State of the Debate on Interference:

Technical Position Paper on Potential Mitigation Solutions and Future Standardization Work

June 2010

This paper serves as a discussion document for the debate on the potential interference by mobile Electronic Communications Networks (ECN) deployed in the 800 MHz band affecting integrated broadband cable and television networks (HFC). It represents the cable industry's views of the current state of the debate on LTE interference and seeks to clarify a number of technical facts regarding the technologies deployed by the cable industry. It also reviews proposals for potential mitigation solutions and presents a position for a way forward in efforts to increase the co-existence of both new and existing services in the 800MHz band.

While there are references to solutions for the cable industry to explore, it is our belief that any potential solutions be considered in a wider context where progress be made with a holistic view of all actors in the ICT community with a view to coexistence. Efficient use of spectrum is only possible if the facts regarding the cable industry and their relation to the wider debate are clarified. Coexistence in the 800MHz band represents the most efficient use of a band currently enjoyed by millions of cable customers relying on broadband, tv and telephony.

Cable's role in Europe is important when considering that cable already delivers high speed broadband services that surpass the Digital Agenda's speed goals. The cable industry already provides +100Mbps across a growing European footprint of DOCSIS 3.0-enabled networks. Our position as challenger to incumbent operators brings the benefits of competition to the European consumer. In the markets where cable invests in its networks, incumbents are spurred into responding with further network investments. All of this benefits Europe, its economy and its citizens.

We continue to invest in the 800MHz band to bring tangible consumer benefits by providing high speed broadband and interactive TV services including HD and VOD. The need for continued bandwidth is not unique to any one market player offering broadband or TV services. As first mover in the fixed line broadband market with an independent infrastructure to the incumbent, we also help to drive the market penetration through competitive pricing.

Our operators are committed to the efficient use of spectrum to the maximum extent. We achieve that through coexistence of mobile and cable services to the benefit of end users; for both networks physical limitations in the separation of signals for their undisturbed transmission have to be considered. To accomplish this demanding task the cable operator needs more spectrum than in the past.

To ensure bridging the digital divide in the rural area while maintaining the diversity of high power broadband fixed line infrastructure, a differentiated approach for rural and urban area has to be made that recognizes the role of a mix of technologies – not a focus on one to the detriment of others.

1 Introduction

Spectrum in the 800 MHz band (790 - 862 MHz) has been assigned for mobile communication networks use by the World Radio-communication Conference (WRC) in 2007. Previously, this spectrum was occupied by terrestrial television broadcasting services. With the introduction of digital terrestrial television and its higher spectral efficiency, these services can be delivered using less frequency resources. This is known as the Digital Dividend. The unused portions of the spectrum are envisioned to deliver mobile broadband services particularly to rural areas in order to help to bridge the Digital Divide.

In integrated broadband cable and television networks (also known as hybrid fibre-coax networks or HFC networks) the 800 MHz band is also used in many cases already now and increasingly in the near future to deliver analogue, digital and interactive television services as well as broadband communication services such as high-speed Internet access and telephony. The change of the electromagnetic environment from primarily a high tower, high power one way transmissions scenario to a mixed mobile and broadcast scenario with mobile transmitters much physically closer to the HFC network gave rise to significant concerns with regard to the potential of interference of mobile and HFC networks. This potential has been proven in numerous studies by national regulators and industry associations and has resulted in the need to reconsider design principles and coexistence scenarios for new and existing communication networks and equipment.

Technical conditions that allow coexistence of mobile networks in the 800 MHz band with other current and previous users of that spectrum were supposed to be defined in CEPT Report 30. However, that report did not consider the presence of HFC networks as pointed out by the cable industry as early as 2007.

This report is an attempt to contribute to the ongoing debate in a constructive way by considering various proposals for mitigation measures that are intended to limit the interference from the deployment of mobile communication networks (particularly LTE) in the 800 MHz band to HFC networks and the attached CPE. The proposals are assessed with regard to their technical feasibility and their impact on the ability of HFC networks to technically and economically efficiently deliver high-quality communication services to millions of users throughout Europe.

2 Interference Scenario and Mitigation Approaches

Interference to the HFC network generated by mobile communications networks can occur due both to the transmission from the base station and due to the transmission from the mobile terminal. Previous studies focused on interference from the mobile terminal (user device). Measurements have shown that the susceptibility of some network elements to this interference is significant. Recent analysis has also shown that using parameters for the mobile network as defined in CEPT Report 30 and referred to in the technical implementation decision of the European Commission, there is also a significant potential for interference from the base stations to the cable distribution network and in-home equipment. It must be noted that interference from the base stations can even be more significant than that caused by the mobile terminal: A base station transmits continuously and the interference potential will be constantly there for users within a certain range around the base station.

It is clear that a large number of cable customers can be affected by the interference. Besides interference from the mobile terminal typically affecting only services consumed in the immediate vicinity, interference from the base stations can affect not only the viewer within their home but several viewers sharing a part of the distribution network (e.g. all customers behind the same amplifier, the same optical node).

Many cable operators already use the channels up to 862 MHz including the frequency band that is potentially subject to interference. Any argument that these channels are not used, or are of less importance to cable operators is not correct. Cable operators are using the channels to provide the total range of services. If the channels cannot be used, it lowers the total capacity that operators can use to provide services to their customers, now and in the future. This capacity can be used for Video-on-Demand, high-definition TV, high-speed internet or other services. As all services share the same physical channel, disturbance of that channel by interference from mobile communication affects all services to the same extent. In a disturbed channel, it is not possible anymore to provide any service.

The cable industry shares the Commission's view on the critical role that NGA deployment may have to support the further development of the European economy. HFC networks are at the forefront of these developments in Europe as some cable operators have started or are about to start offering ultra high speed broadband services of up to 200 Mbps. Upgraded HFC networks therefore represent one of the first NGA networks in the European Community and are very well positioned to compete with the incumbents. However, competition with other NGA networks will be hampered if cable operators are prohibited from making full use of the intrinsic total capacity of their networks. In order to keep up with other fibre based NGA networks, cable operators continuously invest in their networks, e.g. by node splitting and implementing state of the art transmission standards. Coexistence scenarios should take this into account. This paper therefore only covers mitigation measures that allow cable operators to make full use of the intrinsic capacity of their networks. Any mitigation measure that requires cable operators to stop using certain channels should not be considered.

The analysis of proposed mitigation techniques must not be limited to the evaluation of technical aspects. Each measure may also have a more or less significant economic impact requiring investment by the consumer of fixed broadband and television services and/or by the HFC network or mobile network operator. As soon as significant changes to network design and architecture or operational procedures are required to apply a mitigation technique, considerable cost is attached to its implementation both with CAPEX and OPEX. In this way, a sound technical solution efficiently mitigating the interference generated by mobile communication services may still be inacceptable for deployment without proper compensation of its economic impact. Only those proposals with technical and economic merit should be considered.

Another determining factor for the effectiveness of mitigation measures is the timeframe in which it can be deployed. Improving the shielding of the end-to-end system (i.e. not only of the user equipment like TV sets and STBs, but also of the in-home network) would help limit the interference. Successful deployment of this measure, however, requires that the shielding effectiveness is improved for all elements within the home installation from the entry point into the home, cables, connectors, splitters, CPE and TV. The availability of appropriate equipment depends on factors that are beyond the control of the network operator such as the development cycle of CPE manufacturers and their capability to make sufficient quantities available as well as the lifetime of CPE in the market. With the typical lifetime of a TV set 8 to 10 years, and that of cable modems and STBs a bit less but still in the order of 5 years, it would take a significant amount of time before the majority of users is equipped with improved devices.

3 Proposals for Mitigation Measures on HFC Networks and their Assessment

3.1 Mitigation Measures affecting CPE and In-home Installations

3.1.1 Improve Shielding of STB – Swap Devices

While it can be expected that improved shielding of devices would lower the likelihood of interference, this certainly comes at a cost for the operators and manufacturers and needs to be studied further to determine the new electromagnetic environment against the current reference. In this way, equipment suppliers can determine the limits they now need to achieve when costing in design solutions for their equipment that includes increased shielding effectiveness. It is also clear that swapping out the currently installed devices is a significant investment and cost to the operators and consequently the consumer and will take time. TV sets are not owned by the operator and as such the operator has no control over swapping out these devices. As mentioned, the standard lifetime of a TV set is about 8 to 10 years, for STB and cable modems it is a bit less. Given the number of CPE devices – it is a significant figure even if only cable households are considered which amount to about 74 million with several CPEs in each household – the capability of manufacturers to produce them and the capability of the service provider to distribute and fit the unit to the end user adds additional delay. It will take some time before there will be a significant portion of the devices in the market that have improved shielding.

It must be clear that based on the current requirements of the EMC [2004/108/EC] or R&TTE [99/5/EC] directive, boxes that are compliant to these, can suffer greatly from interference. Many deployed devices already perform better than the requirements. However, as measurement results show, even the best CPE with current design would not provide sufficient immunity in the presence of mobile communication services. Making the requirements even more stringent creates a significant extra cost for the cable and CE manufacturer industry.

After considerable diligent investigations, testing and discussion with suppliers of network equipment and software, there are no simple ways to improve immunity of CPE in the short term.

Moreover, with proper shielding of the devices interference can be introduced to the device by the cabling, connectors used and wall outlet (so called conducted interference).

3.1.2 Improve Integrity of In-home Installation

Appropriate protection of the in-home installation would require increasing the immunity of all components including all cabling and connectors (covering fly leads and HDMI cables as well) and all passive and active components (e.g. wall plates, splitters, isolators, amplifiers). In many countries, the installation of the network connection beyond the network termination point (e.g. wall plate) is outside the control of cable operators. While initial installations are usually performed by the operator or a contractor, there is no way to prevent the home owner to change that afterwards. Several cable companies have in recent years begun to certify and promote the use of proper in-home materials. The Dutch cable industry, for example, actively promotes the sale and use of ‘Kabel Keur’ certified materials which are cable accessories recommended by the cable industry as meeting high standards for best performance. Such best practice guidelines for optimal cable construction and appropriate material remain voluntary and there is no guarantee that they are followed.

3.2 Mitigation Measures affecting DOCSIS-based Data Communication

3.2.1 Functional and Operational Principles of DOCSIS

While all services use the same physical channel, specific protocols and signal formats are used to deliver the service to the customer premise equipment (CPE) and, finally, to the user. Besides that, depending on the type of service there is a difference in the number of users consuming a certain portion of the data stream at any given time and, thus, would be affected by interference simultaneously. Mitigation measures might try to exploit these variations. Particularly, the DOCSIS system has been subject to many proposals whose assessment requires a thorough understanding of the underlying functional principles.

DOCSIS is used to deliver IP-based data communication sessions across HFC networks. It is specified under the leadership of CableLabs® in international standards applicable worldwide and is defined by specifications available at http://www.cableeurope.eu/index.php?page=eurodocsis. A technology option accommodating the specifics of HFC networks as deployed in Europe is known as EuroDOCSIS. All considerations below are referring to the European technology option.

The fundamental architecture of an HFC network is a shared system with a central entity (head end) serving up to multiple thousands of end devices (See Cable Network Handbook: http://www.cable-europe.eu/uploads/Specs/CEL-TR-HFC-HANDBOOK-V4_3-091001.pdf). Most relevant for the purpose of this document is the coaxial part of the network extending from the optical node to the CPE. Each coaxial segment can exploit the full frequency spectrum from typically 85 MHz up to 862 MHz (for transmission towards the user). EuroDOCSIS is making use of that underlying architecture.

A group of cable modems - hundreds within a segment - are operating on one or more specific frequencies. It is possible that all cable modems within that segment operate on a single frequency, when only one frequency is available. This channel is continuously received by each cable modem. It contains information for all cable modems (for synchronization, MAC functionality and management purposes, among others). The packets for a specific cable modem are embedded in that stream of information as well and are identified by the device address contained in the protocol header.

It should be noted that the complete data stream has to be decoded up to a certain level in order for a specific modem to filter the relevant packets. Because these packets can be made available at any moment in time, the modem does not know beforehand when a packet will arrive. This allows efficient use of the network resources as it is required for high-speed delivery of internet services. At a specific moment in time, multiple consecutive packets can be sent to a single cable modem, or none.

In summary, the signal delivery in EuroDOCSIS relies on the shared nature of the HFC network architecture. All modems receive all the data delivered on the channel to which they are tuned. A modem can only decide that packets are destined to it *after* decoding. Protocol mechanisms above the physical layer ensure that the point-to-point paradigm of IP communication can be accommodated. Figure 1 depicts the embedding of packets for different modems into the data stream delivered across one of the channels in the frequency spectrum.

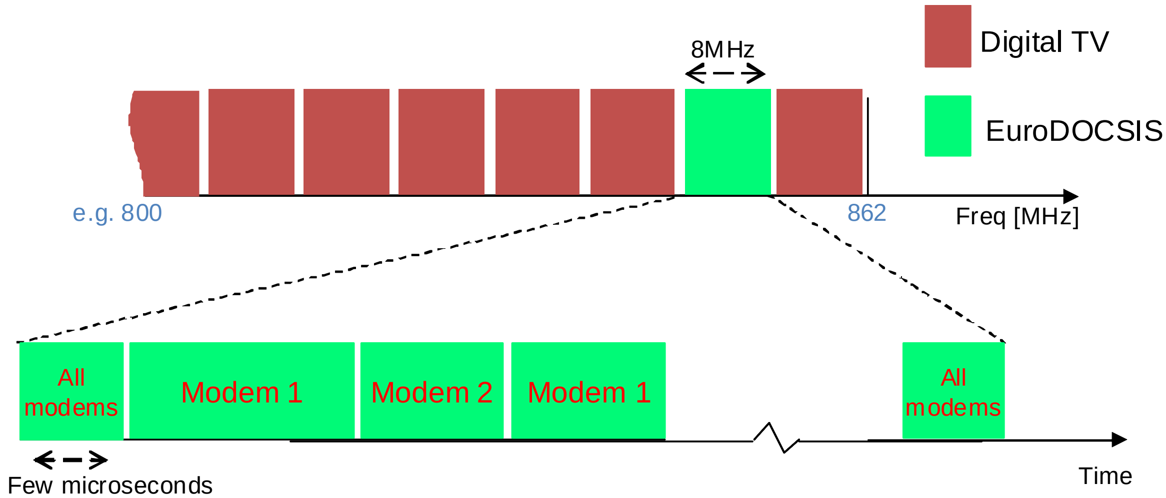

Figure 1: Operation of EuroDOCSIS
(Note: not all occupied channels are shown, typically the full spectrum the network is capable of is used, the assignment of channels can vary significantly from operator to operator, neither the number channels assigned to a particular service nor their positioning with digital channels exclusively at the upper band and EuroDOCSIS channels on top of them is fixed)

Considering the above, it would be wrong to assume that a single EuroDOCSIS channel (8 MHz bandwidth) is divided into multiple sub bands; each sub-band is assigned to a specific cable modem on that segment. Since each segment can have hundreds of cable modems, such a fixed assignment would imply a fixed assignment of only a small portion of the total payload transport capacity of a single 8-MHz channel of about 40 Mbit/s to an individual modem. It is clear that, in this case, it would not be possible to offer high-speed internet services with 10 or 25 Mbit/s and more.

It is equally wrong to assume that each cable modem is exclusively assigned to an 8-MHz band. With hundreds of cable modems on a single segment spectrum resources would be exhausted fairly soon.

3.2.2 Selective Assignment of DOCSIS Channels based on Information about ECN800 Interferer

In EuroDOCSIS, cable modems are not assigned to frequency resources individually. Many cable modems share channels and data streams. With currently deployed CMTSs and CMs it is not possible to dynamically re-assign a modem to a channel that is not being interfered by ECN800, in particular not by taking into account the customer address (post code, history of disturbance or its relative location to a base station).

There seems to be a general assumption that a single cable modem can choose from multiple DOCSIS channels to receive a service. However, this assumption is incorrect. While high-speed data usage in some areas has risen to a level where multiple channels are required to satisfy customer demand, many areas are still serviced by a single channel. Even in areas with multiple channels available, they are used in conjunction to provide the required service quality and not alternatively. DOCSIS cable modems will receive many if not all of the available downstream channels simultaneously.

Thus, it is not realistic to assume that, in general, there will be a choice of independent downstream channels, some within the band overlapped by ECN800 and some outside that band. If the network were to be configured in this manner, it would be operationally challenging to restrict certain cable modems deemed to be likely targets of interference. It is not currently possible to gauge the likelihood of interference based on customer address or postcode or geographic location, e.g. near the base station. There is no way with existing equipment or with equipment to be deployed in a short timeframe that an operator could conclusively determine whether a particular instance of packet loss was caused by ECN800 equipment. Studies would need to be conducted to find out if it is even feasible for an individual cable modem to detect the presence of an ECN800 interferer.

For set-top boxes, a DOCSIS channel is generally used for low bit rate communications related to STB functions (e.g. VoD transactions, delivery of EPG and System Information etc.). Typically, a single channel is utilised to serve as this signalling channel for a large population of STB. Allocating multiple channels for this purpose (some within the ECN800 band and some outside) is unlikely in current systems.

3.2.3 Enhancement of DOCSIS

The inclusion of additional flexibility with regard to the assignment of transmission channels into a future generation of DOCSIS or the increase of its resilience would require a significant change to the DOCSIS system. Still it would not work with the installed base of equipment. It would also come at high cost and will lower the capacity on a cable network.

3.3 Mitigation Measures within the Operating Frequency Range of HFC Networks

3.3.1 Spectrum Usage

The assignment of channels to specific services is a complex process. Cable operators have to consider the overall service portfolio they want to offer, capacity requirements for each service, availability of channels in a specific network segment, local signal quality, technical limitations on the channel usage, user expectations etc. Therefore, channel line-ups vary significantly from operator to operator, from market to market and from region to region. There is no typical parameter, neither on the number of channels for a particular service or on their location within the spectrum. Therefore, it is impossible to predict neither which kind of service will be affected with a particular occurrence of interference nor how many users will suffer from it. As pointed out earlier due to the nature of the signal transmitted across the mobile network in relation to the signals transmitted across the HFC network it is most likely that all services carried on the channel will be disturbed once interference occurs. As such it would be inappropriate to consider interference in the upper portion of the spectrum affecting EuroDOCSIS services less severe than interference in other frequency areas occupied with other services.

It must be clear that the disturbance on the Internet service is not insignificant, because in case of the disturbances observed by the measurements, it was not some limited amount of packet loss that was observed, but it was the whole service that was affected. Note that this also means that the telephony service was not working, since it uses EuroDOCSIS. It is important to note that users will not always be aware that their telephony service is not working, (they cannot be reached and as such do not know that they are being called) so users themselves cannot be triggered to remove the interferer in such a case. To move the EuroDOCSIS service dynamically to another frequency is far from simple as should be clear from the explanation in Section 3.2.1.

Cable operators designed their networks against harmonised EMC standards resulting in the assumption that there is sufficient immunity against all external sources of radiated interference. As incumbent users of the frequency spectrum within the cable distribution network, cable operators aligned their spectrum requirements with the capacity requirements of services such as TV broadcast, high-speed data internet broadband, telephony and interactive services they are offering to the millions of subscribers. Therefore, there is typically no available free space in the frequency spectrum operated within a cable system.

Since digital TV and EuroDOCSIS are subject to interference in the same way (same modulation) and even analogue TV is subject to interference in some cases, a fixed assignment of channels to services with a prescribed ordering is not a suitable mitigation measure. Operators need and use the capacity for their total range of services. A distinction between disturbance on the TV service or Internet service is not relevant, since interference always results in the fact that the channel is just not usable and as such results in a decrease of service quality and available capacity.

Cable operators are very innovative and have made significant investments in the deployment of new services. Services that are increasingly demanded to accommodate the further development of an information society are requiring more capacity. Such services include:

- High-speed internet services (>100 Mbit/s)
- High-definition television
- Video-on-demand
- Non-linear viewing
- 3D-TV (requires more bandwidth than 2D)
- Commercial services (provided to customers ranging from SME to large enterprises)

3.3.2 Frequency Selectivity

It is not relevant if the frequencies suffering from interference are used for analogue TV, digital TV or EuroDOCSIS, this is only a channel allocation issue. But since all services equally suffer from interference, it comes down to a decision which service will be interfered with. If it is the TV service, customers will have a poor TV watching experience (blocking or even total loss of signal as experienced in laboratory testing). If the channels are being used for EuroDOCSIS, customers will suffer from loss of internet service (and as a consequence telephony service).

As a second point, it is very difficult, if not impossible, to determine which channels are potentially subject to interference through prediction of the transmit power of the UE based on a location (be it address, postcode, proximity to the base station) or user characteristics. The UE that interferes with the STB will be indoors. Since for an indoor situation the UE typically transmits at higher power (compensating the attenuation by walls, for example) any location based solution does not make sense.

With respect to EuroDOCSIS, interference will typically cause the cable modem to drop offline, which means that all IP-communication, including telephony, is not possible anymore. When the interferer is removed, it can take a significant number of minutes before the cable modem is operational again. In a certain segment, only a limited number of channels are used for EuroDOCSIS. In the case that the cable operator offers 100Mbit/s+ services, four channels are typically used but for newer services this will increase to eight channels or more. A EuroDOCSIS 2.0 cable modem will tune to one frequency and will use that frequency for a long time, in many cases only one frequency is available for the group of cable modems (100-500) in that segment. Allocating a different frequency to that cable modem is not possible, since it is just not available. Moving the EuroDOCSIS channel to a different frequency means that another service (digital TV) needs to be moved to the frequency that suffers from interference. So the likelihood that in that case somebody suffers from interference on the digital TV is high. Dynamically changing frequencies for digital TV results in loss of picture for some time and, as such, this technique is considered unviable and cannot be used. Once the movie or show has started, the reception has to be flawless. Dynamically changing the frequencies used for EuroDOCSIS also causes modems to lose service and requires significant time (can be minutes of time) to recover. In general, dynamically changing the downstream frequencies used in the network does not work independently of the service.

3.4 Mitigation Measures affecting Design and Operational Principles of HFC Networks

3.4.1 Increase Number of Optical Nodes

Increasing the number of optical nodes creates additional capacity on the HFC network but this comes at a considerable cost to the operator with this investment driven by customer growth subject to business requirements. Operators have an obligation to split nodes anyway to keep up with the customers' demand, but those node splits have been planned since a long time, taking into account growth of services.

Therefore, node splits would not allow confining frequency usage to an area outside of the potentially interfered spectrum and would not enable higher signal strength or an increased signal handling capability of CPE. Consequently, they will not prevent interference of mobile communication services with cable services in the same frequency.

3.4.2 Increase Signal Power in HFC Networks

HFC networks have been designed taking into account the current state-of-the-art technology for amplifiers and other equipment. They are a finely adjusted system and, with the range of two-way signals present at frequencies between 15 - 862 MHz, a careful balance of signal levels is necessary to compensate for the transmission losses whilst not overloading amplifiers and especially CPE.

By simply increasing the signal power, more non-linearity might be introduced. Since in a HFC network multiple amplifiers are in cascade, changing the signal power has a significant impact on the whole network design. Most network amplifiers already operate at the upper end of their range and there is no possibility to increase their output power. Adding extra amplifiers may prove impossible due to existing cascade limitations (impairment thresholds) or limitations on power consumption due to the risk of overloading line-powering arrangements. Overcoming those limitations would require major re-engineering at considerable cost and time.

It must also be considered that the current design was made in such a way that the emission from the network is within the requirements prescribed in Europe by Harmonised Standards. It does not make sense for cable distribution network to violate the limits given by the harmonised standards when increasing the signal power.

3.4.3 Selectively Use More Robust Modulation

There are two possible modulations in the downstream, 64-QAM and 256-QAM. The modulation scheme is the same for all modems operating on that channel. For network planning (from a power management point of view) the power of the less robust modulation will be less than the power of the more robust modulation. As a consequence they are equally susceptible to interference. This has been verified by measurements. It is worth noting that more robust modulation has significantly less capacity. As a consequence, customers would have lower speeds or operators would need to increase the spectrum bandwidth by approximately 30% to compensate for the loss in capacity.

3.5 Mitigation Measures involving User Education

3.5.1 Increase the Separation between STB and Mobile Terminal

To effectively reduce the interference, a significant geographical separation between the CPE connected to the HFC network and the mobile terminal might be needed. In some cases neither the interferer nor the victim might be aware that interference is occurring. An example is the interference to the internet connection while the customer is not surfing the internet, but the phone and internet service might be down due to the impact of the interference. Another example is that if somebody has a planned recording of a movie, the STB will automatically record the movie, but if the interference happens during the recording (making the recorded content unusable) the interferer will have no notification. In cities, interferer and victim could be in a different house/apartment. So while this technique reduces some interference occurrence, it is certainly, by itself, not sufficient enough to reduce it to an acceptable level.

Additionally, since the transmission from the base station (downlink) can also create significant interference, the distance to the mobile terminal is not relevant. A cable customer can not be requested to move because he suffers interference from a base station.

4 Proposals for Mitigation Measures on Mobile Networks and their Assessment

4.1 Selective Limitation on Transmit Power of Base Stations and Mobile Terminals

The level of disturbance of services delivered across HFC networks is mainly determined by the strength of the interfering electrical field which in turn is influenced by the transmit power of the generating signal. The (selective) reduction of the transmit power of the LTE-equipment (terminals and base stations) based on location or environment should provide effective mitigation of the interference effects. This way the LTE power levels and thus the resulting radiated electromagnetic field can be limited to safe levels that ensure no interference to the viewers and broadband users depending on the location of deployment. With this management of the maximum transmit power in areas where likelihood of interference is high, LTE-equipment (both user equipment and base stations) maximum transmit power would be controlled to be of a level that ensures coexistence. In areas where likelihood of interference is low, the maximum power could be higher but still ensuring coexistence without disturbance to consumers of TV and broadband internet services. Including such a mechanism for maximum power control and management in the specifications should be feasible at a minimal cost, and has to be done now, since no equipment is yet deployed.

For the mobile industry any decrease in maximum transmit power has an influence on the network layout (number of BS required, speeds that can be achieved etc.) and as such to the value they place on the spectrum. For initial deployments, having the highest possible transmit power is important, since it makes it easier to achieve full coverage for the service. By having a maximum power control function in the system, where the maximum power that can be used by the mobile terminal is controlled by the BS to which it is connected, in areas of higher risk to interference this risk can be reduced. Regulatory intervention might be required in order to achieve a maximum power control that is in-line with the specified power limits that are not causing interference.

5 Proposals for Mitigation Measures on a Collaborative Basis

5.1 Alignment of Roll-out Timescales

Time scales for the deployment of mobile communication networks in the 800 MHz band and the availability of CPE and network component compliant to the changed requirements of the electromagnetic environment suggest that cooperation between mobile operators on their roll-out plans and HFC network operators on their deployment plans would enable targeting of affected areas to maximise available resources.

Affected equipment in HFC networks will have to be gradually replaced by new devices with improved shielding effectiveness. In combination with the maximum power control technique in mobile networks, this would mean that after sufficient time, the maximum power control feature could be reduced, since the devices have achieved increased immunity as is economically and technically feasible.

6 Standardisation for a Sustainable Approach in the Long Term

While there is significant ongoing effort to define co-existence scenarios for the short and medium-term – and this paper seeks to contribute to this discussion constructively – the ultimate goal must be the smooth coexistence of mobile ECN networks and HFC networks in all concurrently used frequency ranges. The initial focus is determined by the re-assignment currently taking place in the 800 MHz band. However, there are already quite clear indications that a further liberalisation of the 'former' broadcast spectrum 470 - 862 MHz is under consideration. Long-term solutions should be sustainable through further 'Digital Dividends' to prevent uncertainty for the roll out of innovative digital TV and broadband services.

The work started by industry, namely within WG 10 of CENELEC TC 210 operating jointly with ETSI, must be continued under the umbrella of European standardisation organisations. After a thorough characterisation of the electromagnetic environment in the presence of mobile communication services in the 800 MHz band, appropriate standards for radio and electromagnetic compatibility have to be established or updated as appropriate. Experts committees within standardisation bodies being responsible for the relevant standards will have to open up work in order to review the new requirements with a view to improve the performance of the equipment immunity and screening efficiency. Particularly relevant standards include:

- EN 55024: Responsible CENELEC TC210
- EN 55020: Responsible CENELEC TC210
- EN 61000-4-3: Responsible CENELEC TC210
- EN 50083-2: Responsible CENELEC TC209
- Installation and cabling standards as maintained by CLC/TC 206, CLC/TC 209, CLC/TC 215 and ETSI ATTM AT3

Consequently, the standardisation work needs to carried out in close cooperation of CENELEC TC210 (responsible for EMC), CENELEC TC209 (responsible for cable physical layer), ETSI ATTM AT3 (responsible for functional and protocol aspects of cable).

Cable Europe is currently working with the wider industry (including equipment suppliers as well as vendors of measurement equipment) to determine new requirements and will contribute actively to the work of the standardisation committees.