Cable TV Receivers and New Radio Services in the 800 MHz band

An operator perspective

Simon Pike

Chief Engineer, Regulatory and Spectrum

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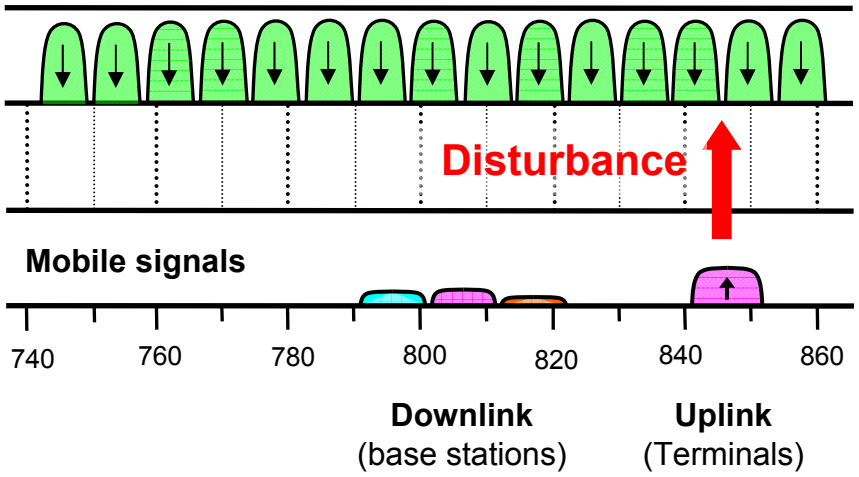
vodafone

Introduction

- The Commission set ETSI and CENELEC an extremely challenging timescale
  - A large amount of data has been collected
- There is enough information to identify the key ways forward for cable networks
  - This does not need more quantitative analysis of the current situation
- This presentation focuses on the potential for disturbance to cable TV networks
  - This has been the main focus of attention in the CENELEC group
  - It is also the most pressing case to address
- This presentation considers the expected future situation, not extreme cases
  - This is the criterion of the ‘essential requirement’ for immunity in the EMC Directive

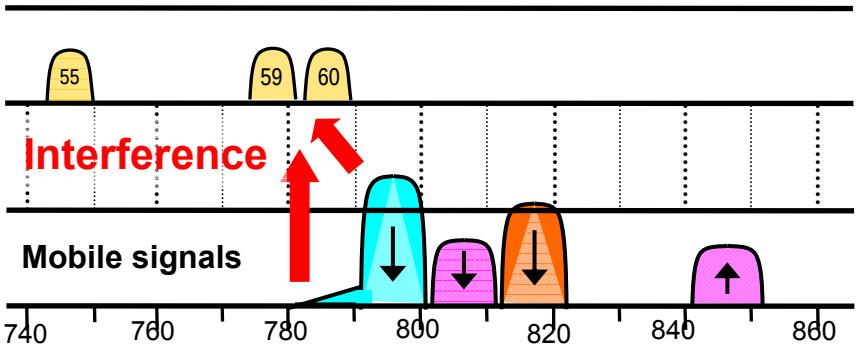
Interference mechanisms in a cable network

Cable network



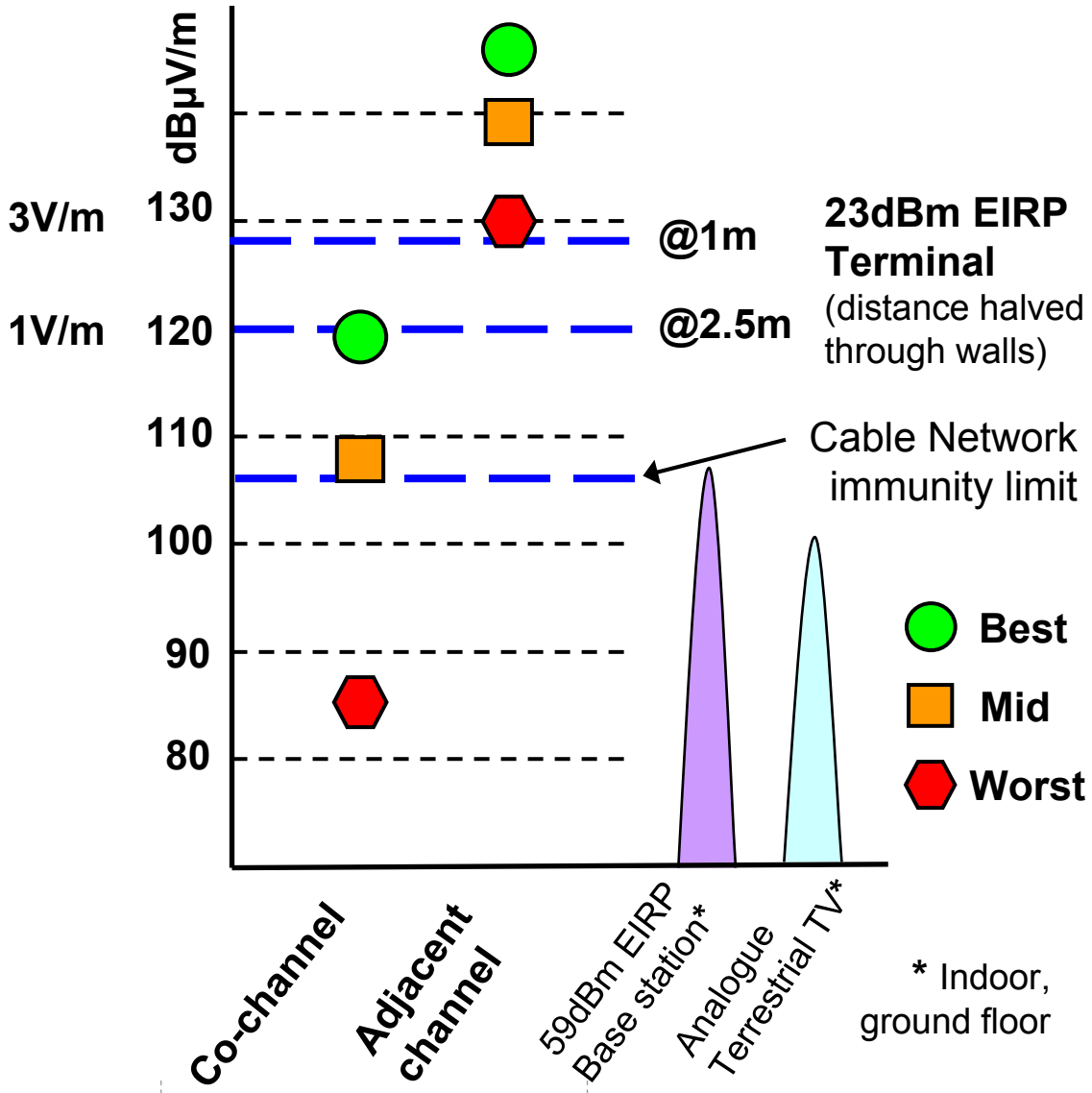
- Limiting case is co-channel interference
- All channels are used
  - Within network bandwidth
- Mobile signal enters through shielding
- Mobile signal is weaker than cable channel at demodulator
  - Interference effects are “linear”
- Unwanted emissions are not significant

Terrestrial TV broadcasting



- Co-channel interference cannot occur
- A few channels below 790MHz used
- Both signals enter through antenna
- Mobile signal is stronger than terrestrial channels at antenna connector
- Unwanted emissions are important

Immunity of current set top boxes

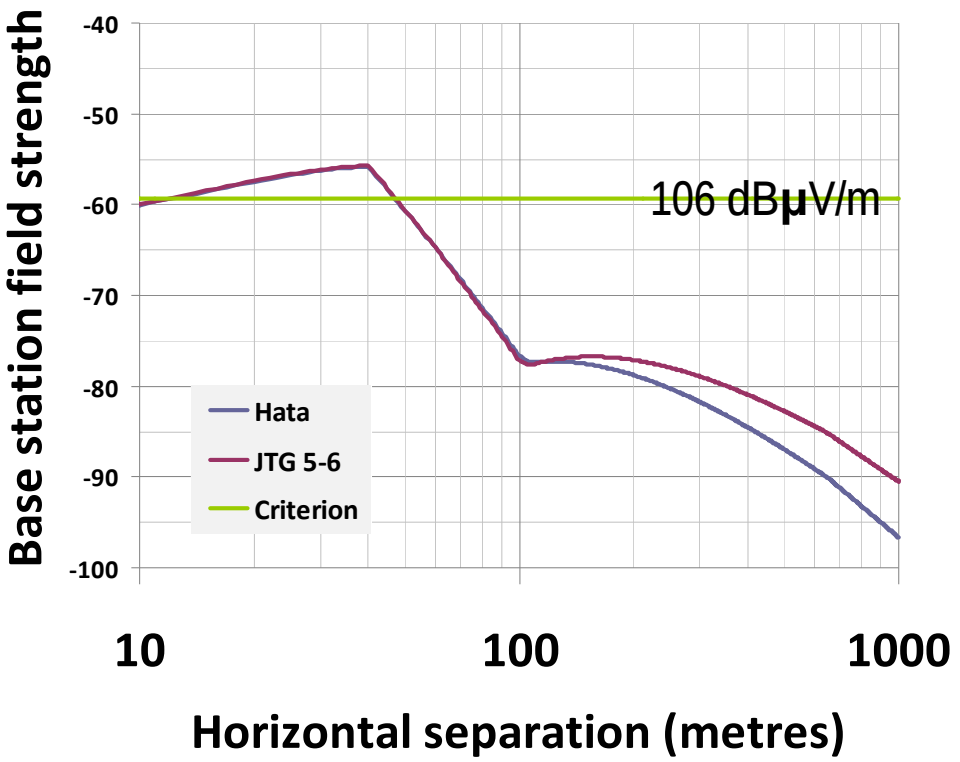


- Co-channel interference is a potential problem
  - Limiting case is terminal
  - Worst performing CPE may suffer disturbance from base stations
    - But they also have inadequate immunity for current analogue TV signals
- Adjacent channel interference is ***not*** a problem
  - Even with current CPE

Based on Cable Europe Labs measurements

(CEL-DD02-S, Graph 1)

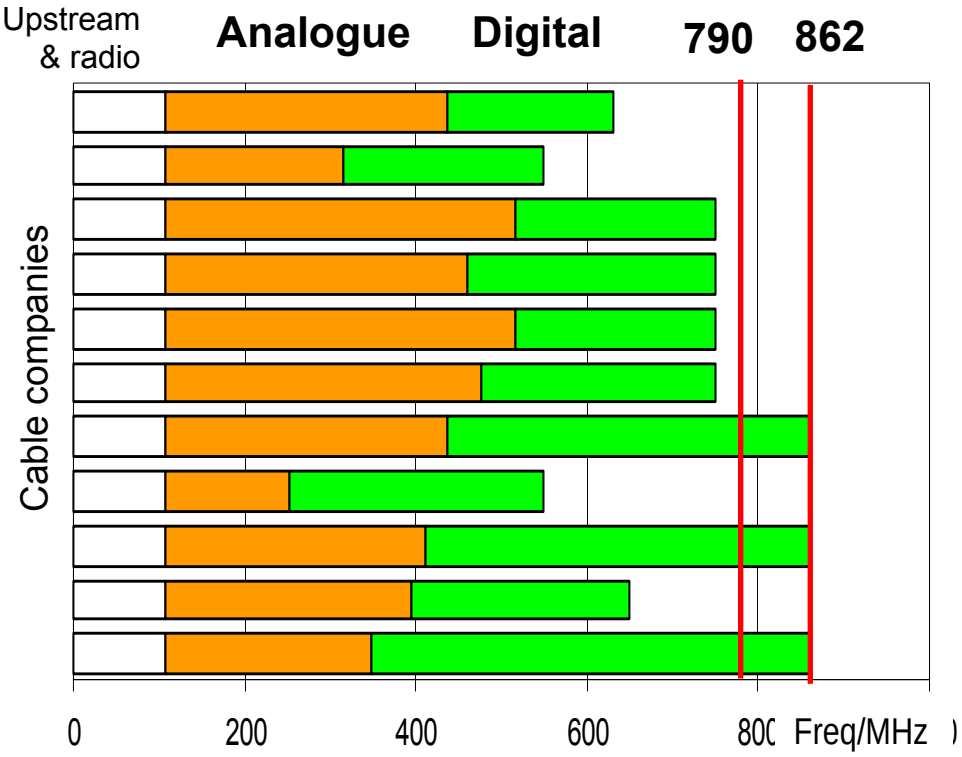
Emissions from base stations



Typical urban/suburban basestation deployment:
- 59dBm EIRP (as in CEPT Report 30 studies)
  - this is near the upper end of the practical range
- 30m antenna height above ground
- Field strength is outdoors at 1.5m above ground

- Field strength only exceeds 106dBµV by a small amount, and only over a small radius close to the base station
  - For the base station deployment expected in urban and suburban areas
  - Optimisation of base station antennas might improve this
- Cable networks have better immunity in practice
  - Immunity of digital channels is better than analogue
    - 106dBµV applies for analogue PAL
  - The limit applies to all cable networks. There are two classes of screening for cable network components, and most networks use the better Class A.

We understand that many cable companies are not currently using these frequencies



Bandwidth utilisation of cable networks

This data is drawn from most recent annual reports of companies that operate cable networks. It is indicative of the bandwidth generally used in the networks of that company in a particular EU country.

- Many cable networks do not operate above 790MHz
  - Operation above 790MHz is a consequence of providing a large number of analogue channels
  - For interference from terminals, only the top four cable channels above 830MHz are significant
- These cable networks will not be affected by mobile networks above 790MHz
- Future network enhancements will meet new immunity requirements

Solutions: mobile terminal is usually the limiting factor

MOBILE
Would degrade user experience to WiFi-like

CABLE
New standards with improved immunity

CABLE
Unable to increase signal levels in network

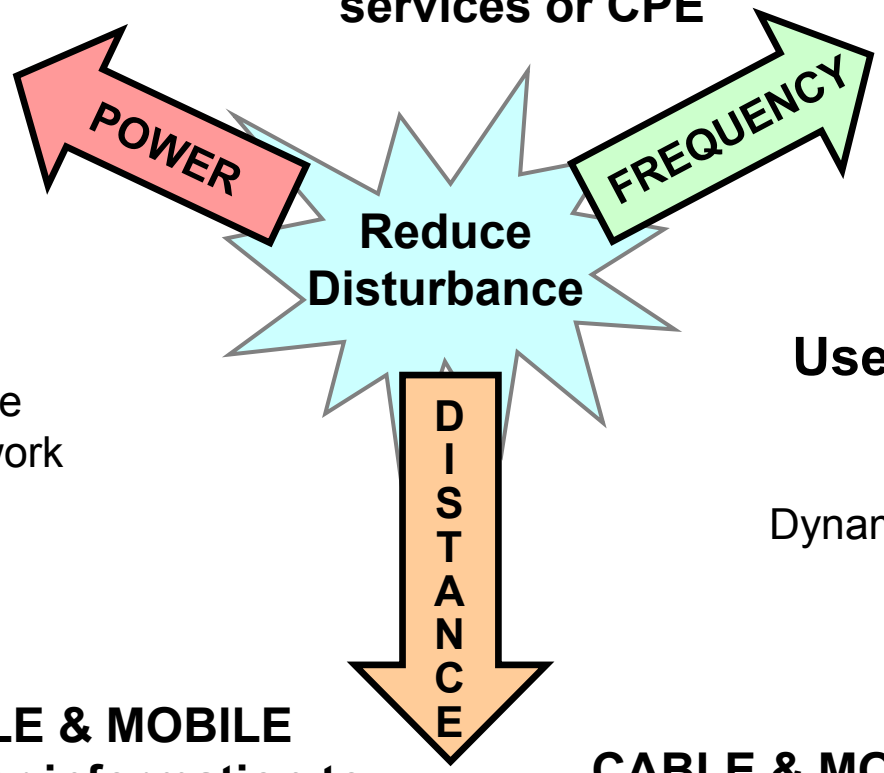
CABLE
Use top few channels for less susceptible services or CPE

MOBILE
One channel per operator
Unable to shift frequency

CABLE
Not using top few channels

MOBILE
Use CEPT bandplan

CABLE
Dynamic channel assignment
(too long term)



CABLE & MOBILE
Customer information to keep CPE and phones apart

CABLE & MOBILE
Cooperate over network deployments

Key conclusions

- The potential for mobile networks to disturb cable TV is less than feared
  - Basestation impact will be small, for expected mobile deployment
  - Many cable networks do not use the channels that might be impacted
    - Only the top four channels out of 94
  - Many cable networks will be upgraded in the next few years
    - The upgraded networks will meet the new immunity limits
    - These will require new CPE, which can be designed to the new immunity limits
      - These can use the top few channels

EUROPE'S LEADING CABLE OPERATORS SIGNAL THEIR SUPPORT FOR DVB-C2

22 September 2009 – Nine of Europe's leading cable network operators, representing more than 35 million connected homes, have shown their immediate support and declared their intention to exploit the operational potential of DVB-C2. In a signed statement cable network operators YouSee (Denmark), Numericable (France), Kabel Baden Württemberg, Unitymedia, Kabel Deutschland (Germany), Ziggo (The Netherlands), ZON (Portugal), ONO (Spain) and Com Hem (Sweden) welcomed DVB-C2, the second generation baseline transmission system for digital television broadcasting via cable networks.

- Vodafone believes that the new immunity limit for cable CPE should be 3V/m
  - 1V/m will still result in some cases of interference.
  - It does not meet the stated quality of service expectations of the cable community
  - The performance of coaxial cables (especially fly leads) needs to be addressed
    - Otherwise, these may become the limiting factor
- There are shortcomings in the current Standards regime for cable TV equipment
  - EN 55020, 55024 and 50529-2 (not yet published)

Thoughts for regulators

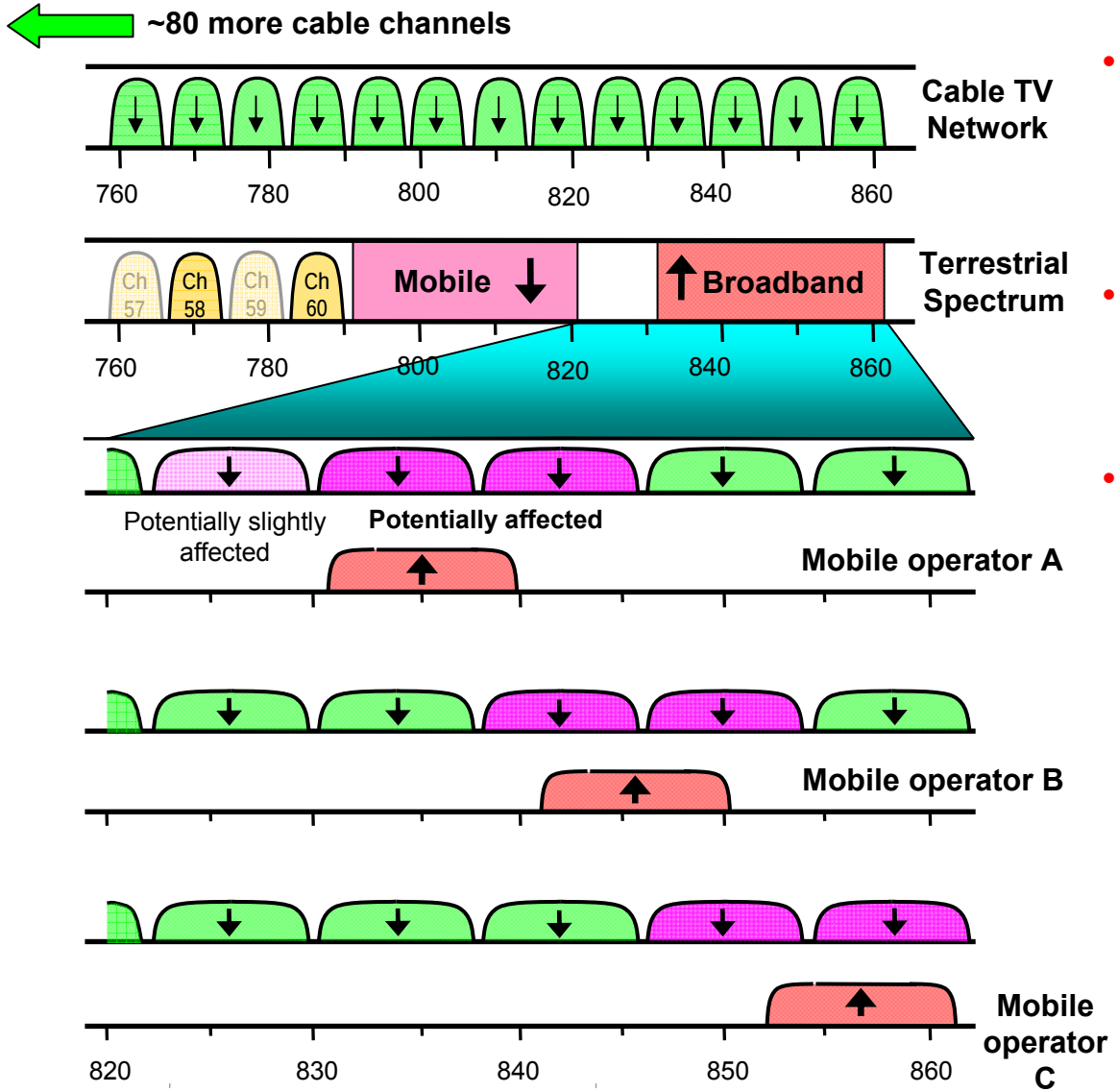
- Regulators should adopt the CEPT FDD bandplan
  - This will provide clarity for cable operators
- Regulators need to understand the extent to which cable networks currently use frequencies above 790MHz
  - If a cable network does not operate above 790MHz, there will be no interference
  - Future cable network enhancements will anyway need to have adequate immunity
- Regulators should consider the extent to which cable networks and their customers are given preferential treatment over terrestrial television viewers
  - Terrestrial viewers will generally be expected to purchase new digital set top boxes
- There is adequate time to implement the measures needed
  - In most countries, mobile networks will not be deployed in this band for a few years.
    - In Germany, the deployment of mobile networks will follow a defined sequence
- Regulatory constraints on mobile network deployment should not be needed

Backup slides

Interference mechanisms in a cable network

- The limiting case for interference to a cable network is co-channel
  - For co-channel interference, the interfering signal is then substantially weaker than the cable signal at the demodulator in the equipment
  - The primary interference mechanism is therefore linear.
    - The only possible exception is a CPE with a 'can tuner' where the ingress signal by-passes the filtering in the tuner. However, such a tuner would also be susceptible to interference from GSM 900
  - The mobile signal enters the system by a different path to the cable channels
  - Cable networks use almost all channels within their operating bandwidth
    - Given the poor immunity of some set top boxes, cable operators may not be able at present to use channels used for terrestrial broadcasting in areas close to TV transmitters.
- In digital terrestrial TV, co-channel interference cannot occur
  - Before mobile networks can be deployed, DTT must be moved below 790MHz
  - Only around 6-10 channels can be used in a particular area
    - These channels are planned to avoid N+5 and N+9 (local oscillator and image frequencies)
    - Therefore, a terrestrial receiver can be susceptible to interference on these frequencies
  - The mobile signal enters the receiver by the same route as the TV signal
  - The block edge masks have been defined to minimise interference due to unwanted emissions from base stations and terminals. Therefore, the dominant mechanism for interference is the selectivity and overload of TV receivers.
  - The primary interference mechanism is therefore non-linear

Cable channels potentially impacted by interference



- Transmissions from terminals can only affect the top four cable channels
  - Out of 94 cable channels
- An individual terminal can only affect two cable channels
  - Perhaps a third slightly
- Transmissions from base stations can only affect five cable channels
  - However, interference is not expected for typical mobile network deployments in urban/suburban areas and well designed cable networks or for CPE with adequate immunity for the current electromagnetic environment.

Immunity of digital cable channels relative to analogue

- EN50083-8 and EN 60728-1 define an immunity immunity performance of 106dBµV/M for a cable network.
- If a cable network meets this requirement for an analogue (PAL) channel), then it will inherently have a better immunity for its digital channels than for PAL.
- This stems from the differences between internal interference generated within a cable network and 'ingress interference'
  - Internal interference is broadband in nature, and its power scales with bandwidth, relative to 120kHz
    - Mainly noise and intermodulation products
  - Ingress interference would have been either PAL or narrowband mobile signals (e.g. NMT, TETRA, PMR).
    - Carrier to interference requirement for PAL is defined in ITU-R Recommendation ITU-R BT.655-7, and is less than bandwidth scaling
    - Narrowband interference would not be subject to bandwidth scaling.
  - LTE would behave similarly to narrowband interference, because often only a few resource blocks are used.

Cable network channel type	Immunity Limit Worst case
PAL	106dB(µV/m)
64-QAM DVB-C or 64-QAM DOCSIS	115dB(µV/m)
256-QAM DVB-C or 256-QAM DOCSIS	116dB(µV/m)

Immunity limits for cable channels
Derived from EN 60728-1 performance requirements

Immunity of Set top boxes

This describes the derivation of slide 5 from information in Graph 1 of the Cable Europe Labs report on set top boxes, CEL-DD02-S

NOTE: as the values have been read from the graph, they may not be exact (especially for the 50%-ile)

	Worst	50% ile	Best
ERP at 779 MHz (lower adj channel)	+17	+26	+33
ERP at 795 MHz (co-channel)	-28.5	-5	+6
ERP at 811 MHz (upper adj channel)	+17.5	+26	+33.5
Adjacent channel lower value	+17	+26	+33

Note: the results for 16MHz offset are used because, for 8MHz offset, the 8MHz DVB-C channel overlaps with the 10MHz LTE channel. It is recognised that these results are therefore probably optimistic compared to the 11MHz offset, which is the minimum that can occur for terminals.

The results in Graph 1 have been calculated for 25dBm ERP. The conversion factors (CF) for the parameters used in the slide are given below:

	CF rel 25dBm ERP	CF rel 0dBm ERP	CF rel 1V/m
1v/m	18dB	-7dB	
23dBm EIRP at 1m	10dB		7dB
23dBm EIRP at 2.5m	19dB		0dB

NOTE: the 50% reduction for penetration through a wall represents a 6dB loss, which is lower than the 8dB used in CEPT Report 30.
Interior walls are generally less absorbtive than exterior walls, but do not include windows (the value used in CEPT Report 30 is based on measurements on penetration loss of real buildings with windows).

The legislative framework for EMC

Cable network equipment and CPE

Equipment* shall be so designed and manufactured, having regard to ***the state of the art***, as to ensure that … it has a level of immunity to the electromagnetic disturbance to be ***expected*** in its ***intended use*** which allows it to operate without ***unacceptable degradation*** of its intended use.

EMC Directive 2004/108/EC, Annex 1.1

⇨ ***Future standards for CPE and future upgrades to cable networks should have a level of immunity such that any performance degradation is considered acceptable by cable operators and consumers, subject to this being possible within the "state of the art"***

Mobile network equipment and terminals

Equipment* shall be so designed and manufactured, having regard to ***the state of the art***, as to ensure that … the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment ***cannot*** operate as intended.

EMC Directive 2004/108/EC, Annex 1.1

⇨ ***Note: "cannot operate", not "does not operate"***

In addition, radio equipment shall be so constructed that it effectively uses the ***spectrum allocated*** to terrestrial ***radio communication*** so as to avoid harmful interference.

RTTE Directive 1999/5/EC, Article 3.2

⇨ ***This provision is not applicable to interference to cable networks, because they do not use allocated spectrum***

* any apparatus or fixed installation Article 2.1 a)

Status of Cable set top boxes and modems

Cable set top boxes and modems fall under the RTTE Directive:

This Directive establishes a regulatory framework for the placing on the market, free movement and putting into service in the Community of radio equipment and telecommunications terminal equipment.

Article 1.1

'telecommunications terminal equipment' means a product enabling communication or a relevant component thereof which is intended to be connected directly or indirectly by any means whatsoever to interfaces of public telecommunications networks (that is to say, telecommunications networks used wholly or partly for the provision of publicly available telecommunications services)

Article 2 (b)

This Directive shall not apply to … receive only ***radio equipment*** intended to be used solely for the reception of sound and TV broadcasting services.

Article 1.4 and Annex I

'radio equipment' means a product, or relevant component thereof, capable of communication by means of the emission and/or reception of ***radio waves*** utilising the ***spectrum allocated*** to terrestrial radiocommunication.

Article 2 (c)

⇒ ***Many cable networks (if not all) provide publicly available telecommunications services. Cable CPE is intended to be connected to these networks. It is therefore a telecommunications terminal equipment. The exemption for broadcast reception equipment does not apply to cable CPE, because it is not radio equipment.***

Presumption of conformity

Where apparatus meets the relevant harmonised standards or parts thereof whose reference numbers have been published in the Official Journal of the European Communities, Member States shall presume compliance with those of the essential requirements referred to in Article 3 as are covered by the said harmonised standards or parts thereof.

RTTE Directive, Article 5.1

The compliance of equipment with the relevant harmonised standards whose references have been published in the *Official Journal of the European Union* shall raise a presumption, on the part of the Member States, of conformity with the essential
requirements referred to in Annex I to which such standards relate. This presumption of conformity is limited to the scope of the harmonised standard(s) applied and the relevant essential requirements covered by such harmonised standard(s).

EMC Directive, Article 6.2

The European Commission publishes separate lists for each Directive. There is only presumption of conformity when a standard is published in the list for the Directive under which the product falls.

'Commission communication in the framework of the implementation of Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

(Text with EEA relevance)

(Publication of titles and references of harmonised standards under the directive)

⇨ ***Two conditions must be met for presumption of conformity to apply:***

- ***The equipment must fall within the scope a harmonised standard***
- ***The equipment must fall within the scope of the Directive(s) under which the standard has been published.***

EMC standards used for cable CPE: EN 55020

The scope of EN55020

This standard for immunity requirements applies to television broadcast receivers, sound broadcast receivers and associated equipment intended for use in the residential, commercial and light industrial environment.

Section 1: Scope

For the purposes of this annex, the following definitions apply:
Digital Television Receivers; Appliances intended for the reception of television broadcast, data and similar services for digital terrestrial, cable and satellite transmissions

Annex I.3 (normative): Broadcast receivers for digital signals

For the measurements at ports related to non-broadcast functions, for example, the telecom and LAN ports, reference is made to the relevant standards, for example CISPR 24

Annex I.1

Immunity requirements

There is no applicable requirement in EN55020 for radiated immunity in the 470-862MHz band – even for the fields strengths that would be generated by existing TV transmissions

NOTE: This is a difference between in requirement between a terrestrial TV receiver and a cable CPE. For a terrestrial TV receiver, the radiated field from terrestrial TV transmissions is the same as the wanted signal at the RF input port, but for a cable network it will be different.

Applicability as a Harmonised Standard

EN 55020 is only referenced in the Official Journal list of harmonised standards under the EMC Directive.

⇨ ***EN 55020 does not give presumption of conformity for most cable CPE. It can still be used to demonstrate conformity to the EMC Directive, making use of a Notified Body and Technical Construction File.***

EMC standards used for cable CPE: EN 55024

The scope of EN55024

This CISPR publication applies to information technology equipment (ITE) as defined in CISPR 22. Harmonized standards prepared by ETSI, which cover the immunity requirements for telecommunications network equipment take precedence over this standard.
The object of this publication is to establish requirements which will provide an adequate level of intrinsic immunity so that the equipment will operate as intended in its environment.
For exceptional environmental conditions, special mitigation measures may be required owing to testing and performance assessment considerations

Section 1: Scope and object

Immunity requirements

The requirement in EN55024 for radiated immunity in the 470-862MHz band for radiated immunity is 3V/m.

However, the standard allows considerable discretion over the performance criteria and the operating frequency of the equipment

Applicability as a Harmonised Standard

EN 55020 is referenced in the Official Journal list of harmonised standards for both the EMC Directive and the RTTE Directive

EMC standards for cable networks

EN 50083-8 (not Harmonised Standard)

- Cable networks for television signals, sound signals and interactive services - Part 8: Electromagnetic compatibility for networks
  - This states (note 2 to Table 2 – Immunity Limits):

    "If an external field strength higher than specified in Table 2 [106 dBµV/m] occurs and this field strength disturbs the corresponding channel in the cable network, special measures have to be taken (e.g. increasing signal level at the system outlet, improving the screening effectiveness of the network or changing/not using the affected cable channel, etc.)."

EN 50529-2

- This standard is completed, in terms of development, public enquiry and vote
  - However, it has not yet been published by CENELEC
  - This standard specifies limits and methods of measurement for [emissions and] immunity of wire-line telecommunication networks This standard specifically refers to networks using coaxial cables.
  - by means of references to harmonised product standards in combination with good engineering practice.
  - Some of these referenced standards contain inadequate limits (e.g. EN 55020)
- This standard was developed before TC210 WG10 started its work
  - It does not appear to define an immunity limit (or target value) for the network as a whole
  - "Good engineering practice" does not address immunity
- It should be reviewed before being adopted as a Harmonised Standard
  - i.e. before the reference is published in the Official Journal
- It is surprising that EN 50529-2 does not define any immunity limit or reference EN 50083-8

Future standards development

- New immunity requirements are needed for cable CPE
- Cable CPE are telecoms terminal equipment; therefore fall under RTTE Directive
- Best to develop a new standard containing radiated immunity requirement
  - This can reference existing standards for other requirements
  - Modifying existing standards would have consequential impacts on other product categories
  - Having separate standards for TV receivers and cable CPE should be considered
    - Although the products are quite similar, the limiting factors in the electromagnetic environment are very different
      - The interference effects are linear for cable CPE and non-linear for terrestrial TV receivers
      - The modulation schemes are also different (OFDM and QAM)
        - The existing 1kHz 80%AM test signal may be adequate for radiated immunity
- It would be appropriate, and most efficient, for ETSI to develop this standard
- The test conditions need to be consistent with the electromagnetic environment
  - The operating frequency of the apparatus under test should be co-channel with the immunity test signal
  - The level of the input signal to the CPE should be representative of the signal level on a cable network
    - Cable operators have indicated that this level is generally towards the bottom of the specified range
- The performance criterion should be explicitly defined
  - It should be consistent with the expectations of cable operators and customers in normal use