About Arqiva

Arqiva has its headquarters in Hampshire, with other major UK offices in Warwick, London, Buckinghamshire and Yorkshire. It has 9 international satellite teleports, over 70 other manned locations, and around 9,000 shared wireless sites throughout the UK and Ireland including masts, towers and rooftops from under 30 to over 300 metres tall.

The company is owned by a consortium of long-term investors led by the Canadian Pension Plan Investment Board (CPPIB) and has three operating divisions: Broadcast & Media, Government, Mobile & Enterprise and Digital Platforms.

Arqiva is technology and service-neutral and operates at the heart of the broadcast and mobile communications industry. We are at the forefront of network solutions and services in an increasingly digital world. The company provides much of the infrastructure behind television, radio and wireless communications in the UK and has a growing presence in Ireland, mainland Europe and the USA.

Arqiva is a founder member of Freeview (Arqiva transmits all 6 Freeview multiplexes and is the licensed operator of 2 of them) and was a key launch technology partner for Freesat. Arqiva is also the licensed operator of the Digital One national commercial DAB multiplex.

Alongside the BBC, Arqiva's Spectrum Planning Group has played a critical role in planning Digital Switch Over (DSO).

In the communications sector, the company supports cellular, wireless broadband, video, voice and data solutions for the mobile phone, public safety, public sector, public space and transport markets.

Major customers include the BBC, ITV, Channel 4, Channel 5, BSkyB, Classic FM, the five UK mobile operators, UKTV, Viacom, Turner Broadcasting, Metropolitan Police and RNLI.

Executive Summary

Arqiva welcomes the opportunity to respond to Ofcom's consultation as the issue of LTE interference into terrestrial broadcast services is a matter of great concern, particularly in light of the investments made by the UK consumer and broadcast industry to facilitate the Digital Switchover process. To this end, we encourage Ofcom to do everything in its power to protect the DTT platform as it is the principal source of TV consumption for the majority of UK households (primary sets) and, more importantly, it is the most significant source of secondary and tertiary set consumption. All DTT reception, on whatever receivers in the home, has the potential to be significantly compromised by the proposed introduction of LTE services in the released spectrum.

A summary of Arqiva's key observations are provided below with detailed responses to Ofcom's consultation questions provided within Part B;

- LTE interference into terrestrial broadcast services has the potential to deprive consumers of their television services and as such it should be a major concern for both Ofcom and Government.

- LTE interference also has the potential to materially undermine the broadcasting industry's huge investment in Digital Switchover. It seems ironic that the introduction of LTE based systems would cause material harm to those who have made the investment to release the spectrum that will enable such systems.

- It is therefore of critical importance that comprehensive analysis is carried out and clear proposals are developed to:

    - establish the potential level of interference caused by LTE based systems;
    - establish an acceptable level of net loss of reception;
    - identify appropriate actions to remedy such interference;
    - define a clear infrastructure to manage the removal of interference; ,
    - ensure that an appropriate framework is developed to fund the cost of removing interference; and,
    - provide a mechanism to compensate the consumers and spectrum users affected

- However, we believe that both Ofcom's analysis and proposals fall well short of adequately addressing the three key issues identified above. These are addressed in turn below.

The potential level of interference. Arqiva believes that it is probable that Ofcom's analysis of the potential level of interference has a significant number of material shortcomings which are likely to mean that, in practice, the level of pre-mitigation interference may be significantly higher than Ofcom's 'worst case' analysis of 760,000 households. We have identified the following issues with Ofcom's analysis:

- **Ofcom's analysis uses key assumptions which do not correspond to the proposals made in the current 800MHz Technical Licence Conditions (TLC) Consultation.** In all cases these inconsistencies are likely to result in an underestimation of the level of potential interference. Taking just two discrete examples of this, Arqiva's own detailed analysis shows that the higher level of proposed EIRP in the TLC Consultation produces a potential level of interference to **3 million** homes – nearly four times the level of Ofcom's 'worst case'. Whilst a variation in network design can result in an increase in the number of households suffering interference by a factor of five. Adjustments for other inconsistencies (for example co-location) would increase interference levels even more.
- **Ofcom's methodology and assumptions for estimating potential interference have a number of limitations which are likely to reduce its level of reliability and result in an understatement of the level of potential interference.** Major examples include the failure to include any non-primary television sets in the analysis, use of extrapolated data as opposed to a full national analysis, assumptions on current antenna alignment, the exclusion of low power base station locations, protection ratio assumptions, receiver antenna quality assumptions and worst channel selection. Arqiva believes that, in all these cases, Ofcom's methodology and assumptions are likely to result in a material understatement of the levels of potential interference. Whilst it is not possible to fully replicate Ofcom's analysis, Arqiva has undertaken its own detailed analysis, which we believe uses more robust methodology and treatment of assumptions. This analysis results in higher potential interference levels and hence higher numbers of households affected. Whilst we are unable to fully quantify the combined effect of these issues we believe the impact would be considerable.
- **No sensitivity analysis has been undertaken by Ofcom.** Despite the issues identified above and despite the complexity of the analysis and the number of variables that need consideration to estimate potential interference levels, Ofcom has undertaken no sensitivity / scenario analysis at all. Ofcom's analysis is therefore not only incorrectly positioned as a 'worst case' but, as a result, the level of interference that can't be mitigated cannot be derived with sufficient certainty. Given that Arqiva's analysis shows the actual 'worst case' may well be a multiple of Ofcom's figure a range of sensitivities / scenarios, using a more appropriate methodology and range of assumptions is vital to enable appropriate identification of remedies, the best way to manage implementation and sufficient funding and funding sources to deliver implementation

An acceptable level of lost reception. The single case of potential unmitigated interference presented by Ofcom's analysis is used to assess the impact of only one combination of mitigation options and concludes that there will be 30,000 lost DTT (primary set) households. There is no consideration of whether this is an acceptable loss for spectrum users or UK consumers. Arqiva believes it is not appropriate to consider alternative actions to remedy interference in isolation from a determination of the acceptable level of loss of reception. Furthermore, we believe that Government needs to be the ultimate arbiter on what is an acceptable level of loss, following appropriate consultation and industry engagement. Therefore Ofcom should be looking to assess the impact of a range of combinations of mitigation options against a range of scenarios for calculating unmitigated loss levels. This will enable Government to arrive at informed decisions on the acceptable level of loss and

inform both Government and Ofcom on the most effective combination of mitigation options and their likely cost.

Mitigation actions to remedy interference. Given the importance of the DTT platform for the provision of broadcast television and given the potentially significantly higher level of interference that Arqiva's analysis suggests, it is essential that mitigation actions are effective for consumers / citizens and current DTT spectrum users who have made substantial investment in the DTT platform. To achieve these objectives, mitigation actions must pro-actively manage and mitigate the risk of interference before the interference occurs.

- As noted above, the appropriate protection regime can only be determined once the level / potential of unmitigated interference is properly established and agreement is reached on the acceptable level of loss. We believe that this level should be set by starting with the principle that DTT should be fully protected.

- Ofcom does consider a broad range of mitigation options. However, it does so without determining acceptable loss and it is therefore unclear what criteria are being used to evaluate the identified options. It is essential that these criteria are clearly spelt out, otherwise it is not possible to determine the most appropriate combination of mitigation options for the range of possible outcomes on potential interference levels.

- Arqiva has also identified further mitigation options which have not been considered by Ofcom. These include exclusion or reduced power operation of block A in areas adjacent to channel 60 and a more considered approach to LTE network planning. These options should be included in any assessment of the best combination of mitigation options.

- Whilst Arqiva recognises that the best combination of mitigation options may vary based on the actual design and specification of LTE use of 800MHz, based on both our understanding of the likely effectiveness of alternative mitigation options and our view of the appropriate criteria for evaluating those options, we have identified a prioritisation of the potential available remedies. This is as follows:

    1. Base station transmit filtering
    2. Careful LTE network planning, base station power reduction and / or relocation
    3. DTT receiver filtering
    4. Improvements or adjustments to DTT installations and equipment
    5. Re-orientation of DTT aerials
    6. Opposite to DTT polarisation
    7. On channel repeaters
    8. Bespoke method
    9. Platform change

    This ranking would need confirmation once the remedies have been properly assessed against the range of potential unmitigated interference levels and agreed evaluation criteria.

Clear infrastructure to manage the removal of interference. Without a clear understanding of the level of potential unmitigated interference and the required level of acceptable loss, it is very difficult to define the most appropriate infrastructure to manage the implementation of mitigation options.

- Arqiva believes that some key principles should be established now which will assist in specifying the required infrastructure once these central issues have been properly addressed. These include:

    - Taking a proactive approach - loss prevention (not service restoration) being the core objective
    - All households should be afforded appropriate mitigation independent of the quality of their DTT installation
    - A commitment to on-going protection of DTT services from harmful interference
    - Remedies should be implemented independent of whether PSB or COM multiplexes have been lost
    - Remedies should be implemented irrespective of the type (e.g. SD or HD) of services lost
    - Compensation should be made available to both the consumer and the DTT spectrum user in the event of platform change

- All available lessons should be learned (and, where relevant, the sharing of information) from the successful role that DUK has played in the DSO process.

- Arqiva endorses the creation of an independent body to administer the protection of DTT services from LTE based interference. DUK's success is a testament to this approach. Given the potential political ramifications of loss of broadcast services, it is vital that this body is accountable to Government. There should not be a regime with split responsibilities / accountabilities.

An appropriate framework to fund the cost of removing interference. Arqiva strongly supports Ofcom's proposal that all costs associated with the rectification of interference issues from the introduction of LTE services in the 800MHz band should be borne by the new licensees. This should include the cost of 'spectrum damage' to multiplex licensees.

- Given the current uncertainty on the level of unmitigated interference and the acceptable level of loss, the above 'polluter pays' principle means that there should be no 'cap' in place with respect to the level of funding required to implement the appropriate mitigation options. There must be sufficient flexibility within the funding arrangements for the independent authority to be able to call on additional funds from the new licensees if the original funding arrangements were found to be inadequate. It is worth noting in this context that Ofcom's overall estimate of costs seems modest when compared with the recent prediction made by the Bouyges Chairman of €0.5-1.7bn for the potential cost of mitigation in France.

- Furthermore it will be essential that MitCo (and not the 800MHz licensees) should have sole responsibility for the determination of the appropriate mitigation options to achieve the agreed level of acceptable loss. Source of funding and the determination of the required implementation plan must be held fully independent of each other.

- In this context, we believe that the tariffing proposals will be prone to huge risk and uncertainty. It would be inappropriate to use an unproven system on a matter as politically and socially sensitive as the loss of television from UK Households. This is why we encourage Ofcom to undertake a thorough and rigorous assessment of the range of interference outcomes working jointly with Government and industry to determine the appropriate mitigation regime and cost base underpinned by the necessary resources and funding to address any programme risk.

Proposed recommendations. In the light of Arqiva's comments on Ofcom's consultation document, we propose the following core recommendations:

- A detailed sensitivity analysis is undertaken to determine the range of possible interference outcomes. We recommend that Ofcom fully appraise the risk of interference to secondary and tertiary sets particularly those utilising a set top aerial
- After detailed sensitivity analysis a follow-on consultation to be issued to inform the industry on the possible interference outcomes and to explore the appropriate combination of mitigation solutions and budget for mitigation to protect DTT services
- Appropriate governance arrangements within Ofcom to ensure consistency between the outcome of the co-existence analysis and the relevant Technical Licence Conditions
- A further Technical Licence Conditions consultation informed by the sensitivity analysis and appropriate measures for mitigation where TLCs are consistent with the assumptions used in the sensitivity analysis
- The approach to mitigation should be designed to be pro-active rather than reactive
- Ofcom's primary objective should be the protection of DTT services. If service loss is considered acceptable then we encourage Ofcom to work with Government and Industry to assess the appropriate level of loss before the mitigation and compensation arrangements are defined.
- Additional mitigation options should be included in the range of options particularly low power operation of Block A spectrum in areas where channel 60 is used
- The mitigation authority should act independently of the new 800MHz licensees
- The interference protection regime should be sustained for the life of the LTE licences
- The LTE licensed operators should be required to share their network roll out plans with the 'Protection Agency' and with the Multiplex License Operators in order to allow for co-ordination of network deployment and optimised mitigation of interference arrangements.
- No cap on the budget for mitigation of DTT interference / compensation for spectrum damage
- Sufficient flexibility should be designed into the funding arrangements to allow additional funds to be called down if initial funding is proven to be inadequate
- Consider how to address interference to set top aerials from up-link traffic in communal dwellings.

- LTE network based mitigations to be prioritised ahead of consumer related options to minimise the potential disruption to the DTT consumer and risk of platform instability.

Part B: Coexistence of new services in the 800 MHz band with DTT

Detailed supporting information and analysis

Q1. Do you have any comments on our modelling approach and assessment of numbers of households affected

Arqiva welcomes the detailed modelling work that Ofcom has carried out to investigate the issue of interference to broadcast television reception. We believe that Ofcom has identified a number of factors which will affect the scale of the problem. However, we remain highly concerned that the significant uncertainty in many of the underlying assumptions has resulted in an optimistically low interference outcome. We believe that the scale of interference experienced in practice could be substantially higher than that predicted. Therefore, we urge Ofcom to consider carrying out further work to test the sensitivity to different assumptions and to investigate the range of outcomes possible. Arqiva, working on behalf of the Broadcasters and Multiplex License Operators, has carried out analysis using a similar approach with a different (Ofcom original) national LTE network design, resulting in the number of households subject to interference being over ***five times*** larger than that reported by Ofcom.

Arqiva analysis

The analysis carried out by Arqiva has assessed Ofcom's results and also considers the impact of alternative assumptions. The interference impact of a representative full national LTE network was calculated using similar assumptions to those used by Ofcom. The interference analysis was carried out using similar methods to those published in the Ofcom Technical Report[1]. The most significant differences to the analysis undertaken by Ofcom are:

- A different LTE site network is used. Ofcom have based their LTE network on a real 900 MHz mobile network, with low power urban sites removed. This information is not available to Arqiva so we have used a 12,952 site nominal network previously developed by Ofcom and used for their earlier analysis in the Technical Working Group. This network covers England, Wales and Scotland only.
- Ofcom's national results are extrapolated from analysis of a subset of transmitters whilst Arqiva's analysis is based on a full national calculation.
- Arqiva's analysis only considers the standard DTT reception assumptions. We have not looked at communal antenna systems or domestic amplifiers due to time restrictions and lack of available data relating to these systems.
- Ofcom's analysis assumes that DTT receiver antennas are aligned to receive the transmitter specified by analogue service area. Arqiva's analysis considers alternative orientations of DTT receivers assuming that reception is optimised either for best PSB coverage or for best coverage of all six multiplexes.

[1] http://stakeholders.ofcom.org.uk/binaries/consultations/dtt/annexes/Technical-Report.pdf

Other assumptions such as proportional method, standard deviation, protection ratio and filter characteristics have been taken from the Ofcom Technical Report[2]. The detailed results from this analysis are contained within Part C of this submission and where relevant the results of the analysis are emphasised singularly within relevant responses to questions 1 and 2. It is also worth noting that the cumulative effect of these factors could further exacerbate the interference problem and is worthy of further consideration.

LTE assumptions

LTE site network density and site locations

Arqiva's analysis predicts that the number of households affected by interference could be ***five times*** (up to 1.04m primary households) higher than the results published by Ofcom (192k primary households (standard + amplifier based household antennas)). The results are strongly dependent on the number and location of the LTE base stations. Arqiva results show that alternative base station networks with a similar or lower number of sites located primarily in populated areas, urban and suburban, could produce a much larger interference problem than that predicted by Ofcom.

The actual number of LTE base stations that will be deployed using this spectrum is unknown and will depend on the business plans of the auction winners as well as future technology and industry developments. Ofcom has assumed that the 800 MHz network will be based on the same base station sites as an existing 900 MHz network. This may be a reasonable assumption if only one network were to be deployed by an existing 900 MHz operator but it does not represent a 'worst case' interference scenario. Furthermore, as the proposed licence conditions do not limit base station density the number of base stations could be significantly larger than that assumed in Ofcom's analysis. An increase in the number of base stations can only increase the scale of the interference problem and we note that Ofcom have excluded from their modelling the impact of femtocells, picocells and microcells whilst this may be valid we believe it important that Ofcom demonstrates this through relevant evidence

The location of base station sites is also a significant factor. Many of the 900 MHz sites considered for the interference analysis will be located in rural areas or targeting transport links, typically areas of low population density. The number of households that have their DTT service impacted in these areas will be limited by the low population density. An alternative base station network with the same number of sites located primarily in populated areas, urban and suburban, would produce a much larger interference problem. Clearly the interference levels will be highly sensitive to the nature of the LTE network design and, as such, we believe that Ofcom should not be basing its interference analysis on one reference network but a range of network topographies and this could form the basis of any subsequent sensitivity analysis.

[2] http://stakeholders.ofcom.org.uk/binaries/consultations/dtt/annexes/Technical-Report.pdf

Ofcom has assumed that all 800 MHz networks share the same sites. This assumption has the effect of reducing interference and hence the number of households impacted. The overall impact of this assumption is uncertain but Ofcom's analysis in section 6 of the Technical Report suggests that co-location reduces interference by 10%. Although there are advantages to base station co-location, it may not occur for various business reasons. The current calculation assumptions appear to include this benefit without any guarantee that it will be realised in practice as there are currently no obligations envisaged for the LTE licence holders to co-site base stations. Currently the 900 MHz networks of O2 and Vodafone are largely sited separately. This implies that, if co-siting is a required mitigation, then it should be included within the Technical Licence Conditions currently under consultation by Ofcom.

Low power base stations

Arqiva notes that Ofcom has excluded low power base station locations from the interference analysis. While the transmit power of these base stations is low, their typical street level location, on or close to buildings, means they *are* likely to cause interference to nearby DTT reception. The number of DTT viewers affected by a single low power base station may be small but the aggregate effect of many such cells could be large.

The extreme case of the low power base station is the femtocell which is deployed within consumer and business premises. These are low power but are likely to be very close to the DTT receiver, possibly in the same room. This would cause significant interference to DTT receivers using set-top antennas potentially up to 20 million devices.

Arqiva believes that it is important that Ofcom should also consider the viewer impact of interference into secondary sets for a true evaluation of the consumer detriment.

Maximum EIRP and Out of block limits

Ofcom's separate consultation on Technical Licence Conditions proposes higher limits for in-band EIRP and out-of-band powers than have been assumed in the co-existence analysis. Arqiva's analysis shows that these changes in Licence Conditions would allow substantial increases in interference, with the number of households affected potentially approaching 3 million.

The interference analysis in this consultation has been based on a maximum EIRP of 59 dBm in 10 MHz with assumptions about out of band power. The separate consultation on technical licence conditions proposes a higher maximum EIRP of 64 dBm in 10 MHz. It is unclear to us whether the interference analysis is consistent with the EIRP in the proposed technical licence conditions and we would encourage Ofcom to be consistent when dealing with linked programmes of work.

Clearly, an LTE network operating at the higher proposed licensed power would have the potential to impact a far higher number of viewers than the current 'worst' case predictions completed by Ofcom. It is worth noting that a recent French study of the senility of interference to power in the Mayenne region, published by the Agence Nationale des

Fréquences[3], concluded that at 59 dBm 2.1% of households receiving channel 60 would be subject to interference but this increases to 4.9% at 64 dBm a factor of 2.3.

Ofcom's interference analysis assumes that the out of block power rolls off at 10 dB per channel but the separate consultation on technical licence conditions proposes only a flat out of block limit of 0 dBm in 8 MHz. The Technical Report mentions the use of base station filtering as a mitigation measure but it appears that some benefit from this has already been taken into account in the baseline numbers. Arqiva analysis shows that if base stations operated at this out of block limit of 0 dBm then ***80% more households*** could be affected by interference. Increasing the in block EIRP to 64 dBm further increases the interference to ***potentially 3 million households.***

Criteria for acceptable reception

As a result of discussions at the stakeholder event held on 5th July 2011, we now understand that the criteria that Ofcom have used for acceptable viewer reception, in assessing the level of viewer impacts, has been to confirm whether or not the household has acceptable reception on the primary receiver. No consideration seems to have been given by Ofcom to achieving acceptable reception on secondary and tertiary sets.

This suggests that Ofcom's 'worst case' approach will significantly underestimate the interference impact on DTT households. Furthermore, it is at odds with Ofcom's own statistics that indicate that twice as many viewers have access to DTT services through secondary and tertiary receivers than on primary sets.

Uplink and set-top reception

The detailed interference analysis carried out by Ofcom has focussed on the interference from the 800 MHz downlink to DTT reception but Arqiva is concerned that the risk of interference from the uplink has not been fully acknowledged. This will be particularly significant for the 20 million secondary DTT receivers potentially using set-top antennas.

Interference calculation assumptions

Propagation model and standard deviation

Ofcom has used an extended Hata pathloss model for predicting interference from LTE base stations. This methodology has not been widely validated and the propagation from many base stations could be closer to free space over longer distances, particularly where the base station is relatively high due to being located on a hill, tall tower or building as is the case for the macro-cellular sites on which the assumed LTE network is based. Arqiva's analysis results show that different propagation model assumptions can significantly change the results. Using a free space propagation model can ***double*** the interference result.

[3] *"Rapport ANFR Expérimentations Mayenne"; "etude_canal_60" and "Etude Canal 60 – Compléments". Available for download at:* *http://www.anfr.fr/fr/planification-international/etudes/compatibilite/bande-800-mhz.html*

The method used to estimate the interference is highly dependent on the assumed standard deviation of the 800 MHz propagation variation. We note that compared to the values assumed in earlier work, Ofcom has reduced the standard deviation to 1 dB close to the base station, increasing to 5.5 dB at 1 km. This new assumption is partly based on measurements in Ofcom's Tamworth trial but we would expect to see a greater quantity of measurements used to validate such a critical assumption which as it currently stands is not defined in a statistically robust manner.

Ofcom's use of the reduced standard deviation results in the predictions for viewer impacts being reduced. As more measurement data would be needed to substantiate these figures, this approach cannot be guaranteed as 'worst' case.

DTT service area and out of area viewers

Analysis of the interference to DTT reception depends on an assumption about which DTT transmitter is being used in each prediction pixel. Ofcom have assumed that reception is defined by the preferred service areas which were defined for planning purposes in the time of analogue television. This is a good starting point for the analysis but it is important to realise that in practice many DTT receivers and antennas are configured for alternative transmitters. This may be because the assigned transmitter is affected by detailed local propagation conditions (which are not included in the propagation calculations) or it may be because of regional or national preferences. A particular reason for such differences in the current DTT network is that only the main sites transmit the full six multiplexes. In many areas the viewers may be using the main transmitter rather than a relay so that they receive all available channels, even though the relay is the assigned 'preferred server' in their area.

Some of the users of these alternative transmitters will be subject to different interference than predicted in the analysis. Analysis carried out by Arqiva has shown that assuming viewers prefer the six multiplex sites, where possible, results in approximately **7% more interference**. A further analysis taking the worst case of these assumptions in each pixel increases the number of households affected by a further **15%**. Such an assumption will be pessimistic to some extent, because we would not expect all viewers to be using the worst case transmitter; however, it does illustrate the uncertainty in the overall impact which might occur. It also causes uncertainty in the location of the affected viewers which may increase mitigation costs and make effective consumer based mitigation more difficult.

Protection ratios

The Ofcom analysis is based on protection ratios measured on a number of typical receivers but there exists a wide range of performance in the receivers in the market. The Ofcom Technical Report states that only a small percentage of receivers have the poorest performance when market share is taken into account. We agree with this observation but it does still mean that there are a small percentage of installed receivers which are highly susceptible to interference and the current Ofcom predictions take no account of these. We believe that the overall interference figures should be adjusted to take this into account.

In addition, the variable performance of DTT receivers in the presence of time-varying interference (due to varying traffic load in the mobile networks) remains a concern. We believe further work is justified on this question as this issue has largely been ignored in Ofcom's consultation document.

Receiver antenna polarisation discrimination

Ofcom's analysis uses the standard ITU template for receiver antenna pattern. In practice there is considerable variation in the discrimination performance of installed antennas due to local scattering effects. This is demonstrated in the measurements shown in section 6.77 of the Technical Report. This variation should also be considered in the sensitivity analysis that we believe is warranted.

Receiver antenna quality

The Ofcom analysis assumes that domestic receiver antenna systems conform to the standard assumptions used in TV planning. It is known that, in practice, the quality of antenna systems is variable and relates to the field strength received. Installed antennas are typically "just good enough" to achieve reliable reception. This variation will have an impact on the interference analysis as the protection ratio used depends on the wanted DTT signal level. In areas close to the DTT site we would expect receiving antenna systems to be worse than the standard, meaning that the received DTT level will be lower than predicted, thus reducing the protection ratio required and increasing the risk of interference. Viewers at the edge of the DTT coverage area often have receiving installations which are better quality than the standard due to weaker field strengths and these installations will be more at risk of interference than predicted. It is unclear what the overall effect of this will be on the total interference but it introduces uncertainty to the numbers of affected viewers and their locations. This point emphasises the complexity of the situation and reinforces our concerns with regard to the predictability of the number of households that will suffer interference further supporting the need for detailed sensitivity analysis.

Communal and domestic amplifier characteristics

Arqiva agrees that it is important to include the impact on the communal and domestic amplifier systems which are more vulnerable to interference than the standard receiver installations. We note that Ofcom has based this analysis on protection ratios measured for a single example of each of these amplifier systems although the consultant's reports show that there is a wide variety of systems in use. We note the warning from the Mandercom report[4] (p11) for the communal amplifier system tested, *"It is therefore difficult to model any mechanism for failure in the presence of strong signals",* with the recommendation that *"…further work is done to characterise the effects of strong signals in such devices"*. There is a risk that the amplifier performance assumptions made are not representative and probably not "worst" case. Therefore, further measurements should be made on a statistically valid range of amplifiers. There is also uncertainty in the number of amplifiers installed. No sensitivity analysis has been presented on the impact of these assumptions.

[4] *"The impact of LTE on Communal Aerial Systems,"Mandercom report for Ofcom*

Extrapolation approach and worst channel selection

Ofcom has calculated the national total for interference households using an extrapolation process based on a subset of DTT transmitters. Arqiva believes that there is a risk that the extrapolation results could be significantly different to the results of a full analysis based on the same assumptions.

We are also unclear as to why the specific channels have been selected for analysis at the subset sites. The channels selected are not necessarily the worst channels at the sites used. For example, at Mendip the channel selected is channel 52. This has the worst protection ratio for the lowest DTT signal level listed (-70 dBm) but not the worst protection ratio at higher DTT signal levels. Arqiva analysis, using similar assumptions to Ofcom, has shown that channel 58 suffers over 65% more interference than channel 52. It is difficult to determine if this difference will have an impact on the overall extrapolation without further investigation of the extrapolation method.

Arqiva urges Ofcom to re-calculate its figures either to include each channel utilised at the 80 core DTT sites or submit the existing calculations to sensitivity analysis to inform the industry of best and worst case interference outcomes.

Conclusions

Arqiva has noted, against Ofcom's detailed analysis, specific sensitivities that may have a bearing on the impact of LTE services on the interference of DTT households. In addition, Arqiva has undertaken detailed analysis against these sensitivities to determine the extent to which they result in DTT interference. In all cases the interference impact is significantly higher than the results published by Ofcom. This emphasises that Ofcom's interpretation of events does not represent the 'worst case.' Furthermore Arqiva's analysis shows larger numbers of households still affected by interference post mitigation leading to a greater number of households being subject to platform change. Arqiva encourages Ofcom to take account of the proposed sensitivity analysis in future work to ensure that a more realistic appraisal of the interference impact to UK DTT households of the launch of LTE services.

Q2. Do you agree with our high level conclusions on mitigation options?

Comments on individual mitigation methods

Arqiva has considered the range of mitigation measures considered by Ofcom and also suggests some additional ones for consideration. We endeavour to consider the relevance of the particular options proposed and also, where relevant, raise issues with regard to the Ofcom analysis.

In addition to mitigation measures Arqiva would like Ofcom to note that, where mitigation fails, Arqiva will be looking for the users of the DTT spectrum to be compensated, where either a Platform change is the only option or where customers migrate from the DTT

platform as a result of the mitigation. . Arqiva believes that this call for compensation is consistent with Ofcom's stated AIP spectrum pricing approach in recognition of the interference reducing the value of the DTT spectrum.

No regulatory intervention

Arqiva agrees with Ofcom's analysis that the negative effects on the DTT network of no regulatory intervention are high; also, as DTT is a primary licensed user of Channels 21 to 60 of UHF spectrum, a high degree of protection is justified.

Base Station Filtering

It is unclear from the Consultation document whether Base Station Filtering has been taken into account. In Table 5.2[5], 'The number of households potentially affected by interference using different combination of filtering', a total of 760,000 households are predicted to be affected by interference when no filtering is used. However, in the accompanying technical report[6], paragraph 3.21 reads:

> "Given the objectives of this report, we assume that MFCN base stations comply with the out-of-block limits of case A over DTT channel 60. In practice, emission levels reduce with increasing frequency offset from the carrier. As a result, we **assume** that the base station out-of-block emissions over channels 59 and below are accordingly lower than those specified in Table 1 (see Sections 5 and 6). [Note Arqiva highlighting]

This paragraph appears to imply that base station filtering beyond that specified as the *baseline* requirements for out-of-block EIRP limits over frequencies occupied by broadcasting have been included in the **No Mitigation** calculations. As the technical licence conditions for mobile network base stations are likely to be those shown in Table 1, Section 3 of the Technical report, this implies that the No Mitigation calculations actually include a level of mitigation with regard to base station filtering. Arqiva would like clarification on this issue; calculations termed 'No Mitigation' impact should be on the basis of the terms included in the technical licensing conditions, and should not assume anything beyond this.

We believe that it is important for Ofcom to differentiate between those mitigation options that are *network-based* (i.e. minimise the impact on consumers) from those that are *consumer-based* (e.g. installation of DTT filters in the home), and rank the available mitigations in the order with which they should be applied, with network-based mitigations generally being considered before consumer-based mitigations.

However, Arqiva agrees that a combination of base-station filtering and DTT receiver filters is an effective means of mitigation, and better than DTT filtering alone. Table 5.5[7] shows the cost of base station filtering to be low with little or no effect on spectrum utility, and

[5] http://stakeholders.ofcom.org.uk/binaries/consultations/dtt/summary/dttcondoc.pdf, page 28.
[6] Technical analysis of interference from mobile network base stations in the 800MHz band to digital terrestrial television, Ofcom Technical Report, 10 June 2011
[7] http://stakeholders.ofcom.org.uk/binaries/consultations/dtt/summary/dttcondoc.pdf, page 40.

competition. Thus, we believe that Ofcom should consider making improved base station filtering a technical licence condition.

DTT Receiver Filtering

Arqiva's analysis of the benefits of mitigation through receiver filtering show that after filters have been deployed potentially ***230,000 households*** could by subject to interference.

Although Arqiva agrees that DTT receiver filters will provide a significant level of protection to DTT reception, the challenges of providing consumer filters should not be underestimated.

Given the timescales for a reactive provision of filters, Arqiva believes that proactive delivery of filters will be required to minimise the impact on consumers. These should be provided for self install.

The likelihood is that filters are most likely to be needed in areas of low DTT field strength, and it is in these areas where domestic installations are more likely to be fitted with amplifiers. Arqiva agrees that communal aerial systems and amplified domestic systems will be more complex to rectify, with higher associated costs. However, given the very small range of measurements made so far by Ofcom into the impact of LTE interference to amplifiers, combined with the likelihood that areas more prone to interference are more likely to make use of domestic amplifiers, there must be a large uncertainty in the number and type of filters required, and thus their associated costs.

A second issue to consider is the provision of base station information to inform where filters will be required, be it for proactive or reactive installation. Calculations by Arqiva, compared to Ofcom, have shown significant sensitivity as to the base station location and level of interference predicted. Given this sensitivity, Arqiva believes that it is **essential** that new licensees are required to provide, and maintain, an accurate database of sites using the 800 MHz band available to any organisation managing the mitigation of viewer impacts. The database should also be made available to the JPP to allow for accurate frequency planning of existing and future DTT services. This will be needed both during and after the initial LTE network roll out. Broadcasters are already required to maintain such a database for broadcasting services; and individual sites are licensed by Ofcom. Without an accurate and well maintained database of LTE base stations, it will be impossible to predict locations that will need proactive delivery of filters, or to confirm that a base station is the cause of interference in the event of reactive complaints.

A third, practical, issue relates to the number of filters required. Proportional counting has been used to determine the number of households affected by interference. This number has then been multiplied by 10 to achieve the number of filters required. However, predictions have been calculated over pixels 100m x 100m, and the change within that pixel is calculated as a percentage locations change. Hence, it is not known exactly which households within an individual pixel will be affected.

For example, consider a hypothetical pixel containing 100 households distributed evenly throughout the pixel. If, prior to LTE network, the pixel is served to 100% locations, then all households are served. If, in the presence of interference, this drops to 98% locations, then 2 households will be predicted to lose reception. However, it is not known which 2 households will be impacted. Following Ofcom's reasoning, a total of 20 (10 x 2) filters would be provided to this pixel. On this basis, there is only a 1 in 5 chance that the households impacted will actually receive a filter. Furthermore, if those households have more than one receiver, the probability of a household receiving the number of filters actually required is further reduced.

Given this uncertainty, it is likely that the number of filters to be provided has been significantly underestimated.

Finally, Arqiva is concerned over the effect that such imposed changes will have on the DTT Platform post switchover. There is a danger that, even with proactive provision of self-install filters, a percentage of DTT households will churn to other platforms as a result of consumer concern and platform instability. Once lost to an alternative platform, these customers are likely to be lost forever to DTT. As Arqiva is a user of the DTT spectrum, and mindful of Ofcom's plans to charge for spectrum usage as part of the proposed AIP regime, we believe that AIP fee levels should be adjusted to take account of any subsequent platform damage caused by LTE interference

Improvements or adjustments to DTT equipment

Arqiva has supported the development of testing by the DTG so that new equipment can be tested for usability in the presence of LTE interference, prior to release to market. With this understanding, it is hoped that future generations of DTT receivers will perform better in the presence of interference, especially given the wide variation in performance seen to date. Therefore, the replacement of DTT receiver equipment (at no cost to the affected viewer) should be considered in cases where receiver filtering is not effective. This mitigation should be included in Ofcom's list of possible mitigation measures.

Arqiva is also aware that companies are developing receive antennas with built in filters. Although these products are not currently available, their development shows that the consumer industry is already preparing for the challenges of base station interference.

Re-orientation of DTT aerials

Ofcom concludes that aerial re-orientation may be a proportionate response to dealing with DTT interference in some cases. Arqiva notes that viewer antenna orientation can be based on a number of issues:

- Availability of services (6 mux station over 3 mux station)
- Local obstructions (trees, buildings, etc, that are not part of the prediction model)
- Viewer choice (regionality)

It should also be noted that in almost all cases a re-orientation of aerials will actually, in practice, require a new aerial installation. This is because the majority of installed receive aerials are "banded" based on the transmit frequencies used at the local site. The UK DTT network topology will usually mean that an alternative DTT transmitter is likely to transmit its multiplexes on channels in a different receive aerial group. Even where this is not the case, after several years exposure to the elements, bolts and brackets on existing antennas are likely to be rusty and therefore impossible to re-orientate.

Re-orientation of DTT aerials could only be offered in conjunction with a home visit to assess whether it is a solution; whether it meets the viewer's expectation in terms of maintaining the same range of services previously received and whether it aligns with any viewer sensitivity to choice over regionality.

Arqiva remains concerned that mitigation based on changes to DTT homes risks increasing churn away from DTT which in turn, will devalue the DTT Platform. In such cases, where mitigation has failed and a DTT household has been lost (for whatever reason), compensation to the DTT platform on the "polluter pays" principle must be addressed.

On Channel Repeaters (OCRs)

Arqiva agrees that there are significant uncertainties about the use of OCRs, particularly with respect to:

- their operation in the presence of multi-sector antennas, where required for multi-channel repair,
- their impact on receiver overload,
- the requirement for a stable isolation,
- the requirement for a relatively high received field strength, whereas the larger areas of interference will be in areas of low received field strength.

There are also a number of practical issues with the operation of OCRs in the broadcasting network:

- Responsibility for planning and licensing – the planning of OCRs would need to be considered in the context of the whole DTT network. Therefore, it would need to be planned by JPP and licensed by Ofcom. It would also be necessary to consider whether OCRs are to be licensed to Broadcasters or to the Base Station operator. The OCR may create interference to the station that it is repairing, resulting in simply moving the problem from one area to another. Thus, any OCR would need to be planned carefully with respect to its impact on DTT coverage.
- Responsibility for operation and maintenance – The impact of faults of an OCR to the wider DTT network is more problematic, given the potential to cause interference. Arqiva would expect a requirement for OCRs to be maintained to a high, broadcast contract standard, in order to minimise the impact of faults on the broadcasting network. This would imply that OCRs be licensed to broadcasters with the capital and operating costs being met by the new LTE licence operators.

- Spectrum Pricing – should Ofcom continue with its plans to introduce AIP, the cost of the use of additional spectrum would need to be covered in addition to the costs of deployment and operation.
- In a dense network of OCRs, it is possible that one OCR may cause interference directly into the receive antenna of a second OCR; thus design issues such as this will need careful consideration.
- The full benefit of OCRs on a tri-sector base station can only be realised with an enhanced echo canceller with multiple external inputs. Arqiva is not aware that existing OCR equipment is capable of this.

Opposite to DTT polarisation

Arqiva agrees that opposite to DTT polarisation is only likely to be useful in limited circumstances. As noted in the Technical report, multipath and scattering in the vicinity of the TV aerial may also reduce the real world effectiveness of this mitigation technique. It is also expected that in real world implementations, LTE network operators are likely to want to take advantage of MIMO techniques, in which case opposite to DTT polarisation would not be possible.

Base station power reductions

Ofcom concludes that extensive power restrictions could limit operators' ability to make efficient use of 800 MHz spectrum and this could ultimately decrease the quality of mobile networks that consumers experience (5.70). However, this conclusion ignores the reduction in quality that existing consumers of the DTT services will suffer in the event of base station interference. In the Technical Report, we note in 6.114 that 'where required, efficient mitigation can be achieved via judicious amounts of EIRP reduction in different sectors of different base stations'. Given this conclusion in the Technical Report, we are surprised that this form of mitigation is not proposed in the consultation document. Since this is an efficient approach, we recommend that, it is recognised as a mitigation method for individual sectors / base stations, particularly in areas using Ch 60 for broadcasting.

According to paragraph 6.60 of the consultation, Ofcom intends to licence a maximum in-block emission of 61 dBm/(5 MHz) or 64 dBm/(10 MHz). This is 6 dB higher than that assumed and tested in the technical analysis. Since Ofcom expects a large number of base stations will radiate close to the regulatory limit[8], we believe that some mitigation analysis should have been carried out assuming this higher EIRP. In particular, it will significantly increase the viewer impacts produced in Ofcom's 'worst' case analysis.

It also appears inconsistent to allow a universal higher in-band limit without considering the advantages of localised reductions in EIRP at selected base stations / sectors.

[8] http://stakeholders.ofcom.org.uk/binaries/consultations/dtt/annexes/Technical-Report.pdf, paragraph 5.15

Platform Changes

We believe that the provision of an alternative television platform should be the option of last resort because the alternative is not a true replacement for DTT either in the range of services provided or the facility with which access can be obtained. However, any analysis of platform changes has to make allowances that affected services may not be available on the alternative platform. We also note that predicting the availability of satellite services has generally proven difficult.

Arqiva would like Ofcom to note that, as a user of DTT Spectrum, we will be looking for the users of spectrum to be compensated where Platform Change is the only option available. In line with Ofcom's stated AIP spectrum pricing policy and in recognition of the reduction in the value of the DTT platform as a result of the loss of customers, the users of the "polluting" spectrum should be financially liable and thus encouraged to minimise their effect on existing services.

Alternative Mitigation Method – Careful Network Planning

Arqiva's analysis of the impact of LTE base station impact on DTT reception shows that the number, and exact location of base stations, can have a large variation on the number of households affected. As commented previously, Arqiva believe that it is essential that an accurate database of base station locations and characteristics is developed for the purposes of predicting locations where filters will be required. However, this concept could be developed further such that base station locations are deliberately planned to minimise interference to DTT services.

Ofcom and Arqiva predictions based on more realistic 900 MHz 2G base stations show a significant reduction in interference to DTT reception. This is because these sites are generally located away from populated areas.

Arqiva predictions also show that if Block A is not used in areas that use Ch 60 for DTT, that the number of households requiring alternative mitigation beyond filters drops from 231,000 households to 51,000 households. There are real advantages in terms of reducing consumer mitigation via careful network planning in these areas. Particularly for Ch 60 areas, careful location of base stations and / or power restrictions should be considered as potential mitigation techniques.

Interference from Uplink to DTT services

Ofcom's consultation has ignored interference from the mobile device itself to DTT reception, This appears to be on the basis that the mobile handset can be moved if it creates interference to a viewer's television reception.

However, this conclusion ignores the fact that, in communal or attached housing, the interference may be created to a neighbour's TV reception. Hence, the LTE handset / device user may not be aware that they are causing interference. Ignoring the interference from the

uplink, particularly in the case of set-top DTT reception, could result in a significant underestimate of the number of DTT viewers suffering intermittent loss of service in practice.

Conclusion

Arqiva have reviewed and commented on the specific mitigation options identified by Ofcom and, in addition, we have identified further mitigation options for consideration. On the basis that Ofcom should be seeking to undertake mitigation in such a way as to minimise viewer disruption we believe that there is merit in prioritising the mitigation solutions to achieve this outcome and as such propose the following priority order, where option 1 is undertaken first and option 9 as last resort;

1) Base Station transmit filtering
2) Careful LTE network planning, base Station power reduction and/or relocation
3) DTT receiver filtering
4) Improvements or adjustments to DTT installations and equipment
5) Re-orientation of DTT aerials
6) Opposite to DTT polarisation
7) On Channel repeaters
8) Bespoke method
9) Platform change

This ranking would need confirmation once the remedies have been properly assessed against the range of potential unmitigated interference levels and agreed evaluation criteria.

Q3. Do you have any comments, views or evidence that you would wish to be considered in our further work looking at the appropriate level of consumer support?

Ofcom has attempted to consider how best to implement the mitigation options identified. However, without a clear, robust understanding of the extent of the likely interference, it is difficult to make a judgement as to the most appropriate level of intervention necessary. Nevertheless Arqiva believes that there are some key principles to be considered in addressing the appropriate means of implementation;

- On the matter of proportionality raised by Ofcom, it would seem wholly unreasonable for any UK consumer who has invested in DTT equipment (thereby enabling the release of 800 MHz spectrum) subsequently to lose service, owing to Ofcom's de-prioritisation of DTT in favour of new services. In addition, to ready remedies (in the form of low cost filters) all households should be afforded the appropriate mitigation independent of the quality of their DTT installation.
- As LTE networks will continue to evolve over the licence period, there is an inherent need for ongoing information and support with regard to the protection and mitigation regime. To this end, Arqiva believes that there should be a commitment, within the licence, for ongoing protection of DTT services from harmful interference.
- Where a remedy to interference is readily available to resolve multiplex loss, we believe that this should be implemented independently of the type of Multiplex (PSB

or COM) that is lost. If this is not agreed, then the DTT platform in aggregate will be devalued and its role as a competitive force in the market diminished. This would be an unfortunate outcome of the launch of LTE services.

- On the subject of SD services versus HD services, we believe that Ofcom should acknowledge the consumer investment, irrespective of the nature of the service. Every effort should be made to prevent loss in the first place; where it is not possible to remedy the loss and platform change is required then both the consumer and the DTT spectrum user should be compensated.

Arqiva believes that the DSO process proves a positive point of reference for the consumer support necessary to underpin the effective protection of DTT services from the launch of LTE services. The role played by DUK, in harmony with the industry, has been hugely effective in managing the DSO process. We believe that the pro-active nature of information, and education of the public, has been key to the success of DSO and DUK. We see this as being a vital ingredient in any successful consumer support activity associated with addressing interference from the rollout of LTE systems. In particular, we note the efforts made by the authorities during the DSO process to ensure that less able members of society had every assistance necessary; with funding of circa £230m set aside to facilitate the process of switching to digital TV. Furthermore, one would assume that the Digital TV Self-Help scheme has records of those consumers who required support and, as such, may benefit from further assistance with regard to interference associated with LTE services. To this end we are concerned that the predicted cost of protection of UK households from interference is a relatively modest number in comparison and as noted in response to questions 1 & 2 the actual range of potential impacts is likely to be considerably greater, Bouyges[9] the French mobile operator has suggested that the cost of mitigation in France could range from €500m - €1.7bn based on its own assessment. We urge Ofcom to ensure its analysis, on which it is planning the mitigation activities, is more realistic, e.g. a modest increase in the number of households with 'Domestic installations with amplifiers' can double the cost of consumer mitigation, see table 1. In addition, one obvious major cost driver may be the extent to which third party intervention is required to resolve interference issues, even simply to install a filter; this may add considerably to the potential rectification costs incurred.

Table 1 Impact of increase in the number of Households having 'Domestic Installations with amplifier' on the cost of consumer mitigation.

Furthermore, Arqiva believes it very important that Ofcom does not underestimate the potential for disruption that could result from the introduction of LTE services. Ofcom makes multiple references to not wanting to over-burden the protection arrangements but the specific broadcast frequencies that will be affected are well understood from their analysis

[9] 4G: Bouygues Telecom saisit le Conseil d'État, Le Figaro, published 24/06/2011.

and hence the areas of the country that will be affected are also known. Therefore, Ofcom has the potential to easily identify the households that will be affected by interference

Ofcom's proposals are not clear in the definition of the point at which all avenues of rectification have been exhausted. i.e. the point when the household is offered an alternative DTV platform. There is a danger that the household will have experienced "weeks" without a television service (which seems difficult to comprehend when the average household consumption of broadcast television is 4 hours per day) and will migrate to an alternative platform by default. To this end, we further encourage Ofcom to approach the mitigation of interference from LTE services in a proactive way; any disruption to UK TV service reception (as noted above) is likely to cause huge frustration to the consumer, immense embarrassment to Ofcom and the UK Government and calls for compensation from those who have invested in the DTT Platform as consumers or spectrum users.

Ofcom should also take note of the mitigation measures being adopted in European countries where DTT has a similar role to that in the United Kingdom, e.g. Sweden and France. There, far greater obligations have been placed on the LTE licence holders than currently envisaged by Ofcom. In Sweden, for example, the regulator has applied lower power restrictions to the blocks adjacent to channel 60 in order to minimise the risk of interference. In our view, their approach is more pragmatic. It recognises the principle that the source of the interference is the LTE service; hence they seek to modify the LTE service as a priority to minimise the impact. Furthermore, there seems to be a logic to the development of a consistent approach across Europe. LTE operators bidding for licences in the UK will be operating networks across multiple territories; inconsistencies across national borders will add complexity to their businesses and potentially increase risk of unwanted interference to DTT.

Finally, we endorse Ofcom's plans to undertake further research to investigate the costs and impacts of the choices and options proposed. In particular we encourage Ofcom to liaise closely with DUK and the Digital Self Help scheme to determine best practice and appropriate scale.

Q4. Do you have any comments or views on how we have assessed the approaches and our preference for the hybrid approach?

Arqiva supports the creation of an independent body to administer the protection of DTT services from LTE based interference. Similarly, the process that has underpinned the DSO process has been predicated on the creation of an independent body, DUK, working closely with the Broadcasters, Network Operators and Retailers. To this end we believe that it is Government's responsibility, as granted by the European Directive, to ensure that the introduction of LTE based services does not lead to the harm of existing broadcast services. We would seek reassurance that Ofcom is not "de-prioritising" DTT following switchover, having incorporated the Digital Switchover process (and its related costs) in the multiplex licences. We believe that it should be Government who subsequently takes responsibility for the protection of the DTT services through the creation of MitCo; direct responsibility for MitCo's actions being to Government itself. The loss of TV services from UK households is too serious a matter for the body administering it not to be directly accountable to Government, its constituencies and, ultimately, the electorate.

In commenting on the creation of MitCo it is illustrative to consider how Digital UK was formed as the managing entity for the digital switchover programme.

Whilst the digital switchover implementation commenced in September 2008, the planning carried out by Digital UK (formally SwitchCo) began many years prior to this. The sequence of events involved discussions with the multiplex operators in December 2004 which led to the drafting of the Memorandum and Articles of Association for the new organisation. In April 2005 Digital UK (or SwitchCo as it was at the time), was incorporated as a not-for-profit company limited by guarantee and following the ministerial announcement on switchover made in September 2005 led to the first publicity campaign. There are two issues here that it is important for Ofcom to note. Firstly the purpose and formation of the managing organisation was carried out with the full involvement of the organisations that would be most impacted by the changes being managed, i.e. the multiplex operators. Nowhere in Ofcom's consultation is reference made to the role of the multiplex operators in the formation and running of MitCo. Whilst we believe that government should take responsibility for the running of MitCo, its formation and day to day operation should be influenced by the views of the multiplex operators whose customers and viewers will be impacted by the outcome of the LTE implementation programme. Secondly, a significant period was necessary to adequately plan the viewer response systems associated with digital switchover. For the LTE implementation the need for adequate preparation time ahead of LTE roll out is just as valid particularly as the support required will need to be targeted as not everyone in the country will be affected.

With regard to the proposed tariffing arrangements, several issues need to be addressed. Firstly, the tariffing arrangement considers payments to consumers when service is lost. This should apply to households that consume DTT irrespective of whether it is on the primary, secondary or the tertiary sets. Secondly, we believe that the tariffing arrangements, as proposed, are subject to too many inherent uncertainties in their impact on interference to be credibly set prior to service launch. We acknowledge that the MNOs have a requirement to rollout networks and enhance services while minimizing costs. However, this, together with the uncertainties associated with the impact of any interference, means that we believe any tariffs specific to the MNOs will be largely irrelevant from the perspective of constraining behaviour. Furthermore, the tariffing approach appears fundamentally flawed in the sense of allowing a trade off between consumer based mitigation and operator based mitigation. In the consultation Ofcom acknowledges that protection is enhanced when consumer based interference protection solutions are used in parallel with network based mitigations. Clearly, this questions the basis under which any trade-off of measures may be applicable or relevant. It is not clear where such a tariffing scheme has been used previously. As such, it would seem odd that Ofcom is proposing to introduce a new mechanism for cost recovery to mitigate for a circumstance as sensitive as the potentially **permanent loss of TV** services for the UK consumer. Moreover, the tariffing scheme, whilst looking to compensate some (but maybe not all) DTT consumers, overlooks the negative impact on the overall attractiveness of the DTT platform. Any churn to other platforms associated with the impact of LTE interference should result in an adjustment of any spectrum charges levied

Ofcom prides itself on evidence based decision making. However, the evidence to support the case for the tariffing arrangements and the hybrid approach to the mitigation authority is

far from clear. As such we would encourage Ofcom to think again and would welcome a revised consultation built on a more secure evidence based approach.

Q5. Do you agree with the options, the assessment approach and our initial conclusions? What are your views on cost risks and how to deal with them?

We are supportive of Ofcom's proposals that ***all* costs** (both cash and non cash) associated with the loss of service and rectification of interference issues caused by the introduction of LTE services in the 800 MHz band should be borne by the new licensees. This is consistent with the 'polluter pays' principle. Furthermore, we would suggest that compensation for "spectrum damage" to the multiplex licensees is included in such calculations. However, as noted above, Arqiva has concerns about the efficacy of the tariffing scheme, as proposed. We believe that all stakeholders require greater certainty as to the level of funding that will be available and where the funds will come from ahead of any launch of LTE services. It is imperative that there is no ambiguity in terms of funding availability and authorisation. This is needed to ensure a speedy and effective resolution of instances of interference in a pro-active manner, or compensation where a resolution is not forthcoming.