Liikenne- ja viestintäministeriö

Mobile network reception problems in low energy buildings

Working group report

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Ministry of Transport and Communications

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Ministry of Transport and Communications

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Abstract

Reliable mobile communications is a basic necessity in today's society. Mobile phone reception is affected by various factors, including buildings located between a base station and a terminal device. Modern energy efficient buildings interfere with radio signals and are one of the causes of indoor reception problems. The Minister of Housing and Communications appointed on 4 September 2012 a Working Group to investigate mobile network reception problems in low energy buildings. The Working Group was to submit its final report by 1 October 2013, providing an overview of the current situation and assessing need for technological or legislative changes associated with different proposed solutions.

The Working Group stresses the importance of increasing awareness about reception problems and considering different solutions to these problems from the earliest stages of building construction and network and services design. It identifies several possible solutions to mobile network reception problems in renovation and new building projects. The measures proposed call for active dialogue and cooperation between the authorities, telecom operators, building contractors, research institutes, housing companies and residents. The Working Group recommends the following short-term measures: to determine a radio signal strength indicator for most common building materials, to provide for intrabuilding mobile network cabling, and to develop home base station solutions. The Working Group's long-term recommendations include the promotion of legal mobile repeaters, an increased research effort into possible solutions, and increased openness and cooperation in drafting legislation in the environment and communications sector.

Contents

Concepts

I Telecommunications concepts:

2G: Second generation mobile communication system (e.g. GSM)

3G: Third generation mobile communication system (e.g. UMTS)

4G: Fourth generation mobile communication system (e.g. LTE)

GSM: Global System for Mobile Communications

UMTS: Universal Mobile Telecommunications System

LTE: Long Term Evolution

WLAN: Wireless Local Area Network

Mobile communication network: A telecommunications network carrying mobile communication.

Base station: A mobile network transmitter-receiver station to which mobile phones or other terminal devices are connected.

Radio wave: Electromagnetic radiation in the frequency range 3 kHz – 300 GHz.

Terminal device: A device using a mobile communication network (e.g. a mobile phone or dongle).

In-building network: Communication network and system within a building or compound.

Decibel (dB): A ratio describing change in signal level (see Table below)

Signal change (coefficient)	Decibels
1 x	0 dB
2 x	3 dB
4 x	6 dB
10 x	10 dB
20 x	13 dB
100 x	20 dB
1000 x	30 dB
10000 x	40 dB

II Building construction concepts:

Low energy house: A building where energy consumption for indoor heating purposes is lower than usual. Building a low energy house currently requires no special arrangements. The exact definition of a low energy house will be revised with the tightening of energy efficiency requirements.

Passive house: A passive energy house, according to the common definition, requires no heating or cooling energy. In the Finnish climate it is not yet cost-effectively possible to build a house that requires no heating at all. According to the VTT Technical Research Centre of Finland definition, a passive house in southern Finland requires approximately 20 kW of heating energy per square metre of floor area per annum, in northern Finland the figure is 30 kW per square metre per annum.

Zero energy house: A zero energy house produces at least the same amount of renewable energy as it consumes non-renewable energy.

U factor: The heat transfer coefficient U (W/(m2K)) refers to the density of heat flow that under steady state conditions passes through a structural component when the temperature difference between the air masses on either side of the structural component equals one unit.

E number: A building's overall energy performance or its E number (kWh/m2) refers to its annual consumption of purchased energy weighted by type of energy used.

Selective glass: Glass with a coating that allows heat from the sun to enter the building but traps long wave thermal radiation from the inside out. Also known as low emissivity glass and low energy glass.

RF value: Numerical value or other description that indicates the average attenuation characteristics of a material at frequencies currently used for mobile telecommunications.

RF aperture: A local structure made of a material that is less resistant to the propagation of radio signals than the surrounding materials.

1. Working Group's mission and objectives

The Ministry of Transport and Communications appointed on 4 September 2012 a Working Group to investigate mobile network reception problems in low energy buildings and to explore possible solutions to these problems.

The European Union's climate and energy policy is committed to the 2020 objectives of reducing greenhouse gas emissions by 20%, increasing the use of renewable energy sources as a proportion of final energy consumption to 20%, and improving indicative energy efficiency by 20%. Climate change and energy issues figure prominently in the Finnish Government Programme, too. In March 2013, the Government submitted its updated National Energy and Climate Strategy to Parliament. This strategy is geared to ensure that Finland will meet the 2020 energy and climate objectives. Finland is committed as part of the EU to reducing its emissions. Energy consumption in buildings and in building construction accounts for around 40% of Finland's final energy consumption and likewise for almost 40% of its greenhouse gas emissions. The building energy efficiency directive for 2020 has particularly important implications for the development of building construction and renovation throughout the European Union. Among other things, the directive requires that by the end of 2020, all new buildings shall be nearly-zero energy buildings; public buildings must comply with the same criteria by the end of 2018. Each EU Member State must specify minimum energy performance requirements for existing buildings undergoing major renovation.

The Working Group's mandate is based on the observation that thermal insulation in these new low energy houses (so-called passive houses) is largely based on structures that often interfere with radio signals. The problems occur in both new buildings and renovated structures. It is possible that resolving these problems will require special measures that can only be identified through close and coordinated dialogue between construction industry representatives, telecommunications operators, building and environmental authorities, and communications authorities. Solutions must be designed for the long term as buildings are made to last for a hundred years or more, while communications technology can change dramatically in a very short space of time. For this reason the only way to ensure future communications in the Finnish built environment is to try, from the earliest stages of renovation and construction work, to prevent major interference of radio frequency radiation in buildings and to promote special radio solutions in buildings where reception problems are likely to occur.

Structures that interfere with radio waves not only limit the availability of mobile services, but also adversely affect indoor radio reception. Most radio receivers are not connected to in-building antenna networks. For this reason the reliability and quality of radio reception depends on outdoor to indoor radio wave propagation. New building structures have a much lesser impact at low frequencies (100 MHz) – the bandwidth range of current FM radio – than they do at the higher frequencies used by mobile networks. Terrestrial television networks, then, are designed to receive the signals broadcast using an external antenna, and therefore the problems caused by new building structures are again less acute than in the case of mobile networks. It was justified therefore that the Working Group's mandate focused specifically on the challenges associated with mobile communications services.

Communications via mobile networks represents a basic necessity in modern society, and therefore it is imperative that a lasting solution is found to the problems of indoor reception. Citizens have come to take efficient and reliable mobile connections for granted, and especially in the case of emergencies indoor reception problems are obviously a serious concern. Already, various concrete measures have been put in place to promote broadband as a universal service. Most notably, telecommunications companies designated as universal service providers must provide every permanent residence and business office with access to reasonably priced and high quality telephone services and a broadband connection with a minimum speed of 1 Mbps. There are furthermore very high coverage requirements. In addition, the Code for Information Society and Communications Services project has been instructed to draft provisions under which telecom companies would be allowed to put up wireless network base stations and radio masts on land or in buildings owned or controlled by a third party.

There are many stakeholders with a vested interest in finding a solution to these reception problems, both in a commercial and operational sense. For telecom companies and building contractors, high quality indoor mobile reception is crucial in order to promote and ensure continued sales of new and renovated houses and mobile subscriptions. For telecommunications operators, another reason why reception problems must be prevented and resolved is that these companies need to be in the position to satisfy the requirement of reasonable indoor coverage set out in the new operating licences for the 800 MHz band spectrum. The coverage problem is further heightened by the fact that mobile communications inside buildings is continuing to grow with the proliferation of mobile data and different types of terminal devices. Finland is an international pioneer in the use of wireless connections. The observations made by the Working Group with regard to ways of improving indoor reception may of course also be useful in addressing other types of reception problems than just those stemming from energy efficient building construction.

Based on the foregoing the Working Group was charged with the following tasks:

- to investigate the current situation with regard to radio signal reception problems and to identify ways of moving forward and potential solutions to these problems both from the point of view of the construction industry and the telecom sector

- to evaluate the solutions proposed and their technological and legislative implications

- to consult outside researchers, experts and stakeholder groups and where necessary to commission relevant surveys

- to explore the experiences gained in other countries and in its reporting to take advantage of international studies and models

- to offer concrete and viable solutions in its final report

The Working Group was appointed for a one year term from 1 October 2012. It was to submit its final report by the end of its term on 1 October 2013.

The Working Group consulted a number of experts and stakeholders from November 2012 onwards. These included Tampere University of Technology; Ericsson; Nokia Siemens Networks; Lasifakta Oy; the Ministry of the Environment; several telecom operators and FiCom; Sähköherkät ry (association providing advice, information and awareness of electrical sensitivity); the Radiation and Nuclear Safety Authority STUK; and the Electrical Contractors' Association STUL. In addition voluntary comments were received from several stakeholders.

The Working Group was chaired by Senior Adviser Olli-Pekka Rantala, Director of the Communications Market Unit at the Ministry of Transport and Communications. The other Working Group members were Senior Adviser Antti Kohtala from the Ministry of Transport and Communications; Reijo Svento, CEO of FiCom; Timo Hietalahti, Head of

Department, TeliaSonera Finland Oy; Pekka Pussinen, Senior Development Manager, Elisa Oyj; Vesa Erkkilä, Business Development Manager, Digita Oy (until 18 Dec 2012 Kari Heiska); Markku Lamminluoto, Senior Advisor, DNA Oy; Tom Wikström, Radio Network Specialist, Finnish Communications Regulatory Authority (until 31 Dec 2012 the Finnish Communications Regulatory Authority was also represented by Pentti Lindfors); General Agent Jani Kemppainen and Branch Manager Juha Luhanka from the Confederation of Finnish Construction Industries RT; and Erkki Laitinen from the Ministry of the Environment. Secretary to the Working Group was Senior Officer Sini Wirén from the Ministry of Transport and Communications.

2. Social and political background

2.1 Mobile network use and consumer needs

The growth of mobile data is a global phenomenon. High quality two-way telephone and data links are by now available virtually the world over, and connections are improving all the time. The vast majority of people in Finland today use mobile networks on a daily basis, at the same time as the number of landline subscribers is steadily declining. According to the Finnish Communications Regulatory Authority's 2012 Consumer Survey of Communications Services, only 15% of Finnish households now have a fixed landline phone. Older people have landline phones more often than average. At the same time 98% of households have a mobile phone subscription. It is clear then that communications through mobile networks can be considered a basic necessity today, and that being able to make emergency mobile calls from within buildings is a crucial safety element in today's society. Wireless broadband use is also very high by international comparison, and is continuing to grow at a significant rate. Service availability depends crucially on the coverage of the mobile network. Current estimates are that at least two-thirds of all mobile voice and data traffic occurs indoors, and that proportion is continuing to grow. It is paramount to ensure that there is adequate indoor coverage for mobile devices in all residential and business premises. Furthermore it is noteworthy that coverage is not the only concern for end users, but also the quality of the service provided. Additional attenuation of radio transmission paths may considerably reduce data transmission speeds and so limit the use of broadband services, for instance.

2.2 Energy efficiency trends in building construction

There is a strong and growing drive in Finland today towards improved energy efficiency in building construction. The trend began around 2008 in response to the EU's new climate and energy policy positions outlined above. Developments prior to that time can be described as more moderate. The current Government Programme includes several commitments to promote energy efficiency, and overall the issue is politically a highly sensitive and loaded one. There is also an ongoing action plan called the Energy-Smart Built Environment 2017 (ERA17) which is aimed at restoring Finland's position as the world leader in the area of energy wisdom. The development of residential housing has been geared towards more energy efficient solutions based on high thermal insulation and air tightness and efficient heat recovery. Some structures have employed metal membranes or metal sheet-like layers that adversely affect the propagation of radio waves. Improved energy efficiency in buildings is aimed first and foremost at achieving energy savings and reduced emissions.

3. Legislative background

3.1 Regulation concerning the energy efficiency of building construction

Drafted by the Ministry of the Environment, the new Act amending the Land Use and Building Act (21 Dec 2012/958) entered into force at the beginning of 2013. Based on this Act, the Ministry of the Environment issued on 27 February 2013 a Decree on the improvement of building energy efficiency in renovation and restoration work (Ministry of the Environment Decree 4/13). The provisions of this Act and Decree are intended to implement the articles of the building energy performance directive that specifically concern the minimum energy performance requirements of existing building that are subject to major renovations as well as the inspection of heating systems. The EU Directive requires that the energy performance of buildings is improved in connection with major renovations. The Act and Decree constitute national implementation of the EU Directive.

Minimum energy performance requirements are specified for major renovation works that are subject to planning, for renovation projects where the designated function of the building is changed, and when new technical systems are installed. These include extensive renovation works and repairs to the building envelope. The decision to undertake major renovations continues to remain voluntary. It remains the discretion of the owner of the property to decide when and on what scale to start renovation work and what is the best way to improve the building's energy performance within the framework of the current provisions. Planning permission applications are processed by local building inspection authorities. Measures to improve the building's energy performance need not be taken if they are not technically, functionally or economically feasible. It is also important to consider the building's distinctive characteristics and intended function. It makes sense to invest in improving the building's energy performance in connection with normal renovation work and other regular building maintenance.

The Ministry of the Environment Decree applies to buildings used by public authorities as of 1 June 2013 and to all other buildings as of 1 September 2013. The Act and the Decree are aimed at enhancing efforts to improve energy performance and at raising the quality of building renovation work. The Act lays down the general principles, the Decree specifies the practical regulations in more detail.

The Decree provides for three alternative ways in which the building's energy performance can be improved in a renovation project. The owner of the building can choose the method that best suits the project. The first alternative is to improve the thermal resistance of renovated building elements to the required standards. The second option is to improve energy performance to the standards specified for the type of building in question. This is based on calculations of the whole building's annual energy consumption during normal use relative to the building's floor area (kWh/m²/year). The third alternative is to calculate the building's typical overall energy consumption, the energy consumption figures as based on the structural applications at the time of construction or at the time of the most recent change to intended function, and to reduce that E number in line with the standards specified for the type of building in question.

3.2 Regulation concerning indoor reception and performance of communications services

The rights and obligations of telecom companies are governed by the Communications Market Act (393/2009), the Act on Radio Frequencies and Telecommunications Equipment (1015/2001) and the Act on Auctioning Certain Radio Frequencies (462/2009) and the provisions and regulations based on the said acts. Section 67 subsections a–g of the Communications Market Act contains regulations governing defects, liabilities and compensation in communications service agreements. Section 67 subsection d of the Act lays down rules regarding defects in the delivery of a communications service. The delivery of a communications service is considered defective if the quality of the service does not meet the requirements of law or the Finnish Communications Regulatory Authority regulation issued by virtue of law; if the delivery of the communications service has been continuously or repeatedly interrupted; or if the communications service does not meet the marketing information or differs from what the user can normally expect from a similar service.

Finnish legislation is based on the premise that all people have the right to a reasonably priced and high quality telephone service in their home or place of business. Chapter 6 a of the Communications Market Act lays down universal service obligation rules concerning the provision of universal telephone services. According to the Act the Finnish Communications Regulatory Authority (FICORA) shall, as necessary, assign a universal service operator that shall have the obligation to provide a telephone subscriber connection that satisfies the universal service requirements within the designated area. The subscriber connection provided shall allow all users to make and receive national and international calls, to make and receive emergency calls and use other ordinary telephone services. The universal service subscription may use a fixed or wireless connection, but it must work flawlessly at the user's permanent place of residence or location. It is FICORA's view that the user can be required to take steps to improve reception for instance by having an antenna installed to the terminal device or by means of a small external antenna. It is noteworthy that FICORA only assigns universal service operators to areas where this is necessary to ensure effective universal service delivery. In areas that have no designated universal service provider, FICORA is satisfied that there is sufficient competition among service providers that meet the universal service definition. Most areas in southern, central and western Finland have no designated operators for the provision of universal telephone services. For the provision of broadband services, by contrast, the authority has designated universal service providers in large parts of the country.

In 2008, following the decision by TeliaSonera Finland to discontinue the provision of landline services, the terms and conditions of the service provider's operating licence were revised to include the requirement of ensuring indoor reception for mobile phones. In these situations the operator is obliged to ensure that each customer has access to wireless reception in at least one area of the building before closing down the landline service.

Indoor reception requirements are also reflected in the new operating licences that are due for issue in the near future. Based on Section 9 of the Act on Auctioning Certain Radio Frequencies (462/2009), as amended in 2012 (592/2012), the Government invited applications for telecommunications operating licences in the frequency bands of 791–821 and 832–862 MHz, or the so-called 800 MHz frequency band. The licences will be granted based on the outcome of the auction that was opened in January 2013. The licences include a specified coverage requirement that at once ensures reasonable indoor coverage. 'Reasonable' coverage means that telecommunications services must be accessible, without additional costs to users, in ordinary environments of use in their permanent residence or place of business. Where necessary the operating licence holder has the obligation to verify that the services are indeed accessible.

The problems associated with indoor mobile reception are relatively new and have only begun to surface in recent years with the growing popularity of highly insulated low energy houses. At the moment, however, there are no specific regulations or policy positions in place regarding liability for reception problems in cases where those problems can be considered to stem from building insulation, for instance, except in the case of universal service providers assigned by the Finnish Communications Regulatory Authority.

4. Technical background

4.1 Operation of mobile networks and mobile phones

A mobile network is essentially a communications network primarily used for targeted communication where the terminal device is connected to the network via freely propagating radio waves. Mobile systems are based on the use of radio waves for communication between fixed network base stations and users' terminal equipment, such as mobile phones. Communication between the mobile phone and the base station is two-way. Mobile network base stations additionally need a fixed backhaul link to the rest of the network and to other base stations as well as electrical supply. Due to these requirements the base station network has to be designed and implemented in a single step, particularly in rural areas where fast enough transmission links are not necessarily available.

4.2 Factors impacting indoor radio reception

Research has shown that the reception of radio signals is dependent on a number of factors. Firstly, the strength of the radio signal transmitted by the base station, the materials used to construct the building and the location of the building relative to the base station all have a major impact on indoor reception. The stronger the network's radio signal in the area, the easier it is for the signal to penetrate the building through its smallest apertures, such as wooden window frames. Reception problems may also be caused by other factors in areas with a fundamentally strong radio network. Factors impacting the propagation of radio signals into buildings include the shape of the building, the direction of the building's outer walls and reflections off other surrounding buildings. Furthermore the mobile network signal strength and the radio signal's direction of arrival in any given location are always dependent on the operator: network reception from one operator may be excellent in the same location where reception from another is poor. What is more the structure of the radio network changes from time to time among other reasons because of the expiry of leases for base station sites and the construction of new base stations, and therefore the direction of radio wave arrival may vary during the building's life span, even for the same operator.

With respect to building materials, experience has shown that the attenuation of radio signals depends on all the elements used in the construction of the building. For instance, energy efficient windows alone will not prevent indoor reception if the walls of the building are of a material that allows radio signals to pass through, and vice versa. Windows are traditionally the points via which radio signals pass through into buildings. However the multiple layers of glass and metallic coatings of new energy efficient windows and metal window profiles reflect mobile phone signals very effectively and prevent them from getting through. In general reception problems occur most particularly in multi-storey stone buildings.

Apart from new windows, other measures taken to promote the energy performance of buildings have included the installation of more effective thermal insulation. In some cases this has involved the use of various types of metallic membranes, which have adversely affected the propagation of radio signals into the building. Measurements conducted at Tampere University of Technology have shown that the attenuation caused by these membranes is significant. By contrast non-metallic insulation courses using mineral or plastic-based materials, even in thicker or denser layers, cause no radio signal attenuation at any frequencies. Other factors impacting the reception of radio signals include the size and location of windows as well as indoor layout (e.g. interior walls). Research also suggests that newer mobile phones and other terminal devices have poorer reception than older models. It is estimated that the radio performance of new mobile phones is at most 3 dB weaker than that of older mobile phones, which means that the minimum signal strength required by the terminal device is twice as high.

It is also noteworthy that the level of attenuation is significantly impacted by the frequency band used. Higher frequencies are attenuated more than lower frequencies. For this reason it is important that low enough bandwidths are allocated to mobile communications, such as the so-called 800 MHz and 700 MHz bands. Indeed some reception problems can be eased by the allocation of new frequency bands.

5. Observations of mobile network reception problems in different types of building

5.1 General observations

Researchers at the Tampere University of Technology (TUT) Department of Electronics and Communications Engineering have done extensive work to examine the propagation attenuation of radio frequency waves in modern residential buildings. In spring 2012 measurements were conducted in 15 houses and 4 multi-storey buildings in the Tampere region. In each case comparisons were made between outdoor and indoor signal strengths using commercial mobile networks at two different frequencies (900 and 2100 MHz). Furthermore measurements of building materials were conducted at five of the research sites as a function of frequency between 100 MHz and 4500 MHz.

The results showed that new building materials such as energy-efficient windows and aluminium-based polyurethane sheets cause significant attenuation, particularly at the most common mobile communications frequencies (900MHz, 2100 MHz).

TUT researchers also found that reception problems were more noticeable on lower floors of the building. Building premises are particularly affected because they are often located on the ground floor of the building, and they typically have larger windows than residential dwellings.

5.2 New buildings

Researchers at the TUT Department of Electronics and Communications Engineering have also conducted measurements to assess the extent of radio signal attenuation through different materials. Their findings show that radio signal penetration into new building structures can be up to 100 times (20dB) weaker than into buildings that are 10 years old. According to the measurements the difference in RF attenuation between new and old buildings is on average 13 dB (i.e. the signal attenuates to one twentieth of its original strength).

5.3 Older buildings and renovation

It is the Working Group’s understanding that in the near future, reception problems will emerge as a more acute and more wide-ranging challenge in renovated old buildings than in new buildings. The rate of building stock turnover in Finland is relatively slow at around 1–1.5% a year. Major renovations are not undertaken very often: envelopes and facades or water supply and sewerage systems are only renovated at intervals of some

40–50 years. However from an energy efficiency and telecommunications point of view the materials and design choices made in connection with these renovations will have profound and long-lasting significance.

Based on the measurements conducted by TUT researchers it is estimated that radio signal reception problems are most likely to occur in buildings built of concrete or other construction materials that naturally attenuate radio signals and that have new, highly energy efficient windows. A substantial proportion of the existing stock of multi-storey buildings in Finland are made of concrete elements, and radio signals usually penetrate the buildings through their windows.

A particular problem with older renovated buildings is that radio signal reception is not something that would have been taken into account at the time of building design.

6. International comparisons

A major trend in building construction throughout Europe is towards improved energy efficiency. However the standards of energy efficiency vary from country to country depending, among other things, on differences in climate. In Finland the main efficiency challenges come from the long cold winters during which buildings have to be heated, whereas in the warmer climes of southern Europe the main issue is the need to keep buildings cool. For this reason the Working Group believes that the other Nordic countries are the most relevant point of reference for a comparison with Finland. Sweden and Norway are probably faced with a similar increase in reception problems as they have the same kind of climate and energy savings targets as we do, even though the issues have as yet not received the same level of public attention. Finland is very much in the vanguard in tackling and trying to find ways of solving the problem. One reason why reception problems have surfaced sooner in Finland than in other countries lies in its pioneering position in the field of wireless communications technology. In many other countries large numbers of households continue to have a fixed landline telephone, for instance.

7. All solutions proposed and discussed

This chapter provides a brief overview and assessment of all the solutions discussed by the Working Group and proposed in connection with consultations with stakeholders and experts. The options proposed can be divided into two categories, viz. structural building solutions and telecommunications solutions.

7.1 Structural building solutions

7.1.1 Proactive structural design using RF value

Based on discussions in the Working Group and consultations with experts, it is thought that it is possible to calculate the rate of attenuation of radio frequency signals passing through exterior walls or windows based on the building materials used, and to determine an attenuation or RF value for wall structures, for instance (e.g. in dB terms or based on some other measure describing the characteristics of the building material). The RF value should be determined according to the building's intended function. For example, the maximum allowed signal attenuation rate for office buildings could be slightly higher than for residential buildings because it is often easier to resolve reception problems in offices.

A method of building construction that takes account of the RF value could help to ensure that no buildings are constructed that cause exceptionally high attenuation of radio propagation. The RF value would be useful not only in the construction of new buildings, but also in renovation projects. The determination of an RF value would help to avoid reception problems most particularly in private and detached houses, as it is much more likely for operators to have special arrangements in place in large multi-storey residential buildings and offices. If the RF value were followed, there would also be much less need for coverage area planning at the individual building level. This would among other things save planning resources and also lower costs from separate arrangements needed for individual buildings. In addition, the use of the RF value in renovation projects would ensure continued good indoor reception on other frequencies as well.

It would certain be useful to gain official status for the RF value in the form of a recommendation, for instance. Concrete guidelines and tables to support insulation planning based on the RF value, for instance, would facilitate the job of structural engineers. Not only building contractors and designers, but also radio network designers would benefit from the existence of an RF value.

Mainstreaming the RF value would require concrete guidelines and recommendations and a calculation equation. For purposes of calculating the RF value it might be justified to require that radio signal attenuation values are specified for different building elements.

7.1.2 Radio apertures in the building envelope

It is the Working Group’s assessment that it might be technically feasible to have RF apertures in concrete structures. There are no energy efficiency regulations that prohibit the opening up of such apertures in the building envelope. An RF aperture is a local structure that is less resistant to the propagation of radio signals than the surrounding materials. It does, however, present a rather bigger challenge from the point of the view of the physics of building construction, architecture, the aesthetics of building facades, sound insulation and potential damp problems, because the required aperture in the building shell is quite large. TUT researchers estimate that the aperture should measure 30x60 cm (width x height) and be undivided. The size of the aperture can be reduced if it is designed with a view to specific wavelengths. As a general rule RF apertures are much harder to incorporate in old renovated buildings than in new buildings.

In order for RF apertures to perform their function it is necessary to have a strong outdoor signal. The direction of radio signal arrival is another important consideration when deciding where to place the aperture. A major limitation with this solution stems from the fact that in practice, one aperture can provide adequate coverage for one room only. Having said that, it might be possible to achieve larger coverage if the signal enters the building in a direct angle through the aperture and if there are no thick interior walls. Electromagnetic radiation may come from any direction, depending on the location of base stations and radio signal reflections, and therefore it might be necessary to have apertures on every side of the building envelope.

Some effort has already gone into developing insulation materials that are transparent to radio waves and that would have RF aperture application in detached wooden frame houses. However more research is still needed to determine whether these materials could have wider application in resolving coverage problems.

The Ministry of Transport and Communications has commissioned a TUT researcher to undertake a more detailed investigation into the benefits of using the RF value. Due for publication in October 2013, the investigation is focused on the use of the RF value as an element of controlling signal attenuation in buildings.

7.1.3 Selective window films

One of the methods used to improve building energy efficiency involves the use of thin metal films in window structures. There is a wide range of energy efficient selective glazing in the marketplace that at once allows sunlight into the building and minimizes the loss of heat from inside out. However it is suggested that selective glazing adversely affects the indoor reception of mobile network signals because the metal film in the window structure interferes with the radio signal.

For this reason one of the solutions proposed to address indoor reception problems has been the incorporation of one or more non-selective windows. It is thought that this might provide an effective solution in cases where the window faces the direction from the which the radio signal arrives. However studies suggest that this will only provide a solution for one room at a time. To resolve the problem for the whole building, it would be necessary to have on each side of the building one window per flat that has no metal films.

The rate of energy loss through non-selective windows is considerably higher than through selective windows, and therefore this solution would not comply with harmonised energy regulations. Under the new Energy Efficiency Decree, however, this would be a viable solution because calculations of building energy efficiency using the E number allow for compensation between different parts of the building.

However the use of non-selective windows involves other challenges. This is not necessarily an ideal solution either for residents or for building contractors. First of all a less energy efficient window might be more expensive than an energy efficient one: the costs of producing a window outside the serial production line will usually be higher than the mass produced window, even when the glass and other components themselves are cheaper. There is also no glass manufacturing industry in Finland, but all glass is imported. Furthermore there may be issues with regard to housing comfort, such as the sense of draught caused by cold surfaces as well as condensation problems. A non-selective window, on the other hand, might in some cases even contribute to improving housing comfort, as there have been reports of excessively energy efficient windows frosting over or freezing. It is also noteworthy that in the future the use of metal blinds, shades or hatches might in any case prevent the propagation of radio signals, and therefore the removal of the selective metal film will not necessarily suffice to resolve the reception problems anyway.

The use of non-selective windows is an option that is already available to building contractors today. It is likely that in the near future other solutions will become available that are associated with selective films, but these will still require further analysis. One option is a window from which part of the selective metal film has been left out. The consequent reduction in energy efficiency resulting from is directly proportional to the surface area opened up. Apart from the straightforward, mechanical elimination of a specific surface area, it is technically possible to create openings in the window that allow certain radio frequencies to pass through the selective film. This will require intensive R&D both to find the appropriate technical solution and to develop cost effective manufacturing techniques. One research study on this kind of frequency selective structure found that a 10% reduction in the surface area of selective film yielded a 20 dB (100-fold) improvement in signal strength, while the increase in energy loss was just 10%. At building level this typically translates into an increase in energy loss of no more than 1–2%. The replacement of selective metal film by some other type of membrane is another area that will require further research and development.

7.1.4 Provision for in-building network cabling

One possible way of improving indoor reception is to install an in-building antenna network for mobile services. The system consists of a coaxial cable run from an in-building distribution facility at the base of the building and feeders that distribute the mobile network signal inside the building to antennas installed on each floor. Repeaters or base stations can be installed in the distribution facility to produce the necessary mobile coverage via the in-building antenna network. Research conducted by Tampere University of Technology confirms that these types of in-building networks are a technically sound solution. Given a sufficiently high quality in-building network, operators could on a voluntary, commercial basis offer special arrangements (as described under 7.2.3 below) for residents in larger blocks of flats in cases where no feasible methods are available to improve coverage outside the building.

It is important to note that retrofitting an in-building antenna network is extremely difficult and expensive. Therefore provision should be made for indoor network cabling in all building and renovation projects where measurements have shown a weak outdoor signal strength and/or where it is known that external wall attenuation is high (RF value). However in older buildings there may be obstacles to installing an in-building antenna network that meet the Working Group's requirements. For instance, the installation of cables or antennas may be restricted in listed staircases, the necessary space is not necessarily available for the larger distribution facility required by an in-building antenna network, or it may be technically impossible to provide for the air-conditioning required by the hardware. Furthermore owners of older buildings in particular may incur significant additional costs from the installation of an in-building antenna network, which must be taken into account in drafting recommendations and options and in defining scopes of application.

In this connection it is furthermore necessary to have a decision of principle regarding key areas of responsibility. For instance, the relevant authorities must be clear amongst themselves about who is responsible for drafting the rules and regulations concerning network design, who shall approve the plans and who shall monitor implementation. Given the high costs and complications of retrofitting a network, it would be useful to consider more closely the prospects of integrating the overseeing of this work with other building supervision. Decisions of principle are also needed with respect to the building and maintenance of the network and questions related to ownership.

The Finnish Communications Regulatory Authority FICORA has recently issued a Draft Order M65 concerning in-building networks and telecommunications contracting. The order will take effect on 1 January 2014. The Working Group has expressed the view that the installation of in-building networks should be incorporated in the order. At this stage it would no longer be appropriate to make extensive revisions to the content of that order, since any delay in its implementation would hamper other measures included in the order. However it is expected that the order will have to be updated as early as 2014 due to changes brought about by the Code for Information Society, and at that point it might be possible to incorporate concrete proposals. Therefore the Working Group proposes that the following requirements concerning buildings and networks are taken into account in creating the conditions for the installation of in-building antenna networks, without ignoring their limitations and economic implications:

- in-building antenna networks should be installed in multi-storey residential buildings, business premises, shopping centres, hotels and in principle all buildings that have staircases

- all telecom operators must be given the opportunity to link up to in-building antenna networks in order to ensure full mobile coverage within the building

- the coaxial cable and distributor frequency range in the in-building antenna network should be as wide as possible, whereas the mobile network frequency bands provided through the antenna network and therefore antennas would be designated to specific telecom operators

- cable, distributor and connector attenuations in the in-building antenna network should be determined so that they can be taken into account in designing the radio network and so that operators can be offered equal access to the antenna network

- sufficient space must be provided in the distribution facility for the base stations and repeaters linked up with the in-building antenna network, and the facility must have adequate air-conditioning

- sufficient cabling space must be provided for the in-building antenna network, including cable runs in conjunction with staircases, with maintenance access doors provided on each floor

- provision must be made for the installation of antennas providing indoor coverage on each floor

- provision must be made for coaxial cables from any antennas located on the roof of the building to the repeaters installed in the distribution facility

- if there are several distribution facilities in the same building, provision must be made for a cable link between these facilities, and this connection must be specified

- if empty piping is allocated for indoor mobile network cabling, it is required that its condition, continuity and accessibility is ascertained in connection with the final inspection of the building and that an appropriate record is entered in the summary of the inspection document

7.2 Telecommunications solutions

7.2.1 Passive antenna solutions complemented by active devices available to consumers (so-called external antennas)

Passive antenna solutions are all repeaters that have no active components. The system comprises an outdoor antenna and an indoor antenna that are connected to each other via coaxial cable or some other transmission line.

It is thought that in individual cases passive antenna solutions can alleviate reception problems, particularly in detached houses, but they cannot offer a more universal solution to the problem in multi-storey residential buildings, for instance.

This solution involves connecting an active terminal device that is available to consumers to a passive antenna line indoors. This terminal device may be a mobile data device or a desktop GSM device. In these solutions the terminal device is rigidly fixed to an antenna installed outside the building. This will help to offset some of the attenuation caused by building structures and so give sufficient signal strength for indoor telephone use, for instance. On the other hand in some cases the solution restricts the indoor movement of the terminal device. However if the mobile device is equipped with a WLAN adapter, this will not be a problem.

Installing antennas and active devices requires some radio expertise, among other things because the antenna has to be properly aligned to point at the direction of signal arrival. Furthermore if the antenna is to provide improved signal reception, it is necessary to have good mobile reception outdoors, too. In addition the solution may restrict the indoor movement of the terminal device, but on the other hand the device will work much more effectively as a result of improved signal strength.

This solution makes use of approved devices that are available to consumers. An important benefit, therefore, is that the extension of passive systems by such active devices causes no interference to other networks. For this reason installation does not require a radio licence from FICORA as specified in Section 7 of the Radio Act. FICORA provides on its website useful information on how to improve mobile phone and broadband reception, including details on the installation of external antennas.

7.2.2 Increasing the density of the base station network

In residential areas telecom operators provide for mobile reception via a network of base stations outside buildings. That network is constantly being expanded and updated on the basis of commercial needs. The growth of communications traffic requires new base stations in any case, but it is difficult to resolve the coverage problem simply by building new base stations if the permeability of buildings is negligible: bringing a base station closer to a building by one-half increases signal strength by no more than 6 dB (fourfold), while energy efficient building solutions can cause attenuations of 20–30 dB (indoor signal strength one-hundredth or one thousandth of outdoor signal strength).

What is more, increasing the density of the base station network is a rather slow and expensive process for operators, if compared against the improvement achieved in signal strength. The attenuation problem cannot be resolved simply by building more base stations. It is also necessary to consider the availability of sites for ever new base stations, especially in densely populated residential areas. To some extent at least the building of a denser network of base stations can be supported through planning and permit measures. Indeed some steps have already been taken to improve the situation. The Code for Information Society currently under preparation at the Ministry of Transport and Communications is set to include provisions under which telecom companies would be allowed to put up wireless network base stations and radio masts on land or in buildings owned or controlled by a third party. Furthermore the introduction of lower frequency ranges, such as the 800 MHz band, will go some way towards alleviating the problem since a lower frequency increases the signal's range, which means that base stations can be further apart than with higher frequencies.

7.2.3 Telecom operators' in-building network solutions

One way of improving indoor reception is to connect one or more active repeaters to the in-building network. These repeaters would be connected to an existing in-building antenna network, and they would remain in the ownership and control of the telecom operator. The building and quality of the in-building network would remain the responsibility of the property owner. The in-building network should accommodate several mobile phone operators so that the housing company always has the option to sign contracts with the operators of its choice. According to telecom operators existing in-building antenna networks would also accelerate the introduction of new radio technologies.

From a network management and non-interference point of view active repeaters are a good solution if they strengthen just the one specified operator's bandwidth, if they are of a good enough quality and if they are controlled by the mobile phone operator.

Installation of active repeaters requires radio expertise, and they must be adaptable to any subsequent changes to the radio network.

One limitation of the use of operator-controlled RF devices is that separate in-building network solutions are only commercially viable in large blocks of flats; they are not suited to tackling indoor reception problems in detached houses.

7.2.4 Home base stations and other fixed broadband-based solutions

In other countries some telecom operators have begun actively to promote femtocell or home base station solutions, while others have opted not to pursue this technology. Femto base stations are popular in Japan, the United States and also in some European countries. In late 2012 there were a total of almost 6 million of them in use around the world. However there are currently only very few operators that offer femto base stations on any significant scale. Even so the number of home base stations is continuing to grow around the world, and it is likely that with the rollout of 4G/LTE technology home base stations will constitute an integral part of Finnish telecom operators' network infrastructure.

Femto base stations are operator-specific, and therefore they can only resolve reception problems for one operator and one household. Furthermore data security, interference and forgery remain recurring concerns. Mutual interference between base stations is more likely to occur in multi-storey residential buildings where large numbers of cells are used simultaneously. Another consideration that must be addressed in home base solutions is the need for frequency allocations.

It is clear that home base stations cannot alone solve indoor reception problems. Firstly, many households in Finland are entirely dependent on wireless broadband, whereas femto base stations needs fixed broadband (fibre/adsl). Another major restriction is that femto base stations do not support older mobile phones, large numbers of which will continue to remain in use in Finland for some time to come. Furthermore the solution may involve some limitations in terms of how they are received by the older population, for instance: at least in other countries femto base stations have been mailed to customers, who have then had to install them themselves.

On the plus side, home base stations have the advantage that they are relatively inexpensive to the end user. They provide good indoor reception in individual cases where there are no other, immediate solutions that would satisfy the user's needs. Network appliance manufacturers expect to see operators increasingly provide home base solutions without cost to the consumer, even though they have to cover the costs not only of home base stations, but also the new control and hub solutions as well as the maintenance of transmission connections (fibre and DSL connections). The Working Group recommends that the home base station option be taken into account in subsequent stages of preparatory work.

A fixed broadband connection also allows for applications that may be useful in situations where an ordinary mobile phone does not have reception inside a building. One such application is Internet telephony or Voice over Internet Protocol (VoIP). In VoIP, speech and data information is transmitted in a packet-switched data connection. In other words Internet telephony does not resolve the reception problems experienced in traditional telephone networks, but it does provide one potential alternative.

When there is no indoor phone reception, VoIP provides easy network access via a fixed data transmission connection. Mobile phone use additionally requires a WLAN base station that is connected to the network. The ease of use of VoIP depends upon each manufacturer's software and hardware. Traditionally, Internet telephony requires a PC or a telephone with VoIP software. New smartphones and even slightly older models support this software. There are also special VoIP phones for sale. VoIP software allows users to make calls from their mobile phone or PC and to send images and other data. Traditional SMS messages cannot be sent, but there is a comparable messaging system via the Internet. Video calls are also possible if the terminal device has a camera. VoIP can also be used to connect to ordinary phone lines. This, however, requires a user account to access the services of an IP operator so that the phone call can be transmitted between networks. Users add credit to their accounts, which is then used to make calls. In most cases it is possible to make VoIP calls to landline or mobile phone numbers, but whether it is possible to make calls in the opposite direction, i.e. to a VoIP address, depends on the Internet Service Provider.

The use of VoIP solutions could be promoted by increasing awareness of the range of services available. It might also be useful to bring the solution to mobile platforms (VoIP software/ISP services – WLAN base station /router – dongle).

7.2.5 Small active repeater solutions

Repeaters, amplifiers and active external antennas have not been designed as consumer devices, unlike mobile terminal devices in which transmission frequency, output level and other transmissions are constantly controlled by the network, so ensuring the quality of the service and the efficient and disturbance-free use of the frequency resource without the consumer needing any radio expertise. This principle has made possible the non-licensed use of mobile network terminal devices.

In contrast to terminal devices, the installation and operation of repeaters, amplifiers and active antennas does require radio expertise and knowledge about the mobile network whose signals need amplifying so that the user does not cause any interference to the network and other users. The mobile phone operator’s network management must be aware that the device has been installed and know its technical parameters so that these can be taken into account whenever changes are made to the mobile network. As in the case of all other mobile network components, the operator’s network management must be made aware of the use and technical parameters of these kinds of devices so that any changes made to the network can be made to apply to these devices as well.

For the time being consumers in Finland are prohibited from puchasing and installing repeaters and active antenna amplifiers. Nonetheless illegal repeaters are readily available online, covering the frequency bands of all operators. These illegal devices can easily cause significant disruption to mobile networks and therefore to other consumers’ mobile connections. Each year FICORA intervenes to explore a number of such cases of interference.

In Sweden, individual consumers need to have the mobile communication operator’s and the Swedish Post and Telecom Authority’s permission to use an active repeater in a frequency band allocated to a mobile operator. The use of repeaters without appropriate permission is a punishable offence. In Russia, too, there are large numbers of small repeaters in use. In Finland active repeaters may only be used by operators, and the devices they use differ both in quality and price considerably from these smaller repeaters.

In Finland the legalisation of small repeaters, amplifiers and active antennas would require legislative changes. The biggest concerns about allowing the use of these devices have to do with the potential interference caused to mobile operators’ networks and with network management problems. According to FICORA one of the problems with the devices using the repeaters’ standard is that that standard has not been designed with a view to radio devices sold for consumers.

On the other hand it is noteworthy that it might be difficult to prevent the spread of non-licensed active devices anyway if reception problems get worse in new buildings and in remote areas. From this point of view it is justified to try and promote the proliferation and use of legal devices.

7.2.6. New radio technologies

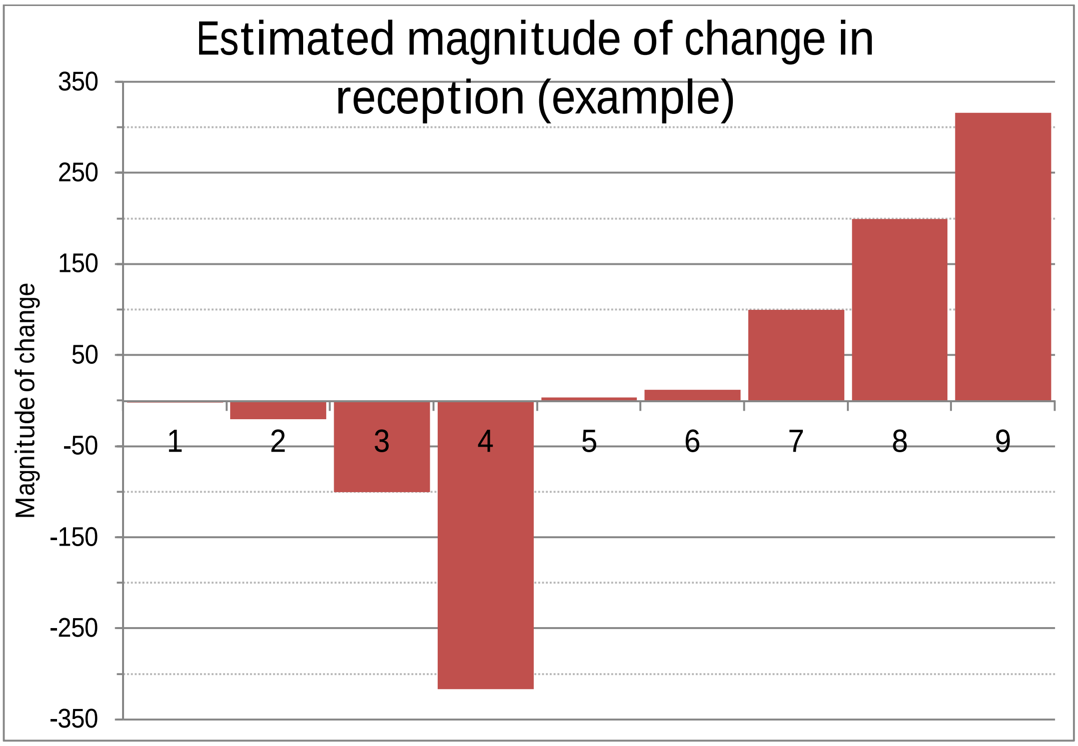
In the future it is thought that among other advances, 4G technology will open up greater opportunities to improve indoor reception. LTE relay devices and femto base station solutions are already included in the requirements specification, which means that it is possible to use consumer-installed equipment without them causing interference. However new radio technologies do not fully resolve all reception problems. For example, in the early stages at least LTE technology will only be available for data transmission, whereas voice communication would still be over GSM and 3G technologies. In the near future, therefore, new radio technologies will not provide a solution to reception problems in mobile voice communication, but can only be expected to improve the situation in the longer term.

7.3 Estimated magnitude of change in reception: example

The impacts of the structural causes and solutions described above on indoor reception in an existing mobile network differ widely from one another. The example here is intended to illustrate the magnitude of the impacts achieved through the proposed solutions in the light of the figures mentioned earlier as well the research reports on which these figures are based. These impacts do not consider the active solutions within the building itself (femto base stations, in-building antenna networks, repeaters and external antennas) because their effect is based on bypassing the radio obstacle, i.e. their impact is always adequate in relation to the original structural obstacle.

The Table and Figure below illustrate the adverse impacts of different measures on reception using a minus sign and their positive effects using a plus sign, giving the effect both in terms of a coefficient and in decibels.

No.	Measure	Change (coefficient)	Change (dB)
1	Impact of mobile phone technology	-2	-3
2	New house compared to old (mean)	-20	-13
3	New house compared to old (worst case)	-100	-20
4	Introduction of selective film windows	-316	-25
5	Fourfold increase in base station density	4	6
6	Replacement of concrete elements with lightweight aggregate blocks (RF aperture)	13	11
7	Partial removal of selective film from windows (RF aperture)	100	20
8	Complete removal of selective film from windows (RF aperture)	200	23
9	Replacement of aluminium-coated insulation sheets with glass wool in wooden frame houses (RF aperture)	316	25



8. Other considerations

8.1. Health effects of radio frequency radiation exposure

With the continuing advances in wireless technology and the ever increasing use of wireless technology, the possible adverse health effects of radio frequency radiation are a subject of recurring interest. In any discussion on the development of wireless technology and ways of improving indoor reception, it is important therefore to address these popular concerns about radiation safety.

According to the Radiation and Nuclear Safety Authority in Finland there is a wide body of international research on the health effects of radio frequency radiation exposure. The only known adverse effect of radio frequency radiation is tissue warming. However at ordinary radiation levels there is no evidence of adverse effects.

There are separate exposure standards for the occupational and the general population to ensure that there are no adverse health effects from radio frequency radiation. Exposure limits for non-ionised radiation in the general population are defined by the Decree of the Ministry of Social Affairs and Health (294/2002), and compliance is monitored by the Radiation and Nuclear Safety Authority.

Some concerns have been voiced by citizens over radiation emitted from mobile network base stations. However surveys by the Radiation and Nuclear Safety Authority have shown that when installed to current standards and regulations, mobile network base stations do not emit radiation levels exceeding the Ministry of Social Affairs and Health standards. The proper installation of antennas ensures that exposure levels in the general population are well below the maximum limits specified. Antennas are installed high above ground level or in otherwise hard-to-reach locations that are not accessible to the general population. Antennas installed on the roofs or exterior walls of buildings cause no significant exposure indoors because the radiation emitted from the antenna is in the forward direction, but very little in the backward and downward direction, i.e. into dwellings and the yard. Transmission output levels from indoor antennas are very low, roughly similar to those from mobile phones, and these antennas are installed in places in the vicinity of which people do not normally stay for long periods. Mechanisms are in place to monitor the placing of antennas, and misplaced antennas will be moved or readjusted so that they cause no harm to the general population.

The Radiation and Nuclear Safety Authority points out that mobile phones, which are held against the ear during phone calls, are in normal use a more intense source of radio frequency radiation exposure than base stations. Mobile phones are the single most significant source of radio frequency fields in living environments. Even exposure from mobile phones does not exceed the limits specified, and it has not been found to cause any adverse health effects to users. However there is as yet no firm evidence on the possible adverse health effects of the long-term use of mobile phones.

Furthermore it is noteworthy that good radio signal reception, which is achieved through a dense network of base stations, for instance, reduces the level of exposure from mobile phones: the better the reception, the lower the mobile phone's transmission power. In normal circumstances mobile phones automatically minimise their transmission power among other reasons to save battery power and to minimise interference to other users. However if reception is poor, the mobile phone has to transmit at full power. Exposure levels are measured with the SAR value. The highest permissible SAR value for normal phone use is 2 W/kg. It is estimated that in a weak radio field a phone call causes exposure levels that represent some 10–60% of this value, whereas in strong fields with good reception the level of exposure is considerably lower. Seen from this point of view finding a solution to indoor reception problems would reduce exposure to radiation from mobile phones – and therefore the Working Group's efforts can also be seen as contributing to combating the health effects of radiation exposure.

9. Working Group's recommendations for further measures

In general terms the Working Group has observed that there can be no single solution to indoor mobile reception problems. Instead it is necessary in each individual case to find the most cost effective and most suitable approach to resolving the problem. One major consideration in weighing different measures and solutions is the type of building, because many solutions are much harder to put in place in existing buildings than in new buildings. Furthermore, some options are better suited to multi-storey buildings and others to detached houses. Most crucially, it is important to promote active collaboration between building designers and building contractors, telecommunications experts and the authorities so that information about reception problems reaches as many people as possible and so that the requirements with respect to radio wave propagation are taken into account from the earliest planning stages in both renovation and new building projects.

The Working Group's concrete recommendations can be divided into two types, viz. shorter term and longer term measures:

9.1 Proposed short term measures

1. Promoting collaboration and awareness among construction industry professionals in the area of radio signal transmission

Proposed measures: Promote closer collaboration between building contractors, building designers, owners and the authorities so that stakeholders have the necessary knowledge and means to avoid reception problems in renovation and new building projects.

Responsible party: Construction industry (information to building contractors and designers and coordination of collaboration) with the support of telecom operators.

2. Consumer information on alternative telecom solutions

Proposed measure: Provide open and easily accessible information about options designed and available for consumer use (e.g. antenna solutions) with which consumers or businesses can autonomously improve their telecommunications connections in their home or place of business.

Responsible party: telecom operators, FICORA

3. Determining attenuations in building envelope by means of RF value

Proposed measure: Determine the equation for calculating the RF reception value as described here for the most common building materials and make the recommendation that it be applied in renovation and new building projects, particularly in detached houses.

Responsible party: Construction industry (concrete advocacy of RF value, guidelines for building contractors and designers) with the support of telecom operators, FICORA and the Ministry of the Environment

4. Making provision for cabling in multi-storey buildings for purposes of an in-building mobile network

Proposed measure: Instruct building contractors and designers to make provision for on-building network cabling and update, at an appropriate junction, the order governing in-building network installation as described in this report.

Responsible party: Construction industry (guidelines for building contractors and designers), FICORA (updating orders)

5. Promoting availability and introduction of legal home base stations

Proposed measures: The authorities shall investigate the need for any updating of rules and regulations concerning the introduction of home base stations. Telecom operators shall actively market their own home base stations.

Responsible party: FICORA, telecom operators

9.2 Proposed long term measures

1. Promoting the availability and introduction of small legal active repeaters

Proposed measures: The authorities shall inform users about legal solutions available and about the problems caused by illegal pirate devices. The authorities shall work closely with telecom operators and other stakeholders to assess on what conditions licences can be granted to small active repeaters, in which cases licences are not required and what steps are needed to promote availability and introduction.

Responsible party: Telecom operators, FICORA

2. Promoting R&D addressing reception problems

Proposed measure: Increase R&D in the area of new building materials and telecommunication network components. Encourage stakeholders to test new innovations and boldly put to use new solutions in preventing and addressing reception problems.

Responsible party: Telecom and building companies, NGOs and authorities (promotion and application of research), R&D institutes and research funding agencies

3. Open and forward-looking drafting of legislation

Proposed measure: In drafting provisions for the telecom and building sector ministries shall take account of both the building construction and telecommunications side by consulting other administrative branches as well as businesses and NGOs in the building construction and telecommunications sector.

Responsible party: Ministry of Transport and Communications and Ministry of the Environment (drafting of legislation and guidelines and coordination of consultations with stakeholder groups)

4. International engagement

Proposed measure: Promote the prevention of reception problems and the development of corrective measures on relevant international forums and particularly at EU level. To kick start international discussion, the analysis and recommendations put forward in this report shall be made available to other EU countries.

Responsible party: Ministry of Transport and Communications, FICORA and Ministry of the Environment as well as construction industry, telecom operators and other stakeholder groups (promotion of awareness and solution-mindedness in European administrative bodies and in other contexts).

9.3 Follow-up of recommendations

Progress made in implementing the measures and recommendations outlined by the Working Group shall be followed up and reported on at a joint meeting coordinated by the Ministry of Transport and Communications between the authorities and stakeholder groups one year after the ending of the Working Group's term of office.

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