

Intellect response to the Ofcom Call for Input:

on the future use of the 700 MHz band

About Intellect

Intellect is the trade association for the UK technology industry. In 2007, the industries Intellect represents accounted for 8% of UK GDP, £92bn of Gross Added Value and employed 1.2m people.

Intellect provides a collective voice for its members and drives connections with government and business to create a commercial environment in which they can thrive. Intellect represents over 750 companies ranging from SMEs to multinationals. As the hub for this community, Intellect is able to draw upon a wealth of experience and expertise to ensure that its members are best placed to tackle challenges now and in the future.

Our members' products and services enable hundreds of millions of phone calls and emails every day, allow the 60 million people in the UK to watch television and listen to the radio, power London's world leading financial services industry, save thousands of lives through accurate blood matching and screening technology, have made possible the Oyster system, which Londoners use to make 28 million journeys every week, and are pushing Formula One drivers closer to their World Championship goal.

In the past 12 months 14,500 people have visited Intellect's offices to participate in over 550 meetings and 3,900 delegates have attended the external conferences and events we organise.

Response

Summary

As the UK's trade association for the technology industries, Intellect welcomes this call for input at this time. Representing companies across the value chain in, both, mobile communications as well as Digital Terrestrial TV (DTT) networks and devices, Intellect is keen to ensure that adequate and appropriate spectrum is available to accommodate the increasing mobile data volumes while ensuring that digital terrestrial television (DTT) has the necessary spectrum to serve its widespread use in the UK.

Intellect welcomes Ofcom's approach to assess the costs and benefits associated with a potential change of use of the 700 MHz band. In doing so, it is important that Ofcom carries out an evidence led process. Given the international momentum building around the future allocation of 700 MHz, and its likely strong influence on UK decisions, Ofcom should ensure that it plays a proactive role in ensuring international decisions are compatible with the UK scenario.

Detailed Responses

Question 1 and 2:

- ***Have we correctly identified and characterised the potential costs set out above, and what other costs – if any – should be taken into account in our assessment?***
- ***What evidence, whether qualitative or quantitative, should we obtain and/or take into account in assessing each of these potential costs? Please identify any sources of specific evidence to which we should have regard ?***

Intellect generally agrees with the costs listed in section 4. In addition, Intellect would like to clarify the following aspects:

Costs to Upgrade and Modify Reception Installations

OFCOM's studies should also have further analysis of UK households, not limited only to the aerials but taking into account the whole reception equipment. From the experience of LTE800 the interference issues are mainly influenced by the aerial reception (including mast and distribution amplifiers). Using this experience, OFCOM should therefore obtain a detailed picture of aerial installations in the UK.

A particular focus should be on the need to upgrade the installations (i.e. filters or swapping amplifiers) or possibly to replace the antennas.

- The DTT success was built on widely reusing existing installations. This means that households receiving DTT are not necessarily meeting recent standards. Nevertheless, consumers will have an expectation of having uninterrupted reception through any frequency changes.
- Reorientation or replacement of antennas may be necessary if re-planning results in a need for many frequency changes and new sites. This may be the result of international coordination with the target to keep the same number of layers whilst obtaining protection from mobile services in the band 694 – 790 MHz.

Cost of Transition to DVB-T2

There will be additional costs associated with a transition to T2 or any other technology change and the accompanying communications effort. In the event that higher receiver immunity forms a large part of the transition to release the 700 MHz strategy, as outlined in the response to question 21, additional costs could arise from an increased price for the consumer. Our response to question 20 addresses the trade off between speed of release of the 700 MHz band and achieving better receiver immunity.

Cost associated with Secondary TVs

Secondary TVs need to be considered as well when assessing the costs. These are often former primary TVs and consequently very often represent MPEG-2 / DVB-T receiver technology.

Cost of Interference management

Irrespective of how immune receivers will be, there may well be need for proactive interference management as carried out with DMSL / at800.

Cost of Consumer Communication

This will be needed to be accompanied with additional communication effort in order to deliver a clear message to the consumer after the DMS activities and the start of White Space Services, and the temporary introduction of additional services in the 600 MHz band.

Cost to Consumer Equipment (CE) manufacturers

From a manufacturer perspective, should new interference immunity requirements be formulated, additional costs will occur. These will be through R & D costs for new performance levels, higher performance components and tighter immunity requirements. It is essential that such technology upgrades are part of international developments in order that they address as wide a market as possible.

Cost on Mobile Phone Manufacturers

There may be additional costs to improve the out of band emissions of mobile handsets, if for example a more expensive or regionally specific duplex filter is required.

Costs of equipment and capital write-offs

Additional costs and liabilities are likely to be created as a result of equipment and capital write-offs caused by any 700 MHz clearance process. Depending on when clearance occurs, investments that have been made in capital assets such as antennas will not have reached the end of their life before any 700 MHz clearance.

Cost of planning and programme management

As with the DSO and the Channel 61/62 clearance programme, a change on this scale will require extensive planning and programme management resources from those involved.

Question 3:

Have we correctly identified and characterised the potential benefits set out above, and what other benefits – if any – should be taken into account in our assessment?

Yes, Intellect believes that Ofcom has correctly identified the potential benefits that should be taken into account.

Question 4: What evidence, whether qualitative or quantitative, should we obtain and/or take into account in assessing each of these potential benefits? Please identify any sources of specific evidence to which we should have regard.

The Real Wireless report of 2012¹ set out that a spectrum demand “crunch” would occur post 2020, under given assumptions on the increase of mobile data volumes. This report highlighted the significant value that mobile operators would derive from additional spectrum. It hypothesised that unless additional spectrum was provided for mobile applications, either demand would need to be managed or alternative capacity mechanisms would be required. Additional spectrum or alternative mechanisms, such as cell splitting, would result in significant additional cost and be unpopular as additional base station sites would be required.

The Analysys Mason/Aegis report², subsequently commissioned by Ofcom, analysed the relative value of the use of the 700MHz spectrum for mobile services set against retained use by DTT and concluded that the cost saving associated with the former significantly exceeded the latter.

¹ “Techniques for increasing the capacity of wireless broadband networks: UK, 2012-2030”, <http://www.ofcom.org.uk/static/uhf/real-wireless-report.pdf>

² “Opportunity cost of the spectrum used by digital terrestrial TV and digital audio broadcasting”, <http://stakeholders.ofcom.org.uk/binaries/consultations/aip13/annexes/report.pdf>

However, member companies with an interest in DTT point out that the financial beneficiaries of any 700 MHz clearance are not often the same as those incurring costs of facilitating any transition and so suggest that Ofcom should carefully consider the necessary incentivisation. Conversely, member companies with mobile interests highlight that since mobile penetration is very high, the majority of those consumers facing costs due to DTT migration will also be beneficiaries of improved broadband efficiency.

The potential changes to the 700 MHz allocation have a strong worldwide context. The UK will inevitably be influenced by these developments. Ofcom must therefore play a strong role in influencing these international decisions to ensure that resulting changes suit the UK environment and ambitions. For example, within the timing of this consultation, both France and Germany have launched initiatives relating to the 700 MHz spectrum.

A further potential benefit to society of the reallocation of the 700MHz band is in the provision of spectrum to support communications within the emergency services, by allowing spectrum to be provided for a resilient network to satisfy their needs. ECC Report 199, published 2013, identifies a need for 10+10MHz of spectrum for this purpose. Various recent studies have quantified the socio-economic benefits to society of such an allocation of spectrum, which can have a net positive value to society of several billion pounds per annum.

For example, it has been estimated by the London School of Economics (LSE) that if mobile broadband can be utilised to assist ambulance crews deliver faster and more direct responses to treat heart attack victims, for every 560 lives saved, an estimated £1bn socio economic benefit could result, with the current target being 3,000 'extra lives' by the Ambulance Service. Increased efficiency by police forces resulting from the availability of resilient mobile broadband services also show dramatic benefits: a 10% efficiency gain could deliver socio-economic benefits of £1 to £4 billion p.a., depending on the mix of crimes (Johur, 2013). LSE³ indicates that expected improvements to efficiency and effectiveness are estimated to provide socio-economic benefits of between £4bn and £12bn per annum.

Further reports which consider the benefits of emergency services communications and government strategies in this sector are listed in Annex A.

Question 5: In particular, what is your view of the likely future demand for additional sub-1 GHz spectrum for the provision of mobile data services, and what evidence supports this view?

The rising volume of mobile data traffic is well documented. This results in demand for more spectrum to accommodate the traffic volumes. This demand for spectrum has a sub 1 GHz spectrum component for coverage and a higher frequency component to achieve capacity requirements. The ideal scenario for Intellect would be one that results in the availability of adequate and appropriate

³ LSE (2013), "The Socio Economic Value of Mission Critical Mobile Applications for Public Safety in the UK: 2x10MHz in 700MHz." Grous, A. London School of Economics.

spectrum above and below 1 GHz for mobile services while ensuring sufficient spectrum for UK's significant take up of DTT services. Ofcom should undertake the necessary evaluations for taking account of a practicable trajectory for incorporating TV and reception technology evolution in the coming years.

With estimates of machine to machine (M2M) devices far outnumbering other mobile devices from 2020 onwards, such uplink oriented low data rate traffic may constitute a considerable portion of traffic in sub 1 GHz spectrum. As a result of its favourable propagation characteristics these frequencies are ideal for the associated wide area use.

Question 6: Should we place different weights on some costs and benefits than on others, for example depending on whether costs would be borne by consumers, DTT operators, or mobile operators?

Intellect agrees that the weight given to particular factors may vary. For example, the impact on consumers, who may have to meet costs but cannot control them. In this context it is important to note that the beneficiaries of any release could often be different to those who would incur the costs and disruption. Ofcom needs therefore to develop a forward plan giving sufficient notice to affected stakeholders and to carefully design incentives to achieve the outcomes.

Question 7: Do you have any other comments on the work we are currently undertaking on potential costs and benefits?

The key objective should be to achieve a European harmonized market at an early stage - to the extent possible at the stage of preparing and starting the transition in UK. This is valid for both the consumer electronics and the mobile industries.

It is therefore of prime importance that OFCOM seeks common understanding on the release of the 700 MHz and encourages other European countries to set informed perspective on the UHF band. This would facilitate the transition process and lead to economies of scales.

Question 8: Have we correctly identified the costs and benefits that could vary depending on the timing of release, and the impact of those factors? Are there other costs and benefits which would vary depending on the timing of release of the 700 MHz band which we should take into account?

It is important to acknowledge that the ongoing international process may mean that Ofcom may not have significant freedom of action when determining the timing of any release. However it is clear that the timing will have a significant impact on consumers. When considering timing it is important to minimise disruption to DTT consumers and this disruption will be minimised if a transition from 700 MHz to 600 MHz happens at the same time as transition from DVB-T to DVB-T2. Conversely, it must be recognised that if the timing of the release is delayed significantly beyond

that being discussed in Europe, the additional expenditure discussed in response to Question 4 could already have become necessary.

Question 9: How quickly could the 700 MHz band be released? What would be the impact on DTT infrastructure costs of releasing at the earliest possible time compared to a later time? What would be the factors which affect these costs?

There are a number of factors to be considered in connection with the date of the 700 MHz release and its costs:

- A desynchronized date with other European countries would lead to additional costs
 - o Simple filtering of the band would not be possible on a Europe wide basis - it complicates the logistics and diversity of receivers
 - o LTE800 was introduced on the basis of a Europe- wide EC Decision. However LTE800 was deployed with different national approaches with different interference management, resulting in different performance requirements for DTT receivers and different test signals. These elements were generally defined in a two year frame between the start of discussion and the implementation. Such a short time frame and fragmented approaches increase the difficulty for manufacturers to react accordingly.
 - o Given the common replacement cycle for IDTVs of 7 years and much longer cycle for aerial installations, it is important that an appropriate timescale is set for transition which allows a suitable timeframe for TV manufacturers to offer suitable products. The transition timescales should also be compatible with other related initiatives such as the deployment of LTE800, white space devices (WSD) and the 600 MHz DTT deployment.
- To move DTT multiplexes from 700 MHz to 600 MHz will be a significant engineering project. In order to understand the timing of such a project there will need to be clarity in a number of areas. Key amongst those are the frequency and transition plans. As noted earlier the timing of any release is dependent on the international process and a stable frequency plan will depend on international coordination that may not be complete before WRC-15. The transition plan will determine when clearance will take place around the country and will be required in order to scope the engineering work.

These points are developed further in question 21.

Question 10: How, and to what extent, are the costs for existing (PMSE) and potential (WSD) interleaved users of the 700 MHz band likely to vary depending on the timing of release? What would be the factors which affect these costs?

Intellect has no input at this stage.

Question 11: Should we consider any other cost-related arguments / evidence in favour of an earlier or later release date?

As raised in the response to Question 8, the possible harmonization and clarification on a long term strategy for terrestrial delivery of broadcast content are needed in order to motivate stakeholders to take a proactive approach. These aspects are further raised under Question 21.

Question 12: What would be the impact on mobile broadband delivery and competition of releasing the 700 MHz band later rather than sooner?

The release date may have a bearing on competition, but is potentially not the most significant aspect of the auction in this regard. The overall design will need to promote competition and innovation and the date is just one aspect. Other factors such as the number of packages and aspects such as caps, floors, coverage obligations etc will all need to be considered in light of circumstances nearer the time of the award.

Question 13: Should we consider any other benefit-related arguments / evidence in favour of an earlier or later release date?

Intellect has no input at this stage.

Question 14 to 17:

- ***Is the range of potential dates for release likely to be wide enough to merit consideration of an incentive auction approach?***
- ***If so, what are the challenges to designing an effective incentive auction in this case, and how might these challenges be addressed?***
- ***If we followed an incentive auction approach, how should we take account of wider costs and benefits – i.e. those not felt by participants in the auction?***
- ***Do you have any views at this stage as to the parameters of an incentive auction, such as the default date and payment mechanism?***

A fixed date may be a better approach than determining it by auction as certainty on timing, well in advance, may be of greatest benefits to consumers and industry and will enable early planning. To determine the spectrum release date only at the conclusion of the auction would be disruptive to consumers and would leave unhelpful uncertainty.

Question 18: Is there a version of the overlay auction approach which could be suitable for 700 MHz release?

Due to the number of stakeholders involved (mobile equipment industry, mobile operators, installers, broadcasters, broadcast network operators, CE manufacturers, PMSE users, WSD users and WSD management), it may be extremely challenging to establish mechanisms to vary the target date of release and to ensure that all the impacted stakeholders are adequately compensated.

Question 19: What are the benefits and risks of conducting an overlay auction in this case?

An overlay auction would lead to mixed / scattered operation of mobile and broadcast networks which may not be beneficial due to the challenging coexistence scenario.

Question 20: Have we correctly identified and characterised the potential impact of 700 MHz release on consumers accessing DTT? What other impact – if any – should be taken into account in order to identify pre-emptive measures to reduce this impact?

Given the importance of the DTT platform as identified by Ofcom in their UHF strategy it is important that any clearance minimises and mitigates any disruption to DTT viewers. Some member companies believe that this should entail that consumers continue to receive at least the same DTT services as they did before clearance. This would mean that there needs to be sufficient spectrum for all of the DTT multiplexes with at least the same coverage, regionality and number of channels as they had before clearance. This would also require Ofcom to ensure that DTT can use Channel 48 without harmful interference from other services.

If the decision is taken to clear 700 MHz then the associated decision to simultaneously migrate to DVB-T2 should also be taken as a later and fragmented transition would prove more disruptive for DTT viewers than a single co-ordinated set of changes. Ofcom should give consumers and industry certainty that there will be this transition of the entire DTT platform to DVB-T2. This will allow more HD channels on the DTT platform thus adding to consumer choice, and allow consumer to invest in equipment with certainty.

Freeview viewers should not be disadvantaged by decisions to clear DTT from the 700 MHz band and migrate to a DVB-T2 platform (noting that this would require equipment and aerial upgrades). Therefore any decisions relating to 700 MHz clearance and a DVB-T2 transition would have to be accompanied by careful planning and support for viewers.

Clearly the DTT/mobile interference, that Ofcom has identified, is a critical element that will also need to be addressed. This will be a source of disruption and potential cost for DTT viewers. Given that these viewers will also be mobile consumers, mobile operators will also wish to minimise any disruption.

Question 21: Do you have any comments on the pre-emptive measures relevant to DTT identified above? Are there other pre-emptive measures we should be considering?

Interference management and communications measures will be needed to allow for a timely release of the 700 MHz band. In order to avoid confusion to the customer, it may be beneficial to merge LTE800, WSD and LTE700 interference management activities.

OFCOM should work with the CE industry to define stable and long term targets for immunity requirements in Europe. This should be defined when the interference environment and the technologies applicable to these devices are known; in other words:

- when a clear longer term commitment to a stable DTT delivery spectrum framework for the development of cost efficient and technically effective immunity performance is reached. This commitment needs to be European market wide.
- when channel arrangements and out of band emission levels of the 700 MHz are stable
- when other influencing factors like transitions to other technologies beyond T2/AVC are understood.

With regard to consumers, the stability is also necessary to deliver a credible message to them. Additional value proposition for DTT is needed to counterbalance the negative impact of new migrations (upgrades). Further details are presented in Annexe B.

Question 22: Have we identified the correct measures to support consumer adoption of DVB-T2?

In general, Intellect agrees with the measures developed and the migration of the entire DTT platform to DVB-T2. Additionally, we would like to underline:

- At present there are higher costs associated with T2 receivers and AVC decoders, but these costs are likely to reduce in the medium term. In the long term DVB-T/ MPEG-2 receivers may become obsolete, but this can be reasonably assumed only in a 2020 horizon.
- There will be a cost associated by a migration and with the communication of it. So far the message was that DVB-T2 / AVC is associated with HD simulcast. Giving up the simulcast needs explanation to consumers in order to achieve acceptance
- There is a need for user motivation to upgrade their receivers or alternatively subsidies needed to help to upgrade households on large scale.
- These motivations have obviously to be driven by the services and the necessary provisions need to be devised with the broadcasters and broadcast network operators.

Question 23: What regard, if any, should we have to wider technical evolution of the DTT platform, such as HEVC?

A migration towards more efficient technologies is beneficial, although the specific situation of UK households with already advanced deployment of DVB-T2 /AVC need to be taken into account:

- It was recognized already from the responses to previous questions that there is an important need to avoid confusing and demotivating the consumer.
- The expected difference of potential added value to the user between T2/AVC generalization and T2/HEVC introduction seem to be low at this stage.

We therefore consider that the transition to HEVC should only be coupled when at least one of the two milestones is achieved:

- the introduction and transition to UHD services
- the integration of HEVC in DTT receivers is systematic and a high number of households are sufficiently equipped. This will be influenced by the fact that other countries will associate T2 and HEVC introduction.

As such, some member companies believe that HEVC should not be associated with the release of the 700 MHz spectrum on the basis that it would delay the process and instead feel it should be forward planned in a long term roadmap for creating additional value to the user without disruption.

Some member companies believe that Ofcom should be very proactive in driving spectrum efficiency, through the encouragement of DVB-T2 + HEVC (SD & HD) as early as possible with the aim of deploying services in 2016.

In order for the efficient planning within organisations and to give consumers a clear view, switch on and switch off dates should be clearly communicated. This should help with the timing and availability for these spectrum efficient technologies.

Use of SFN instead of MFN by DTT should be considered. The cost of this infrastructure change should be funded by the beneficiaries from freeing up the 700 MHz spectrum.

Question 24: Have we correctly identified and characterised the potential impact of 700 MHz release on PMSE users? What other impact – if any – should be taken into account in order to identify pre-emptive measures to mitigate this impact?

Question 25: Do you have any comments on the pre-emptive measures identified above? Are there other pre-emptive measures we should be considering?

Question 26: Do you have suggestions for how we can assess the impact on PMSE users and equipment if 700 MHz is no longer available for PMSE use?

Intellect has no input at this stage.

Annexe A: Further reports on the benefits of spectrum allocations for emergency services radio

Analysys Mason (2012)	Impact of radio spectrum on the UK economy and factors influencing future spectrum demand. Final Report for Department for Business, Innovation and Skills, and Department for Culture, Media and Sport. Kende, M, Bates, P, Steward, J, Vroobel, M.
Cabinet Office (2011)	The UK Cyber Security Strategy. Protecting and promoting the UK in a digital world. Cabinet Office. www.gov.uk/government/uploads/system/uploads/attachment_data/file/60961/uk-cyber-security-strategy-final.pdf
ECC Report 199 (2013)	User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks)
Henley Business School (2013)	Summary of findings: Evaluating the benefits of mission-critical mobile broadband to the UK Police Service. Dissertation. Johur, J. Henley Business School.
Home Office (2000)	The economic and social costs of crime. Home Office Research Study 217. Brand, S & Price, R. London: Home Office. webarchive.nationalarchives.gov.uk/20110218135832/rds.homeoffice.gov.uk/rds/pdfs/hors217.pdf
Home Office (2005)	The economic and social costs of crime against individuals and households 2003/4. Home Office Online Report 30/05. Home Office. webarchive.nationalarchives.gov.uk/20110218135832/rds.homeoffice.gov.uk/rds/pdfs05/rdsolr3005.pdf
Home Office (2011)	Revisions made to the multipliers and unit costs of crime used in the Integrated Offender Management Value for Money Toolkit. September 2011. Home Office. www.gov.uk/government/uploads/system/uploads/attachment_data/file/118042/IOM-phase2-costs-multipliers.pdf
LSE (2013)	The Socio Economic Value of Mission Critical Mobile Applications for Public Safety in the UK: 2x10MHz in 700MHz. Grous, A. London School of Economics.

RCVP (2012)	After the riots: The final report of the Riots Communities and Victims Panel. webarchive.nationalarchives.gov.uk/20121003195935/http://riotspanel.independent.gov.uk/wp-content/uploads/2012/03/Riots-Panel-Final-Report1.pdf
WIK (2013)	The Need for PPDR Broadband Spectrum in the bands below 1GHz

Annex B: Possible pre-emptive immunity measures to protect against anticipated interference

As outlined below, immunity improvement to protect against LTE interference needs to be developed in conjunction with the CE industry in order to minimise cost.

Most receivers have a common architecture which is based on low noise amplification with automatic gain control and channel decoding. This allows high receiver sensitivity with an affordable price. To increase the immunity, several elementary measures are possible and some are discussed hereafter:

- Filtering out the band 470 – 694 MHz:
 - o Advantages
 - An external filter such as the approach being employed currently to address any LTE 800 MHz interference gives flexibility to only apply filtering (albeit with loss of sensitivity) to the reception areas that are suffering from interference thus minimising reception problems in other areas. Internal filters are not considered a practicable solution.
 - o Drawbacks
 - Possible extensions of the band for WBB and immunity against other interferers require new filters.
 - It requires a clear trajectory towards a 700 MHz band plan and a coordinated release of the 700 MHz band. If not, this leads to additional diversity in the market which is challenging to achieve and lead to additional costs
 - DVB-T and DVB-C channel decoders are generally integrated, but DVB-C services exist above 700MHz. Such a method will increase the costs due to the need of two different decoders or include some switchable RF filter bypass circuitry under software control with additional losses of sensitivity and costs
 - Cumulative effects with already installed filters (LTE800) needs further assessment
- Decrease the sensitivity of receivers
 - o It may be a strategy adopted by some manufacturers if challenging mandatory requirements on immunity would appear.
 - o Advantages:
 - Raises the maximum input power

- Reduce adjacent channel interference sensitivity
- Drawbacks
 - This has the obvious drawback that aerials and transmitters will need to be upgraded to compensate the degradation.
- Increasing the dynamic range of the receiver front end
 - Advantages
 - This leads to some improvement with respect to receiver blocking
 - Drawbacks
 - Increasing the dynamic range is difficult to achieve with the limited power supply voltage and power dissipation requirements of silicon tuners used in modern TV sets
 - Increasing the dynamic range is difficult to achieve with the limited power supply voltage and power dissipation requirements of silicon tuners used in modern TV sets
 - Decreases the performance of zapping time, adaptation in multipath environment
 - Reduces the sensitivity in presence of strong adjacent signals
 - Increase of recovery time in case of transient signals
- Increasing the resolution of Analogue to Digital Conversion and Digital Signal Processing
 - Advantages
 - Increases the selectivity of receivers and their blocking level assuming that the tuner is not the limiting factor (see above).
 -
 - Drawbacks
 - Increases significantly the costs of a higher resolution and fast AD converter
 - Required processing performance must be significantly increased otherwise an effective channel equalization, a fast synchronization is not possible anymore. This could mean extending the width of the data path throughout the whole demodulator design, adding significantly to silicon area, cost and power consumption

- Higher order additional digital filtering
- Higher amount of data sample to be processed
- Larger on-chip memory requirements
- Higher Processing power increases
 - the power consumption
 - the costs of components
 - heat dissipation and therefore form factor constraints
- Due to the non availability of components which such higher digital signal processing it can be anticipated that it would reduce the number of available vendors and highly increase the price of DTT tuners & channel decoders

It can be therefore concluded that the receivers cannot substantially improve their immunity against LTE interference without an impact on the cost and price of receivers.

Uncertainties on the interference environment and on the future of DTT increase the investments risk of R & D on better immunity

Additionally to the challenging character of increasing immunity, DTT receiver manufacturers are confronted with a very unstable interference environment and its associated regulatory environment:

- The deployment of LTE800 was on very short term and different countries adopted different regimes and requirements from 2009 to 2013.
- In 2009 and in 2012 the European Commission requested two times a better immunity of receivers with respect to the LTE interference
- The introduction of receive only devices in the Radio Equipment Directive may lead to other new requirements
- The CEPT has to defined yet the technical conditions and the band plan of LTE700
- The introduction of possible interferers like WSD and PPDR may impact the requirements although these services are deemed to be introduced on non interference basis.

This instable interference environment is associated with the general question of future of DTT as several new systems and concepts are discussed as a replacement of DVB T/T2. Additionally, the

European Commission considers converged systems as a possible option⁴ and the CEPT has started a general discussion on the UHF band.

In this context, the development of new receiving architectures and design is a risk investment, which can be seen as additional costs for a receiver development with better immunity.

The effect of higher immunity requirements will not necessarily strongly decrease the amount of needed interference management

Receiver chip development, verification and design-in takes place over several years, so a rapid change in design does not appear realistic. It was recognized by OFCOM that only 80 % of primary household TV receivers will be equipped with T2 receivers by 2018, although users are motivated by HD services. In analogy, when considering replacement of receivers with better immunity, the motivation of users to upgrade to receivers with higher prices without clear added value will be lower. It is difficult to expect faster replacement.

From the experience of LTE800 almost of the interference cases were not due to the receivers, but due to the reception and distribution system weakness. Therefore, a better immunity of receiver may not lead to a lower effort on interference management.

Avoid consumer's confusion with new multiple interferers and needed upgrade of installation represents an important challenge to be carefully organized

From the viewer's perspective, it may be difficult to identify the correct interference management authority when an interference case occurs (LTE800, LTE700, WSD, other). It would be therefore beneficial to merge the activities under one umbrella organization, so that the viewer only needs to establish contact with one body. Synergies could even emerge from such cooperation.

Moreover, in case due to re-planning aerial need to be reoriented and upgraded, the activities of making interference proof and upgrading the aerials could be conducted together.

A clear and sustainable message on DTT with an additional value proposition is needed to counterbalance the negative impact of a need to upgrade to manage new interference sources

The success of the DTT switch over was due to significant effort expended by stakeholders to create a high motivation for users to upgrade their receiving equipment. Significant effort was invested in communicating to the viewer the implication that their investment would have a reasonable lifetime.

⁴ XXX Paper of European Commission on 700 MHz - Option 4

It is already foreseeable that a new upgrade of the reception installation will be needed.

In the interest of maintaining consumer confidence in technology, there is a need to avoid multiple operational cycles in the next years to upgrade reception installations and receivers. In addition any impact on DTT consumers should be linked as far as possible with resultant increased consumer value and experience.

The time window of 2015 and 2020 will be associated with UHDTV introduction on other delivery paths. So far, DTT has been offering similar FTA services over terrestrial as on other delivery paths with affordable costs. If the receivers' prices are higher, the differential of value proposition for the consumer, broadcaster and manufacturers compared to other delivery means would be even higher and increase the migration towards other delivery means. In the meantime, there is a risk that the remaining households reject any upgrade.