooms of a private flat, especially in those rooms where people spend a great deal of time, (e.g. bedrooms).

This procedure, for example, could be adequate in studies for those being investigated who are exposed in their sleeping quarters to emissions from mobile phone base stations which are higher than the above-average guidelines.

In the meantime, by means of a new isotropic and frequency selective sensor,
it is possible to record the extend of exposure in rooms for both short-term measurements and for measurements recorded over a longer period of time. In comparison with wideband procedures where only the emissions caused by mobile phone base stations can be quantified, with this device it is also possible to identify other possible sources of exposure, e.g. radio and TV transmitters. This kind of measuring system will be presented.

Within the framework of this type of epidemiological study, it is vital that a considerable distinction be made between people or flats which are considered to be “high” or low” in terms of exposure. Typical results from our own exposure measurements show, in an exemplary way, which exposure values concerning mobile radio could occur in flats labelled “high” and which inter-daily fluctuations can be expected due to the changing volume of calls.

Realistic modeling of BTS antennas and human body for numerical dosimetric studies

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The accurate model of both the antenna and the human body is the crucial input source for E-field predictive codes both in near and far field. In the former case, it allows the absorption in the human body to be calculated; in the latter, the knowledge of the complete radiation pattern improves the E-field prediction accuracy at locations far from main irradiation lobe.

The following steps were followed:

1) The FDTD model of a commercial GSM 900 MHz base transceiver station dipole-array antenna has been generated. It has been obtained by inspection and direct measurement of electrical and mechanical characteristics of the actual antenna. The results so obtained, both in the near and far field (radiation pattern), have been compared with E-field measurements in anechoic chamber, and with the results obtained from a freeware MoM code (NEC). As expected, the model accuracy depends on the matching between actual (precise) and FDTD (discretized) mechanical lengths of metallic parts. Instead, there is non-significant dependence of the simulated results on other implementation choices, such as the dipole excitation technique, its temporal waveform, and the FDTD representation of metallic parts.
2) A numerical dielectric model of the human body was obtained. A Magnetic Resonance Imaging (MRI) tomographer was used to directly map water content and consequently complex permittivities.
   It is different by the commonly used techniques which are based on diagnostic images processing to identify different regions/organs and assignment of dielectric values to them. The proposed method provides a phantom in which permittivity varies with continuity even throughout the same organ and presents a wide spectrum of values which reflects the intrinsic realistic spatial dispersion of such parameter.

Both the antenna and the body models have been validated against known solutions and measurements. The final goal will be to embed the models in a large FDTD grid, possibly making use of subgridding techniques, to evaluate the absorption of human subjects exposed to BTS antennas in near field.

Neuropsychiatric and psychological effects of exposure to electromagnetic fields

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Over the past decade there has been increasing concern among scientists, health authorities and the general public about the possible negative health consequences of exposure to electromagnetic fields (EMF) emitted by mobile telephones and their base stations, radar installations, power lines and other sources. When investigating the health effects of any kind of exposure it is important to distinguish between direct and indirect health effects. Direct effects are those effects, which are directly attributable to the biological impact of the exposure on the living organisms. With indirect effects we mean any effect, biological or other, which is a consequence of the individual or societal response to the exposure. This may be physical, e.g. increased risk of car accidents associated with the use of mobile telephones while driving a motor vehicle, or psychological, e.g. fatigue due to monotonous work with computer screens, or a stress among workers in radar stations. Although theoretically straightforward, in practice it usually very hard to distinguish direct effects and indirect effects form one another, and from spurious associations. In this presentation I will focus on psychological effects of EMF and more specifically on the putative syndrome of "electric hypersensitivity".

When considering the subject of psychological effects of EMF it is important to realize that these effects are usually incurred by exclusion, i.e. when an adverse health effect has been demonstrated to be present and other, biological effects are sufficiently excluded. In the case of exposure to EMF neither of these conditions is fulfilled unequivocally. First, there is the real possibility of effects of EMF on the brain itself. There is now a growing body of evidence, albeit not entirely consistent, that EMF in extremely low frequency (ELF) and radio frequency (RF) wavelengths may have a direct impact on the nervous system, both in vitro and in vivo. The most clear-cut and best researched example is the therapeutic application of slow repetitive transcranial magnetic stimulation (rTMS) to the brain as a novel treatment for a range of disorders. rTMS is now a promising new treatment for depression and hallucinations in patients suffering from schizophrenia. It has also been reported as potentially beneficial in combating suicidal behaviour multiple sclerosis and involuntary movements in Giles de la Tourettes syndrome. One of the interesting features of the research into these therapeutic effects on the brain is that they seem tot produce different results depending on a large number of variables, such as frequency, strength and location for the exposure, and possibly a number psychological variables defining traits and states of the exposed persons. It is precisely these later observations, which give food to speculations about possible physical explanations for the controversial syndrome of "electrical hypersensitivity".

On the other hand it has been suggested the exposure to EMF may induce a non-specific syndrome of physical and psychological complaints among sensitive individuals through entirely psychological mechanisms. Several authors have pointed out the phenomenological similarities between the syndrome of electrical hypersensitivity and syndromes which are regularly seen after exposure to other agents which are believed to hazardous, e.g. ionising radiation, toxic chemicals after technological accidents, chemical or biological weapons during the first Gulf War, and multiple chemical sensitivity to food additives. So far the evidence for strictly psychological effects of exposure to potentially harmful agents is mostly circumstantial. However there are number of studies which show the occurrence of non-specific complaints under conditions of sham exposure. These studies seem to confirm that such exposures may have a nocebo (as opposed to placebo) effect. Especially of interest are a number of studies, not related to EMF exposure, which show the importance of information and other context variables, which moderate this nocebo effect. The relevance of these findings will be discussed in the light of the need for public information about the potential health hazard associated with the exposure to EMF's.

Exposure to EMF from base station antennas: subjective symptoms and cognitive functions in ”sensitive” subjects – study setup

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In the Netherlands, the Monitoring Network on Health and Environment is a non-profit, non-governmental volunteer's organisation, which registers environmentally related health complaints. The Network has a registry of people who have presented with complaints they attribute to exposure to electromagnetic fields and / or living close to antennas. This population might possibly be considered as a 'sensitive' group of people and it was considered an interesting population to study the effects of EMF exposure. An experiment was set up in which a number of these subjects and an equal number of non-complaining controls would be exposed under double-blind conditions in an anechoic room to 900 MHz, 1800 MHz or UMTS-like EMF. Complaints are registered with questionnaires that are filled in before and after sessions. During sessions several cognitive functions are determined with computer-run tests. The experiment is expected to be completed by the end of April. Results will be available within a couple of months

Sleeping disorders associated with mobile phone base stations: A pilot study

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Background: In recent years an increasing number of people have been reporting symptoms of ill health which they attributed to the setting up of new mobile phone base stations. A questionnaire survey in Switzerland revealed that the most frequent complaints are sleep disorders (*Röösli et al. 2002*). We developed an epidemiological study design to examine these complaints more systematically, and tested its feasibility under real life conditions in a pilot study of 24 persons.

Methods: We aimed to conduct a panel study in the vicinity of a future base station site during the process of setting the station up. Because the date transmission started is not known to the public, this design may allow the distinction between psychological effects (due to the building of a station) and physical effect (due to radiation). In the event, we could only examine the period during which the station was set up due to time restrictions and lack of appropriate sites. Study participants were recruited from areas that were expected to be most heavily exposed. The project was communicated as a study on the impact of the environment on sleep disorders. Study participants filled in a sleep diary every evening and morning during 6 weeks (the mast was set up on day 16). Every Wednesday morning we collected samples of first void urine to determine cortisol levels. In one participant we also tested an actiwatch device to record activity during the night. At the beginning and the end of the study period we performed a home visit and asked about exposure to various environmental factors (e.g. indoor and outdoor noise) and measured radiation in the radio and microwave frequency range.

Results: The pilot study revealed that most participants filled in the diary diligently during 6 weeks. Only two of 24 diaries were of insufficient quality. Preliminary analyses of the diary data indicate that sleep variables can be modelled adequately. Further analyses will be performed (and presented at the workshop) to evaluate the explanatory power of cortisol and activity data. Furthermore, data on within- and between-subject variability will be reported.

Conclusions: Collaboration with telecommunication companies is necessary to make such studies possible. Close collaboration could allow manipulation of exposure if dummy signals were used and radiation was interrupted within the framework of a randomised controlled trial. An important drawback of this approach is that only short-term effects can be investigated. Cross-over designs in which participants represent their own control are the preferred design if between-subject variability is large. This pilot study will inform the design of a future large scale trial planned in Switzerland.

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Perceived sensibility to physical noxes - a psychological approach

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The purpose of this paper is to present a research project of which important parts have already been carried out. The theoretical background might be described as follows. What might psychology contribute to the question formulated in the title? A psychologist's ideal research situation would be like this:

Physical input variables, measured objectively, and applied at random in a doubly blind experiment
  acting on
person, to be described by relevant organismic and psychological variables
  producing
"objective" output variables (like mortality or morbidity), and
"subjective" output variables (accessible only through self-reports).

In such a situation one would be able to attribute, by means of statistical methods, definite portions of the output variables to the physical input, the personality conditions, and possible interactions between them.
The research project in question includes over 6000 inhabitants of Heidelberg (Germany) of age 33-46 between 1971 and 1978 of whom the following data are available:
1. some general personality variables introduced by Grossarth-Maticek (like "self-regulation" or the six personality "types" (dimensions)) which have proved to be psychosomatically relevant;
2. habitual tendencies of attributing the causes of personal problems to the self or the social (human) environment or the physical environment;
3. an attempt has been made to assess, by means of a complex interviewer rating, tendencies of repressing or displacing social conflicts.
In particular, subjects answered questions about potential adverse influences of various physical factors like passive smoking, air pollution, chemicals, and electricity on their health and well-being. Mobile telephone transmitters did not exist at the time. In addition, data about nutrition, smoking, alcohol consumption, physical activity and body weight were collected.
The intention of the research project is to retrieve the subjects and to collect data about their current perception of being adversely affected by mobile telephone transmitters in their neighbourhood. Grossarth-Maticek has particular hypotheses about the mediation of this response by his personality and attributional variables. At the same time, general health variables would be assessed (mortality, in any case, would automatically emerge on retrieval) and related to the personality and attributional traits.
Perhaps it will be possible to set up a rough estimate of physical exposition by assessing subjects' residential and occupational history and relating it to the time of installation and the energy of the mobile telephone transmitters in the neighbourhood of these places (through an inverse squared distance law). It would be interesting to see whether, if some relevance of the physical input is established, it is not only complemented, but also mediated by the personality variables. A possible irrelevance of the physical input, however, could hardly be established this way because the estimate may be far too crude. On the other hand, knowledge of the presence of a transmitter may well lead to something like an inverse distance law of perceived influence.
In any case, if the psychological variables turn out relevant, this would furnish a systematic explanation of variations in subjective output variables even if experiments like the above-mentioned ideal one would establish complete irrelevance of the physical input.

Interviews with people with perceived symptoms related to mobile phone base stations

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In connection with the extension of the new 3G network, many people contacted net operators and our institute and expressed concern about health aspects. Most of them claimed that they had subjective symptoms related to a nearby base station. At this point we decided to do a structured interview with a number of people who relate their symptoms (or the symptoms become aggravated) by just being near a base station. The study was performed as a degree project in Psychology at Umeå University by Magnus Lindfors and the work was done at our department at the Institute for Working Life, Umeå.

The study was divided into two parts. The first part was a structured interview to find out about the symptoms and what action they had taken. The second part was a qualitative study based on telephone interviews with focus on risk perception in connection with the extension of the 3G network.

An advertisement of the project was done in 10 daily newspapers in Sweden during a period of 14 days. The reader was asked to call us for an interview if they had symptoms related to base stations. Only 18 people responded to the request. Seventeen of the respondents claimed that they were “electrical hypersensitive” and reacted to other electrical and electronic equipment as mobile phones, fluorescent tubes, DECT phones, TV sets, VDTs, electronic article surveillance systems etc. The most common reported symptoms were difficulties to concentrate, headache and fatigue. As a mean, the respondents reported 8 symptoms each out of the 12 listed symptoms. Fifth teen of the eighteen respondents had earlier discussed the problem with the authorities, the net operators, the press or medical experts. Many of the respondents were members of the Swedish Association for the Electrosensitive.

The qualitative study was based on phone interview with 11 of the respondents in the first study and focused on the following contents:

- Consequences of the extension of the 3G network for the interviewed persons,
- What parameters affect the interviewed persons risk perceptions,
- Communication with researcher, press and authorities and how do they act on possible risks,
- Strategies for the interviewed persons to influence the extension of the new 3G network and strategies to minimise the risks.

A summary of the result of the qualitative study will be presented.

Mobile fears? - Risk perceptions regarding RF EMF

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Preferred topic areas: Political and societal framework/ Health issues or Technology and Society
Interdisciplinary Paper

Abstract:
The so called electrosmog is an hot issue in western societies. Many citizen fear that cellular phones and base stations might adversely impact their health. Thus, industry is facing growing resistance to the siting of base stations.

The roots of the issues are seen in the intuitive risk perceptions of lay people that differs from experts´ assessment of risk (Slovic 1992).

In the past, a series of surveys were conducted (Hutter *et al*. 2001; Schütz & Wiedemann 1998; Wiedemann, Bobis-Seidenschwanz & Schütz 1994, Yaguchi *et al*. 2000; Schroeder 2002, Zwick & Renn 2002,) in order to monitor public risk perceptions. They indicate – surprisingly – that the public does not worry too much about these risks. On the contrary , mass media coverage of the issue is growing (about 2000 clippings per month in German newspapers) and the political controversy has reached a high level.

One of the reason of this contradiction might be that the above cited surveys focus on the average person, not taking into account inter-individual differences. Another reason might be that the recent surveys focussed too much on general risk attitudes, thereby neglecting subtle issues, e.g. how people view the future development of this risk issue.

We conducted in Summer 2002 in Tyrol, Austria, an quasi-experimental study (N= 151) in order to explore: (1) inter-individual differences in the risk perceptions related to cellular phones/base stations, (2) how main arguments in risk communications about cellular phones/base stations are appraised, and (3) how future events might change risk perceptions.

Group differences: Based on principal component analysis of an attitude scale consisting of six items we were able to differentiated among three groups. The first group (risk neglectors) see no risks at all associated with cellular phones/base stations. The individuals of second group (undecided people) feel that they do not know enough about the issue and are unable to take a side in the controversy. The third group consists of concerned people.

It is no surprise that these groups differ in risk perceptions However, and interestingly they differ also in their appraisal of the main arguments used risk communications and, above all, in the willingness to change their risk perceptions in the light of new evidence. Further difference among the groups pertain to the subjective assessment of their knowledge about the issue, and their willingness to engage in the debate.

Appraisal of main arguments: The subjects were asked to appraise a number of pro- and con-arguments taken from the recent debate on the risk f mobile phones (Example: Cellular phones are a new technology, To date, there are no long term studies available. Thus, society should be particularly cautious in dealing with this technology).

The findings demonstrate that both extreme groups (neglectors, concerned people) favor those arguments that are in line with their views they already hold on the issue. Only the undecided are willing to take both pro – and con – arguments into account. This results clearly indicates the limits of rational risk communication. Thus, changing risk perceptions by providing information seems to be ineffective for those people who have already made up their minds. This suggests that timely information is a critical variable.

Changes in risk perceptions: We confronted our subjects with 13 different scenarios outlining possible critical in the debate on risks from cellular phones/base stations. Half of the scenarios described warnings (e.g. the radiation protection commission publishes an explicit warning communiqué about cellular phones technology), about the other half of the scenarios consisted of reassuring messages that this technology is safe).

From a rational point of view one would expect that subjects would take into account the new events. Our findings reveal a strong asymmetry between warnings and reassuring messages. The former turned out to be much more influential. Furthermore this effect is stronger for the concerned compared to the undecided and neglectors.

Two conclusions can be drawn: First, effects of risk communications depend strongly on the prior beliefs of the recipients. Second, the concept of risk communication as informing and educating people is challenged. A better understanding of how other variables – such as social norms and emotions – influence risk perceptions is obviously needed.

Risk Communication as a means of Anticipating and Responding to Pre and Post Telecoms Stressors

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Every day in the UK, newspaper reports around the country raise “human interest” stories about local communities opposed to the siting of radio base stations (“mobile phone masts”) in their areas. Objections arise for many reasons, but on the whole, these are not merely “Not In My Back Yard” objections.

In some communities, people hold deeply-held fears and concerns that mobile phone masts may give off high levels of harmful radiation - Electro Magnetic Fields (EMF). This issue was partly addressed in the Report of the Independent Expert Group on Mobile Phones (the "Stewart Report" after its chairman, Sir William Stewart) which was published in May 2000. However, government responses, revised public exposure guidelines, research by the National Radiological Protection Board (NRPB), and new planning procedures all fail properly to address the central issue. Namely, that certain individuals and communities undergo an experience that is not dissimilar to Post Traumatic Stress Disorder (PTSD) in many respects. This manifests itself once telecoms mast development proposals are discovered - and may continue once the mast has been switched on.

Recent initiatives in the areas of dialogue and increased transparency by mobile phone operators in the UK and elsewhere have led to altered attitudes and approaches to network development by the mobile telecoms industry. This has sought to reduce stress in the community, but there is much still to achieve. Further research is needed into the effectiveness of risk communication and longer-term effects of post telecoms stress on communities.

This presentation describes the underlying issues, outlines recent risk communication initiatives in mobile phone deployment, and identifies some key areas for future research and action.

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The communication of risks from electromagnetic fields

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The risk communication represents a crucial step in the management of risks from electromagnetic fields. The continuing controversies about power lines, base stations and other sources have in fact made evident a wide gap between the evaluation of health risks by experts and the perception of the same risks by lay people.

The International EMF Project of the World Health Organization (WHO) has recently issued the manual “Establishing a dialogue on risks from electromagnetic fields”. As the title indicates, the manual stresses the need for an open confrontation between all the stakeholders involved in decision processes, rather than a one-way communication from scientists to the public. Such a dialog requires a careful planning, with clear identification of when, what, how, and to whom to communicate.

Research on the mechanisms of risk perception has indicated that the perception depends on several factors that actually play a role in the case of electromagnetic fields; they include scientific aspects such as the lack of familiarity with the agent, the difficulty of understanding mechanisms, and the uncertainty in knowledge about health effects. Scientific communication is therefore central in the process; however, it faces difficulties, and poses several challenges to the communicator.:

- The scientific language is specialistic and difficult; simplification is therefore required, which unavoidably implies subjectivity.
- Lay people tend to reason in terms of dichotomic categories (e.g. safe/dangerous, carcinogenic/non-carcinogenic, etc.), while science ranks risks on a continuous scale, or at least based on a finer classification (e.g. IARC).
- Scientists evaluate data based on their quality (peer-review, replicability), while the public is sensitive to what data indicate or suggest (potential health consequences).
- Ethical problems may arise when partial, preliminary results suggest the possibility of some health risk. While a timely publicity could favour early cautionary measures, it is against established criteria of science communication, and could create alarmism.
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The instruments of communication are also important. Reports, manuals, leaflets etc. are suitable tools to convey “direct”, explicit messages to the public; these are, however, undermined by “indirect”, hidden messages that are generally much more effective. Such messages include unduly restrictive exposure standards, cautionary measures not well justified and explained, sentences of Courts, and “good advice” for risk prevention.

All these aspects should be kept in mind in order to establish a dialogue which is effective non only in communicating correctly research findings, but also in restoring trust in health authorities, and in science.

Public concerns of possible health risks from exposure to GSM mobile phone base stations in Poland – a 5-year experience.

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Public concerns of possible health risks from exposure to newly settled GSM mobile phone base stations in Poland during 1998 – 2002 were analysed, according to their intensity, complaints and symptoms reported by residents and emotional commitment of the participants. In Poland public concerns to newly settled GSM mobile phone base stations occur with increasing frequency from 1998, but in most cases were organized spontaneously by small groups of residents or even single active individuals without sound background in knowledge of bioeffects and health risks of microwaves and/or experience in risk communication. Nevertheless, the poorly documented health complaints related to base station emissions gained interest from growing number of residents and the group remonstrating against settlement of the GSM base station increased quickly.

In 1998 – 2000 the most frequent complaints included a variety of neurological symptoms and diseases, as well as dysfunctions of the nervous system, while in 2001 – 2002 the concerns were oriented mostly toward risks of neoplastic diseases, mainly brain tumours and leukaemias. Surprisingly, possible risks from organic and functional dysfunctions of cardiovascular system, as well as concerns of miscarriage risks were rarely claimed by residents throughout the whole period of analysis. From analysis, it became obvious that type and frequency of particular complaints reflected the present subject of publications in Polish mass media at the same time.

A questionnairy inquiry was performed on a group of about 1000 residents, who participated in groups remonstrating against settlement of the GSM base stations. The inquiry was directed toward recognition of awarness of possible risks from EMFs, knowledge of bioeffects of microwaves, acceptance of localization of mobile phone base stations and reasons of the concerns. The results of the inquiry will be presented and briefly discussed. It was found that both the awarness of possible risks from EMFs and knowledge of bioeffects of microwaves were very low in all tested groups of residents. Additionally, there existed a very high negative correlation between the state of knowledge of bioeffects of EMFs and state of fears from EMFs. Mobile phone base stations were only accepted as high towers, but not these located on buildings.

On base of all available data, the main causes of public concerns of possible health risks from exposure to newly settled GSM mobile phone base stations in Poland were identified:

1. The NIMB (*not in my backyard*) principle;
2. Fears from unknown and/or unrecognized health risks;
3. Lack of confirming results of scientific investigations which indicate safety of exposure to base station emissions;
4. Splurge of certain individuals in the local society and dummy activity of local leaders to gain approval in the society;
5. Provisions of Polish law which are to some extent conducing public concerns to base stations (multiphase procedures for adjustment of localisation of base stations, requiring agreement from residents who are not fully aware of the problem and risks).

Conciliation in case of public concerns of possible health risks from exposure to newly settled GSM mobile phone base stations, which is at present in elaboration in Poland includes three main aspects:

1. Application of modern methods of risk communication in form of clear, valid and understandable information;
2. Meetings and negotiations with representatives of residents with participation of independent experts, preferably selected by the residents;
3. Initiation and sponsoring of independent research on interaction of base stations on human beings and the environment to provide objective arguments for the residents. Examples of such research projects, initiated recently by Polkomtel SA, Poland will be briefly presented.