

Domestic TV Aerial Performance

research for

Ofcom

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EXECUTIVE SUMMARY

This report describes work undertaken for Ofcom by Aegis Systems and i2 media research limited to obtain an up to date understanding of the conditions and performance of household television aerials in the UK, in the context of digital television switchover (DSO).

The report provides valuable new insights based on analyses of new measurement data on aerial performance, combined with new in-depth research on consumer attitudes to switchover and their expectations and information requirements to plan to receive television after switchover.

These analyses make important new contributions in our understanding of:

- the current quality of UK domestic aerials;
- the relationship between aerial quality and field strength at its location;
- the relationship between aerial quality and whether digital terrestrial television signals are available at its location;
- the effectiveness of aerial amplifiers; and
- the information requirements of consumers experiencing difficulties with their domestic terrestrial television reception.

In addition, the report provides a new summary of commentary on the parameters which determine whether a household/ locality is considered covered for digital terrestrial television.

Detailed up to date view of the quality of the UK aerial installed base

The project's analyses showed that:

- Aerial system gain tends to be inversely proportional to available field strength. A trendline fitted to the data showed a dependence of -0.7 on the available analogue field strength. From this trendline, the assumed system gain of 7dBd is generally only achieved in locations where the available analogue field strength is 75dBµV/m or less.
- 29% of UK household aerials have some form of amplification in the system (33% for DTT, homes, 19% for analogue only homes). Where amplification is used, it improves both the system gain and the C/N or MER.
- Older installations exhibit somewhat lower system gain - a 30 year old system has an average gain some 10dB below a new installation.
- Approximately 75% of UK households have grouped aerials. There is no difference in overall gain between systems with 'grouped' and 'wideband' aerials, although the former would be expected to show a higher gain. This is possibly due to age differences (i.e., grouped aerials tend to be older).

- The assumptions about aerial performance on which digital terrestrial television coverage planning is based are consistent with the most recent measurement data.

Up to date estimate provided of aerial upgrades to receive digital terrestrial

Based on the project's analyses:

- Under 5% of households (approximately 3.4%) are likely to need an aerial upgrade to receive PSB services after digital television switchover.
- For reliable reception of all multiplexes, this figure rises to just under 10% (approximately 9.6%).

Consumer communications about aerials considered broadly appropriate

The information about aerials in the Digital UK information leaflets shown to participants in the research groups was considered both sufficient and useful, particularly for people without alternative platforms (e.g., satellite, cable or IPTV).

Most participants were aware that current roof aerials might need to be updated for digital terrestrial reception, with many reporting that their awareness had been raised by sources including word of mouth, local press and Digital UK. Interestingly, many indicated that communications which illustrated the options of a range of typical households would benefit consumers, helping them to identify factors that may be relevant to their own switchover related decisions.

Potential for future communications to be more reassuring

The project's consumer research showed that participants reported thinking that pixelation of digital terrestrial television before switchover indicated a need for a new aerial, and that indications of low signal strength via their set top boxes could be interpreted similarly. There was little direct experience in the group of having replaced roof aerial systems. This was in the context of little or no awareness of various official aerial checking tools (e.g., teletext test, handheld aerial checker).

Participants identified scope to give more prominence to messaging that digital terrestrial television signal levels are increased substantially relative to pre-switchover levels. This finding was consistent with project participants favouring advice that consumers should 'wait and see' what their reception is like after switchover, given the expectation that the majority of aerial systems should be sufficient for digital terrestrial reception.

Mixed experiences of digital terrestrial television reception

Supportive of the project's technical research results, there were several reports within the project's consumer research groups of reception issues with digital terrestrial television, both pre- and post-switchover. These issues included pixelation, allocation of channels to unexpected channel positions, and loss of specific channels.

Many participants used and persevered with equipment that gave them good enough but not optimal reception, and in this regard extensive use of indoor aerials was reported. Some participants reported having purchased several indoor aerials, to try to improve their reception, when a better roof aerial may have been a more effective longer term solution.

A need for an impartial post-switchover troubleshooting advice source

Participants expressed a need for in an impartial advice source available across different media for provision of post-switchover troubleshooting information (potentially available via a pre-recorded phone line providing solutions to typical problems).

Many had prepared for switchover in advance, and had few concerns

A key theme emerging from the research was that many participants had been ready often well in advance of switchover, with at least one television set already converted. Because of this, expenditure cited as directly related to switchover was low.

1 INTRODUCTION

This report describes a study undertaken to obtain an up to date understanding of the conditions and performance of household television aerials in the UK, in the context of digital television switchover (DSO).

The report describes the project's analysis of new measurement data gathered for BERR alongside the project (BERR 2009 survey), and new research on consumer attitudes to switchover and expectations and information requirements to plan to receive television after switchover.

A key finding of the study is that the performance of the installed base of domestic aerials does not appear to have changed significantly since 2004, with aerial system gain still tending to be inversely proportional to field strength. Few installations meet the gain value (7dBd) assumed in the UK Planning Model.

1.1 Background

Previous studies have generated a breadth of insight pertaining to the quality and performance of UK household aerials, and consumer understanding and expectations in relation to television reception.

A key finding from previous research is that the quality of household aerial installations (as measured by the gain provided by an aerial) correlates inversely with available signal at the aerial's location. This finding is consistent with installers performing installations to provide sufficient signal for reliable terrestrial television reception.

Previous technical and consumer focused research studies have consistently indicated that due to both ageing and damage, approximately 5-10% of UK households have aerial installations of insufficient quality for reliable reception of digital terrestrial television. The estimate of 5-10% of aerials being of insufficient quality includes those providing poor reception because of the quality of the aerials themselves, and also the quality of cabling from the aerial to the wall plates.

A much higher proportion, 50%, of indoor aerials has been predicted to give reception of insufficient quality for reliable digital terrestrial television, largely because of variability in signal quality within the home environment.

It is important to note that the majority of people living in households with aerial installations of insufficient quality to receive digital terrestrial television also experience poor analogue picture quality. That said, poor signal quality (arising from weak signal at an address or a poor quality aerial installation) and interference (for example, impulse interference, time varying interference) impact more severely on the consumer experience of digital than analogue television. An up to date understanding of consumer expectations and needs from communications about television reception, and an updated technical snapshot of current aerial performance are both important resources to plan for the provision of reliable

terrestrial reception for UK citizens and consumers through switchover. This is particularly so in the context of lessons learned from early switchovers where, for example, some digital terrestrial television equipment failed in areas where signal is available from more than one transmitter, or where some multiplexes move out of the aerial group previously used for analogue terrestrial reception.

Key for communicating with consumers to help them prepare for switchover, is an understanding of their expectations and understanding of television reception. Previous research has consistently shown that consumers tend to want to avoid spending money on their television reception equipment if they can, with many initially trying to improve their reception themselves (e.g., buying amplifiers/boosters or 'digital ready' indoor aerials). Further, consumers are generally unable to differentiate between coverage and reception issues with digital terrestrial reception, and are likely to attribute reception problems to a 'broken box' and problems with transmissions rather than their own aerial systems. Whilst a range of tools or tests have been developed to help consumers identify if their aerials are in a good enough condition to receive digital terrestrial television¹, available evidence suggests that these have not been used extensively. With regard to seeking professional assistance, a 'wait and see' attitude tends to prevail over early action to get aerials checked.

Alongside this generally low understanding and low motivation to check the performance of their aerial systems, consumers tend to have high expectations of switchover. For example, there is a general expectation that, once teething problems are overcome, digital reception will be perfect. Many assume that digital television switchover would not be happening if it was known in advance that coverage and reception issues will affect consumers.

Research that has involved consumers affected by known coverage issues (including poor coverage, and time varying interference) want accurate, meaningful, and honest descriptions of their likely reception situations. Even amongst such consumers, previous research has revealed low awareness of non-terrestrial subscription-free ways of getting digital television, and that many do not know who to complain to when they experience reception difficulties. A final issue indirectly related to coverage and reception, but an integral part of the consumer experience of digital terrestrial television reception is retuning. Retuning has been proven to be problematic for many consumers in early switching areas, and for more consumers than would otherwise be expected when combined with group changes to any digital multiplex.

¹ e.g., comparison of picture quality to a reference picture, analogue text test (page 284), and a handheld aerial checker.

1.2 Objectives and research questions

Existing technical research has of course informed planning for the digital terrestrial network, as consumer research has informed communications to the public about switchover. There were though two key drivers to the current project. First was to establish whether an up to date analysis of the performance of household aerials revealed a consistent picture to that provided by previous research. Second was to fill gaps in the existing knowledge base on consumer information requirements and expectations to enable them to plan for switchover. The consumer research was also designed to identify consumers' information requirements about how best to plan to receive television through switchover.

The primary technical objective then was to analyse new household aerial survey data, provided by BERR, to determine whether there has been any significant change in the statistics of domestic aerial performance since the previous studies. Further objectives included the development of an understanding of the link between aerial system performance and coverage area, television services available to the household and type of installation.

It was determined that no significant change in system performance has occurred since the last survey, although aerial systems in DTT households do demonstrate a significantly better (~12dB) overall gain.

The main objective from the consumer perspective was to understand consumer information requirements about television reception methods to enable them to plan to receive television after switchover.

This objective was addressed by conducting focus group research in an area that had recently switched – Torquay (Beacon Hill transmitter). This area was selected as it enabled the objective to be explored by participants who had recent direct experience of the switch; they were better positioned to acknowledge any changes they needed to accommodate (purchase and learning to use new equipment), and to reflect on their experiences leading up to, during and after switchover.

This approach generated a series of research questions addressed in the focus groups. These included:

- What were people's general (warm-up) and television reception related experiences of digital television switchover? Were they prepared?
- To what extent was the messaging approach about aerials considered adequate, effective, and sufficient for households in different situations?
- What were consumer information requirements to plan to receive television after DSO?
- What were consumer expectations of how and where information should be made available?

- To what extent did consumers perceive a range of other variables (e.g., functionality required, content, cost etc.) influence people's satisfaction with the messaging approach?

The consumer research comprised:

- a questionnaire/survey study (distributed within the parallel study commissioned by BERR) conducted throughout England over February and March 2009, and used in some of the technical analyses of the project; and
- three focus groups conducted in Torquay on 11th May 2009.

(See Chapters 6 and 7 for description and analysis of the consumer research)

2 DOMESTIC TV AERIAL SYSTEMS

The technical planning for digital switchover (DSO) is complicated by two significant factors that are substantially beyond the control of the broadcasters – the propagation channel and the domestic receiver installations. The vagaries of the propagation channel have been extensively studied and can be reliably modelled on a statistical basis.

What becomes of the signal as it is intercepted by a domestic aerial, fed through a more or less complex system of feeders, amplifiers and splitters and delivered to the receiver is less well characterised. To allow coverage planning to be undertaken, some assumptions must be made, and to this end it is assumed in the UK planning model (UKPM) that all aerials have a gain of 10dB with a feeder loss of 3dB (both independent of frequency), and a directivity represented by the template given in ITU-R Recommendation BT.419.

If the actual installed base of aerial systems has significantly different characteristics from this assumption, the coverage achieved will be different from that predicted. It may be argued that, if the broadcasters have provided 'sufficient' signal, it is a matter of personal choice by the consumer as to whether they choose to make full use of this by installing an efficient aerial system. Because reception of digital terrestrial signals is more binary in nature than is reception of analogue signals, a robust understanding of the statistical characteristics of domestic aerial systems is important within the DSO process.

Two previous studies have examined these issues. The first was undertaken in the context of the launch of the fifth analogue TV channel in 1995, and paid particular attention to the ability of household aerials to receive relatively low-powered services transmitted on (the previously out-of-band) channels 35 and 37. This study showed that installed antenna gain was dependent on the field strength available at the antenna, as shown in the figure below.

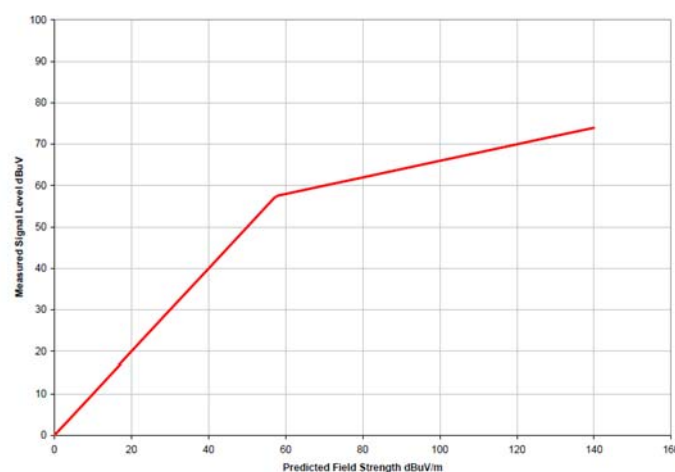


Figure 2.1: Variation of aerial gain with field strength in 1995 study
(source: ITC)

In the initial planning for DSO, there was concern that the statistics from this work might not be sufficiently reliable, and new work was undertaken jointly by the BBC and NTL (now Arqiva) in collaboration with the ITC. The headline conclusion from this survey, which encompassed ~300 households in four areas, was that most domestic aerials had a performance just sufficient to provide acceptable reception given the available field strength at that location. In the Crystal Palace service area, for example, the assumed 7dB system gain was achieved where the field strength was ~72dB μ V/m, rising by 18dB where the signal was 20dB lower, and falling by 17dB where the signal was 20dB higher. In the event, the new study agreed closely with the 1995 results. The overall best-fit trendline is shown in Figure 2.2.

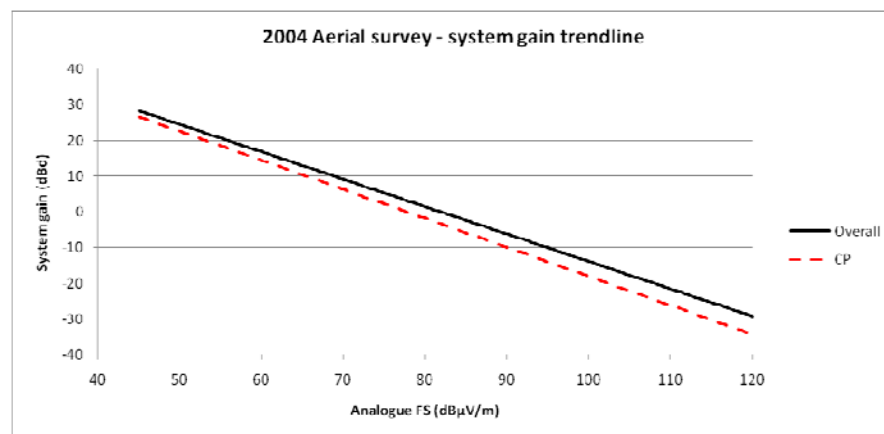


Figure 2.2: Variation of aerial gain with field strength in 2004 study

This dependence of aerial gain on DTT field strength is not modelled in the UKPM², and it must therefore be expected that viewers' experience of reception may be different from that predicted, although the prediction correctly describes what services are potentially available.

2.1 Aerial system bandwidth

The laws of physics imply that, for a given physical size, an aerial that works over a narrow range of frequencies will have a higher gain than a more broadband version.

The UHF broadcast band covers almost an octave of spectrum, between 470 and 857 MHz, and manufacturers have traditionally produced aerials designed to work only over subsets of these frequencies. Partly to accommodate this, and partly because the same considerations apply to transmitter aerials, broadcasters have historically 'grouped' the various transmissions from each transmitter site. Although wideband aerials have always been available, their use has not generally been popular as they have a gain typically 3dB below a 'grouped' aerial.

In analogue days, the normal span of the original four channels was 80 MHz, and domestic aerials were available in the following groups:

² Although such an algorithm was introduced, it is no longer applied

Table 2.1: Domestic aerial groups

Group	Channels	Frequencies
A	21 - 37	470 – 599 MHz
B	35 - 53	583 – 727 MHz
C/D	48 - 68	687 – 847 MHz
E	35 - 68	583 – 847 MHz
W	21 - 68	470 – 857 MHz

NB: A, B & E group aerials were not originally (prior to mid-1990s) intended to cover the channels 35-38, which were not used for broadcasting. A further group (K) has since been added.

Considerable effort was expended in the development of the switchover plan to minimise the number of cases in which it would be necessary to make use of channels which were out of band relative to the existing analogue services. This is not always possible, partly on account of the need to radiate on six rather than four channels post-switchover, in a reduced broadcast band, and partly owing to continental interference constraints.

An audit of 200 homes was carried out by ITV Digital, using both indoor and outdoor measurements, which showed that the shortfall in aerial system gain increased by some 3dB when the (interim) DTT services were out of group (relative to the existing analogue services). It might be expected that, in areas in which out-of-band DTT services have been available for some time, a higher percentage of homes will have adopted wideband aerials.

One of the aims of the new 2009 BERR household aerial survey was to identify the grouping of the aerials at the sampled households. The use of this data will allow the proposed study to make an estimate of the degree to which the population of grouped aerials is a constraint to further changes in the DSO plan. Such changes would, for instance, be necessitated by any decision to release channels 61 and 62 for other (non DTT) uses.

3 NEW HOUSEHOLD AERIAL SURVEY BY BERR

BERR, now the Department for Business, Innovation and Skills (BIS), commissioned GTech Systems Limited to undertake a survey of domestic aerial performance by way of a series of indoor and outdoor measurements of signal strength.

3.1 Measurement locations

The intention was to characterise aerials in the following areas:

- Inner London
- Coverage overlap / marginal areas
- Rural, near to a TV transmission mast
- Rural, distant from a TV transmission mast

The distribution of the actual measurements is indicated in the figure below, which also shows the relevant transmitter locations (identified by the acronyms, given in Table 3.1).

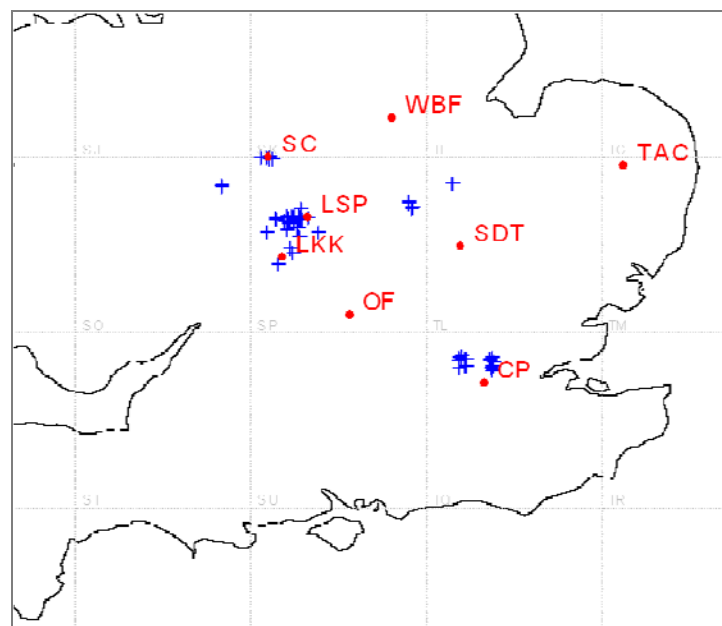


Figure 3.1: Geographical distribution of BERR measurements

The breakdown of measurements with respect to each transmitter is recorded in Table 3.1

Table 3.1: Summary of BERR measurements

Transmitter	Outdoor	Indoor	Average gain (4 analogue)	Path length, area
Crystal Palace (CP)	33	67	-7.0 dBd	~20 km, urban
Sutton Coldfield (SC)	62	142	+4.7 dBd	~35 km, rural, suburban ~1-2km, suburban
Larkstoke (LKK)	17	49	+1.2 dBd	5-25km (rural, suburban)
Leamington Spa (LSP)	3	5	-5.6 dBd	1-5km, Suburban
Oxford (OF)	2	8	+5.9 dBd	50 km, rural
Tacolneston (TAC)	2	5	+12.3 dBd	98 km, rural
Waltham (WBF)	3	3	-2.6 dBd	50 km, rural, suburban
Sandy Heath (SDT)	6	13	-2.7 dBd	37km, rural, suburban
Totals	129	292		

The majority of measurements were those made in two areas of inner London (from the Crystal Palace transmitter), and those made around Warwick (from the Lark stoke and Sutton Coldfield transmitters, with a few contributions from Leamington Spa and Oxford).

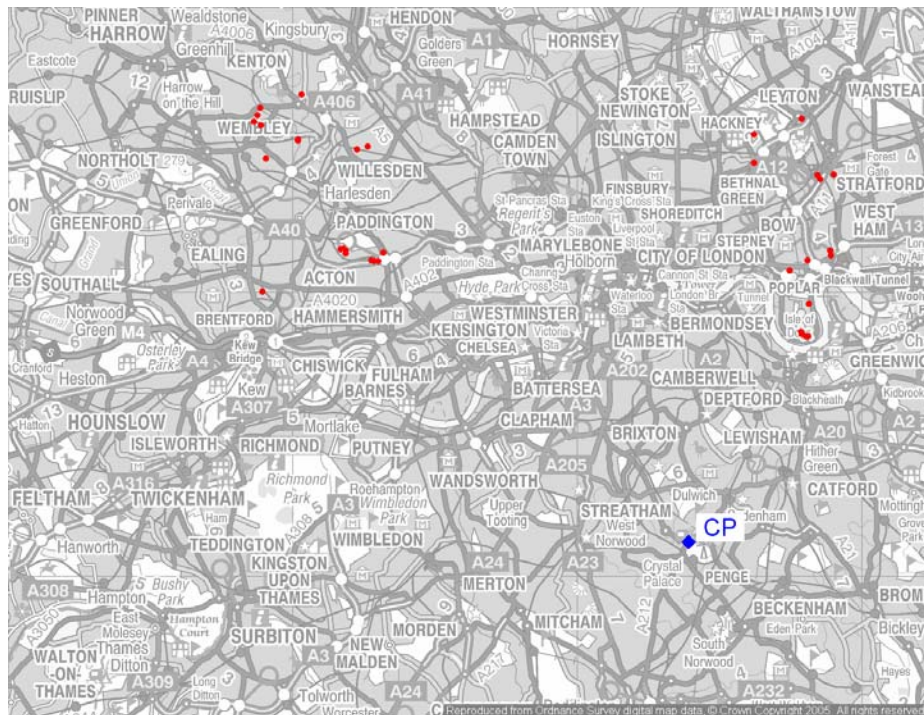


Figure 3.2: Measurements in London

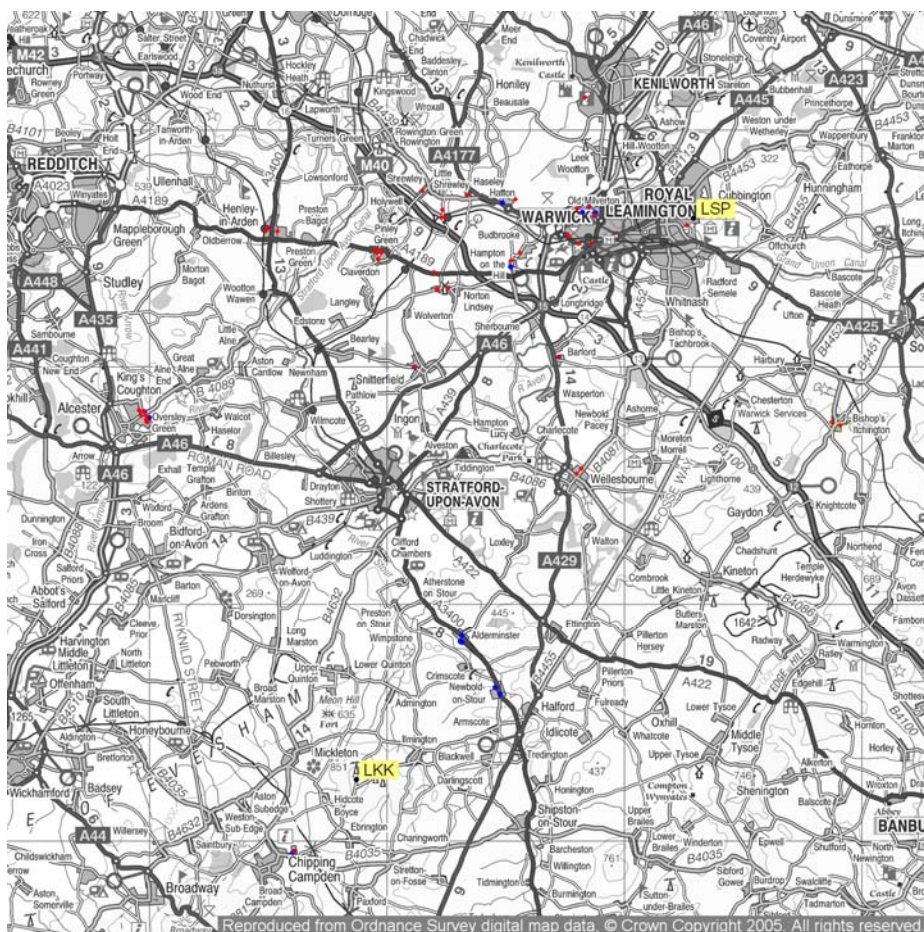


Figure 3.3: Measurements in Warwickshire

A small number of measurements were made in a rural area around Kettering, where the service is from a mixture of Tacolneston, Waltham and Sandy Heath (Figure 3.4).

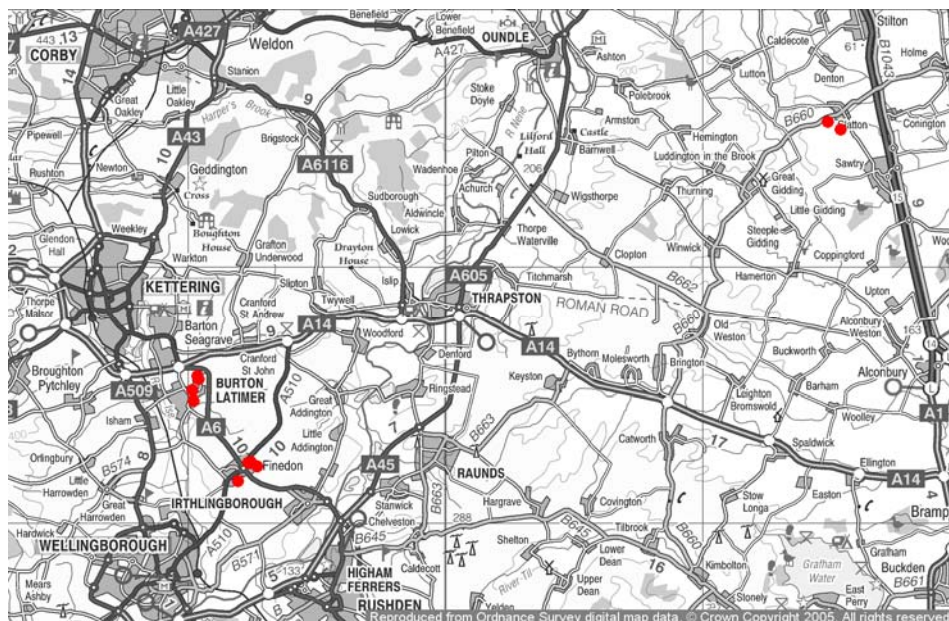


Figure 3.4 : Measurements of ‘overlap area’ in East Midlands

3.2 Measurements made

At each household visited, the terminated voltage (dB μ V) for each service (DTT or analogue) was measured at the wallplate, or coaxial flylead at the main set.

Measurements were also made of field strength (dB μ V/m) using a 10m pump-up mast, generally at a single location considered representative for 2-3 of the houses measured.

For both the indoor and outdoor measurements, records were also made of the carrier/noise ratio (C/N) and Modulation Error Ratio (MER), for analogue and digital signals respectively.

Finally, information was recorded regarding the technical characteristics of the installation (Grouped aerials?, amplifiers?) and for more general consumer research.

The handheld Reception Checker was also used at the majority of households, and the answers recorded.

3.3 Postcode checker

A comparison has been made between the transmitter used at each household in the survey, and that predicted by the Digital UK ‘postcode checker’ website to be the “most likely transmitter”.

Table 3.2: Postcode checker 'most likely' prediction accuracy

Postcode Checker 'most likely'	Sample	Accuracy	Other Transmitters used
Crystal Palace	67	100%	
Sutton Coldfield	147	84%	17 Larkstoke, 6 Oxford
Larkstoke	22	100%	
Leamington Spa	8	38%	3 Sutton Coldfield, 2 Lark Stoke
Sandy Heath	11	55%	2 Waltham, 3 Tacolneston
Tacolneston	3	67%	1 Sandy Heath
Waltham	5	0%	5 Sandy Heath

It is probably not possible to draw any conclusions on the general accuracy of the checker predictions from this sample; the Crystal palace measurements were made in areas where this transmitter is the only likely source, while the East Midlands measurement area was deliberately chosen to offer multiple available sources.

Perhaps of more interest is the comparison of the predicted (current) DTT coverage, and the measured values of field strength at each location.

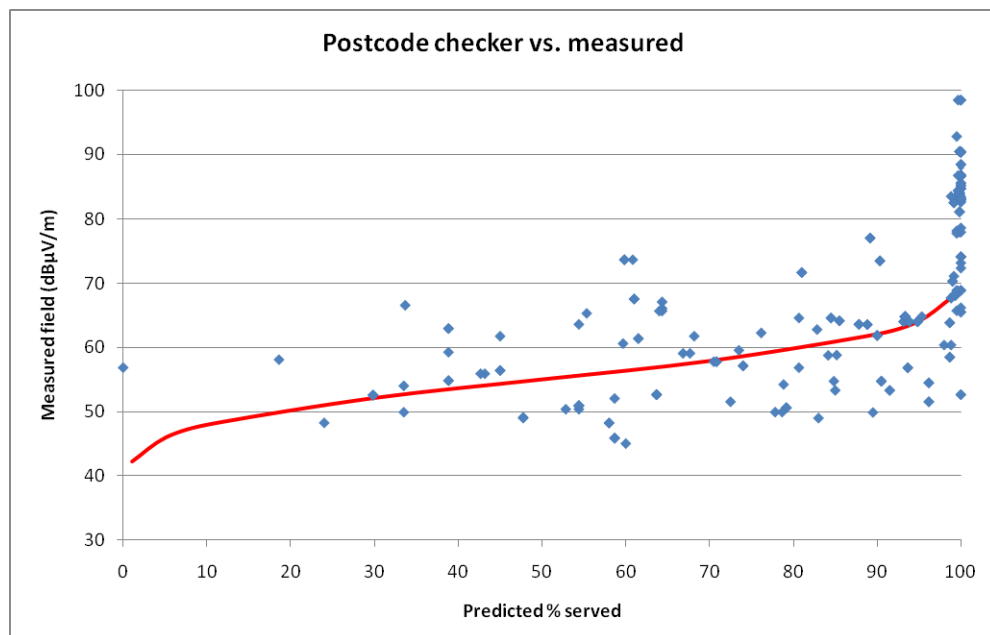
**Figure 3.5: Measured 10m field strength vs. checker prediction**

Figure 3.5 shows the relationship between the 'served' percentage indicated by the postcode checker, and the actual field strength from the relevant transmitter measured in the BERR study. It can be seen that the 100% point is reached where the field strength exceeds about 65dBµV/m. The checker percentage figures correspond to the proportion of a pixel predicted served assuming a location variability of 5.5dB. The theoretical log-normal signal distribution corresponding to

this value is plotted (red curve) in Figure 3.5, and it can be seen to show reasonable agreement with the measured data. The spread in results is due to the fact that (i) the BERR measurements were not made at the exact addresses used and (ii) the measurements take no account of interference, while the predictions do.

Figure 3.5 is re-plotted with a logarithmic abscissa in Figure 3.6.

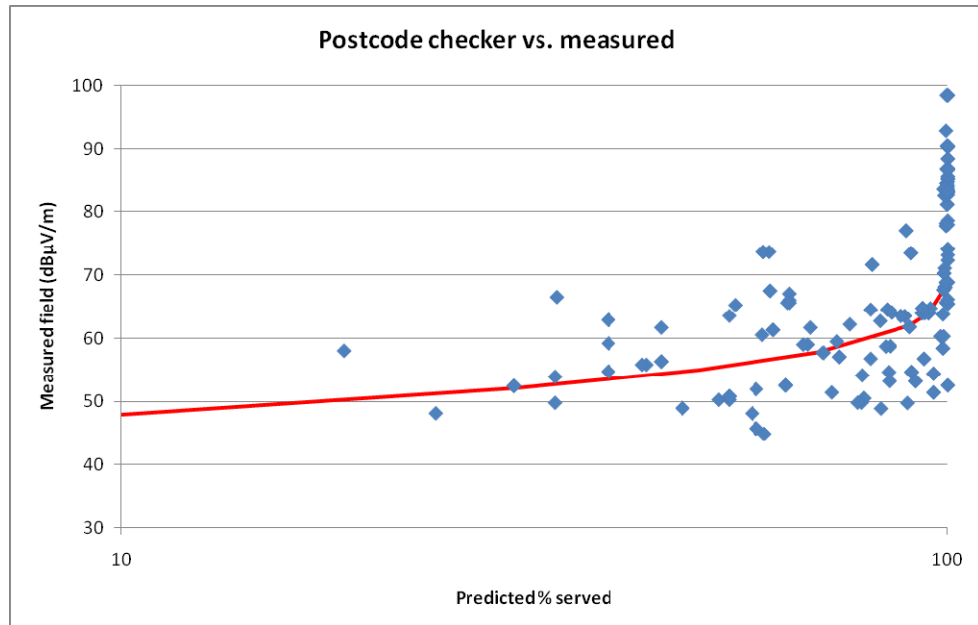


Figure 3.6: Measured 10m field strength vs. checker prediction

4 TECHNICAL ANALYSIS

The primary aim of the new analysis was to make a comparison with the statistics derived from the 2003/4 survey. One hypothesis might be that aerial system performance could be expected to have improved, as the rapid take-up of the current, low-power, DTT service might inspire upgrade and renewal work.

4.1 System gain

The primary output of the analysis must therefore be a trendline similar to that shown in Figure 2.2, showing the relationship between available field strength and aerial system performance. To generate these statistics, the difference between indoor measurements and outdoor field strength is compared, making appropriate allowance for the effective aperture of a dipole element at each specific frequency of interest, and for matching to a 50Ω system. This gives a figure for 'aerial system gain', which includes the gain of the antenna and any amplifiers, and the losses due to the feeder system.

The majority of aerials measured will have been intended for reception of the original analogue group from each transmitter, and post-DSO, services are largely planned to fall in the same groups. The first analysis was, therefore, in terms of the aerial system gain for the four original analogue channels. Figure 4.1 shows a scatter plot of all such measurements made in the BERR survey, with a linear trendline superimposed.

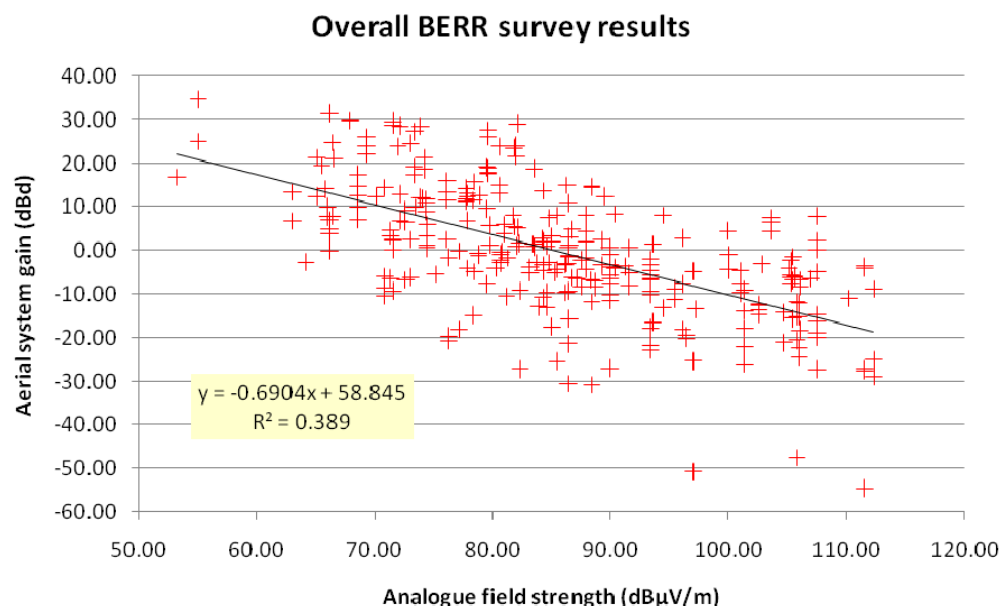


Figure 4.1: Overall trend of BERR 2009 results

A very marked trend can be seen for the system gain to fall with increasing available field strength, as was noted before. Figure 4.2 compares the old and new trendlines directly.

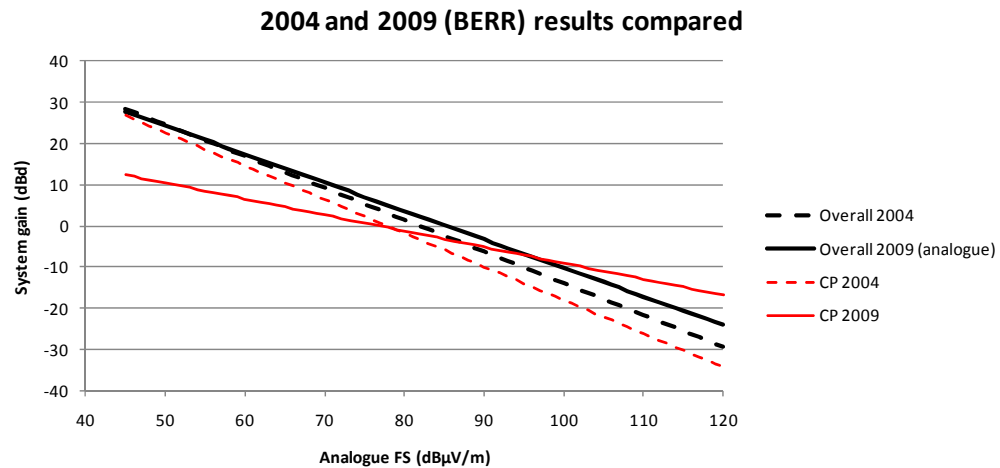


Figure 4.2: Comparison of results

It can be seen that there is very little difference in the two sets of overall results, though the dependence of system gain on field strength is slightly reduced. Thus, where field strength is very high, aerial systems in the new survey are slightly better than in the old survey (3dB better at 90dBµV/m).

Further examination, however, shows that the majority of this difference is attributable to the new results for Crystal Palace, which show a very marked reduction in dependence on field strength (from a factor of -0.81 to -0.39). If the CP results are removed from the new data, the trend is almost identical, albeit with a small positive offset.

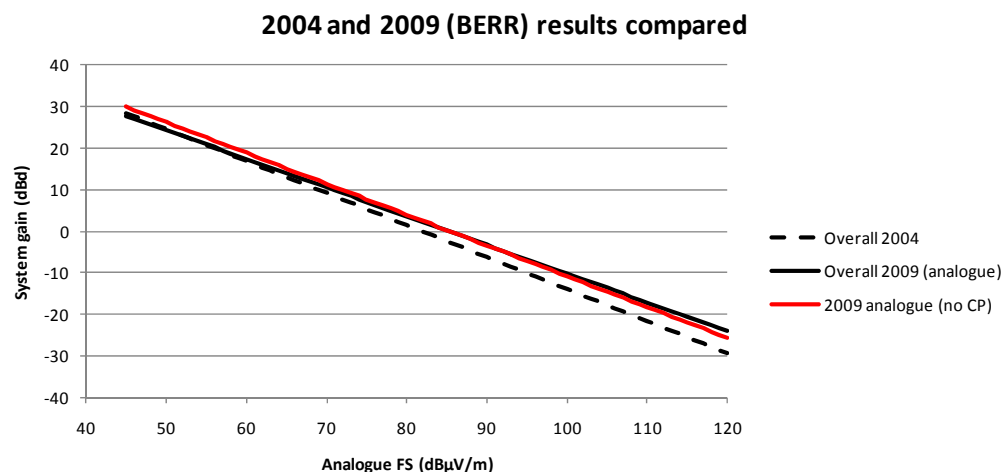


Figure 4.3: Comparison of results without BERR CP

In addition to the characterisation of the system gain for the original analogue channels, the same process can be undertaken to show the performance of the aerial at the frequencies used for the interim DTT service. It might be expected that the same trend would be evident, but perhaps offset by a reduction in gain to reflect the fact that many of the current DTT services are out of group.

Figure 4.4 compares the results for the two cases, and shows that there is little difference between the two groups of data, suggesting that the majority of the interim DTT services examined are radiated on channels for which installed aerial performance is adequate.

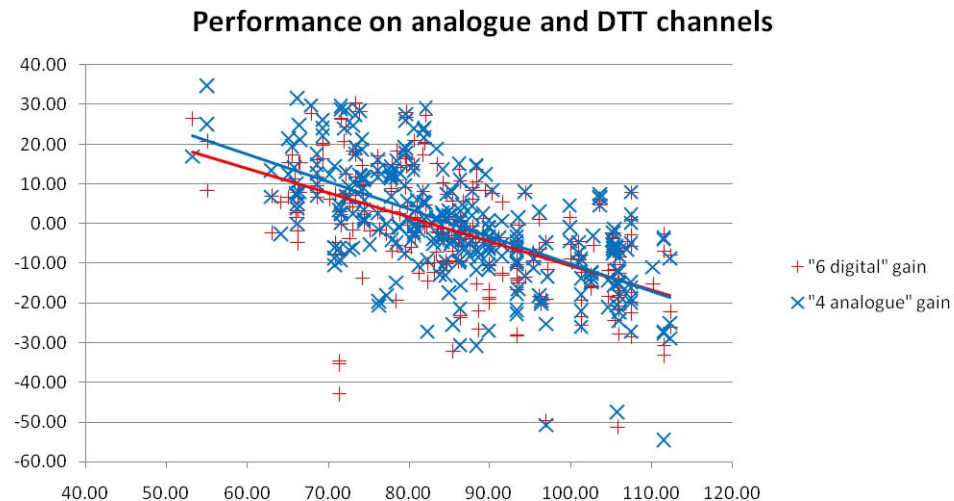


Figure 4.4: Comparison of '4 analogue' and '6 DTT' gains

The additional information logged in the course of the BERR survey work allows analysis of the raw data with respect to a number of variables. Such analyses are presented in the sections below.

The close correlation between the system gains on the two sets of channels is more explicit in the plot shown in Figure 4.5,

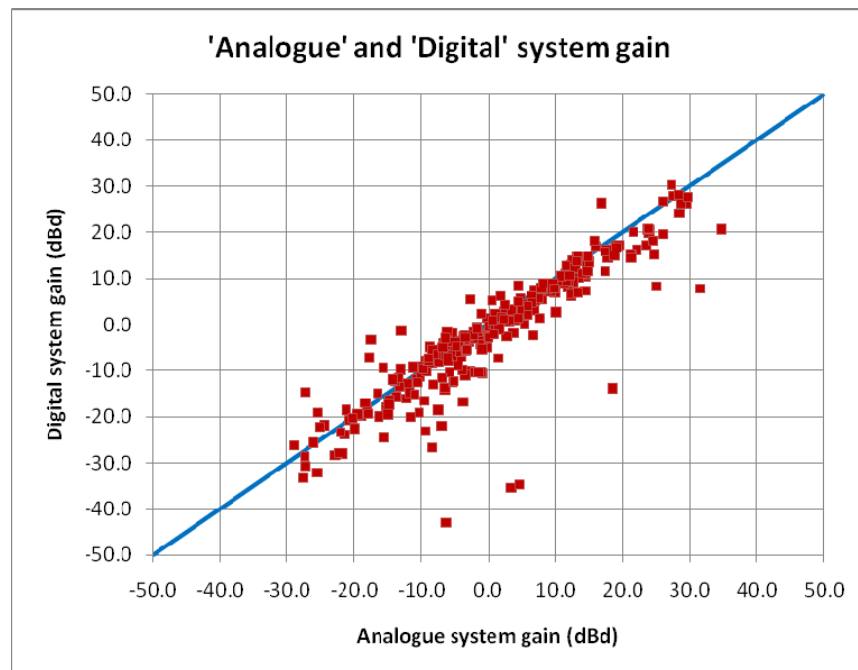


Figure 4.5: Correlation between analogue & digital system gain

As the analysis method takes into account the differences in transmitter power and radiation between the different channels, the only differences between the two sets of measurements will be due to the frequency response of the domestic aerial. The outliers represent cases where some DTT channels are well outside the nominal group (i.e. at Lark Stoke, where the analogue group is 'A' but two DTT channels fall in Group C/D).

4.1.1 System performance - cumulative distribution

The statistics of system gain may be expressed in terms of a cumulative distribution function (CDF), showing the percentage of the population for which a given system gain is exceeded.

The data from the overall BERR measurements (as shown in Figure 4.1) is plotted below in this form.

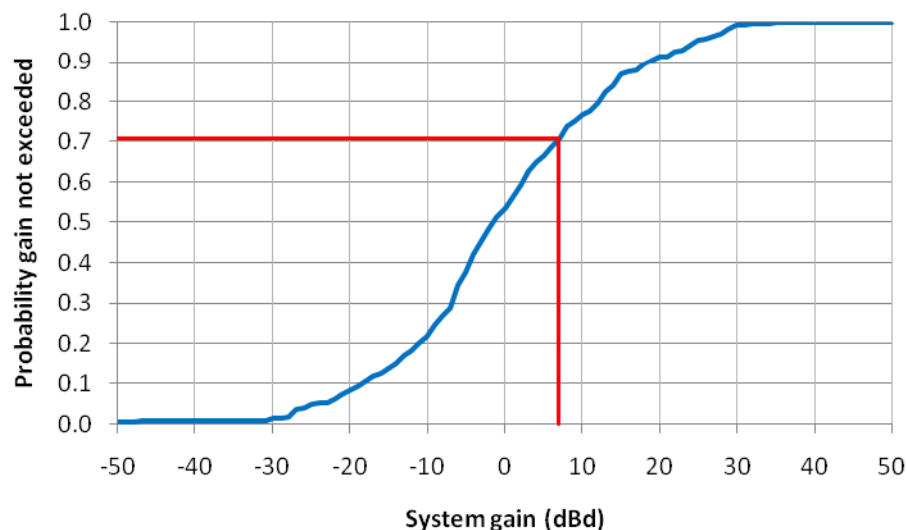


Figure 4.6: CDF of aerial system gain

From this plot it can be seen that 70.9% of domestic aerial systems have a gain less than the 7dBd assumed in the UK planning model.

It can also be seen that the slope is greatest, and almost constant, for gain values between -6 and +5dB. In this range, a 1dB change corresponds to some 2.9% of the population. In itself, however, this statistic is not particularly helpful. The distribution of system gain is really a reflection of the available field strength, which will follow a very similarly shaped distribution (as can be inferred from the linear trends seen in the previous graphs of gain versus field strength).

Thus, these statistics of aerial gain are not of direct help to the planner. What is really required is similar curve relating the reception margin³ to the population of aerial system.

The raw data from the BERR survey may be presented in terms of the predicted margin that will be available on the PSB multiplexes in the survey households following DSO. This data is re-plotted below, firstly as a histogram and then as a CDF.

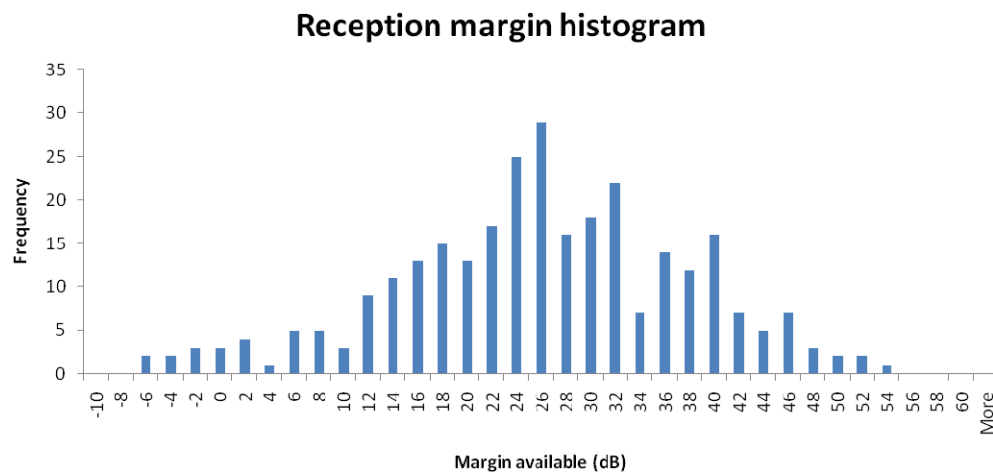


Figure 4.7: Histogram of reception margin likely to be available post-DSO

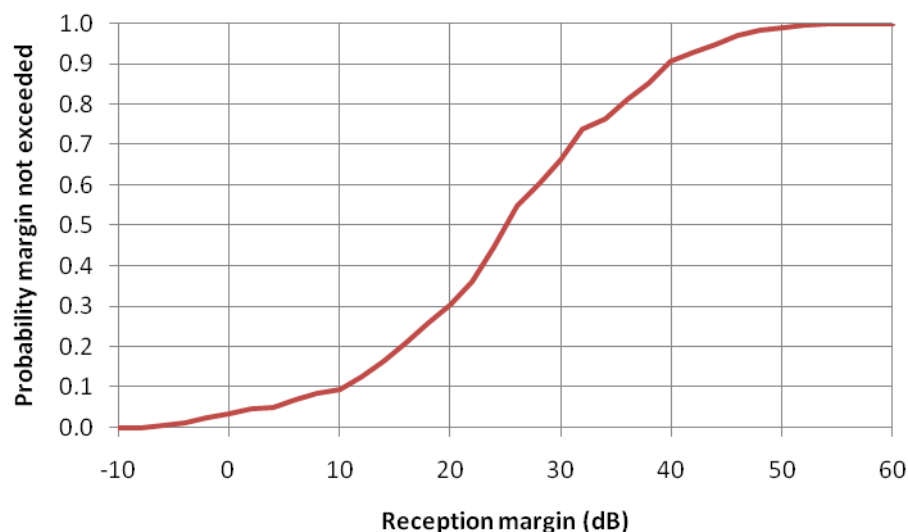


Figure 4.8: CDF of reception margin likely to be available post-DSO

From the CDF it is apparent that some 3.4% of households will have a negative margin, and will, therefore be unable to receive DTT services post-switchover. If an allowance of 10dB is included to cater for noise, interference and signal variability,

³ The difference between the minimum required signal, and the actual signal available (field strength or receiver input voltage)

as well as the generally lower power planned for the COM multiplexes, this figure rises to 9.6% of households.

This data may be relevant in informing future mode changes, or the choice of DVB-T2 parameters, in that it allows an estimate of the number of households who are likely to lose, or be unable to receive services for any incremental change in required minimum field strength, as tabulated below.

Table 4.1: Impact of incremental changes of threshold

Change in required minimum field strength	Households requiring aerial upgrade (PSB multiplexes)
0 dB	3.4 %
1 dB	4.1 %
2 dB	4.8 %
3 dB	5.1 %
4 dB	5.1 %
5 dB	6.2 %
6 dB	6.9 %

It should be noted that this selection of data is based on very few samples, as can be inferred from the fact that results at 3dB and 4dB are identical; the decimal place in the percentage figures is not really justified. In broad terms, for households near the margin, each additional decibel of required signal will cause around 0.6% of additional households to suffer a loss of service if they do not upgrade the aerial system.

4.1.2 System performance - DTT vs. analogue households

It might be expected that those households with DTT equipment might have aerial systems with better performance than others, given the low power of the present DTT network.

The data shown in Figure 4.1 is re-plotted in Figure 4.9, separating the two groups of households. It can be seen that, while the trend is largely unchanged, there is an almost constant offset between the two populations, of ~10dB.

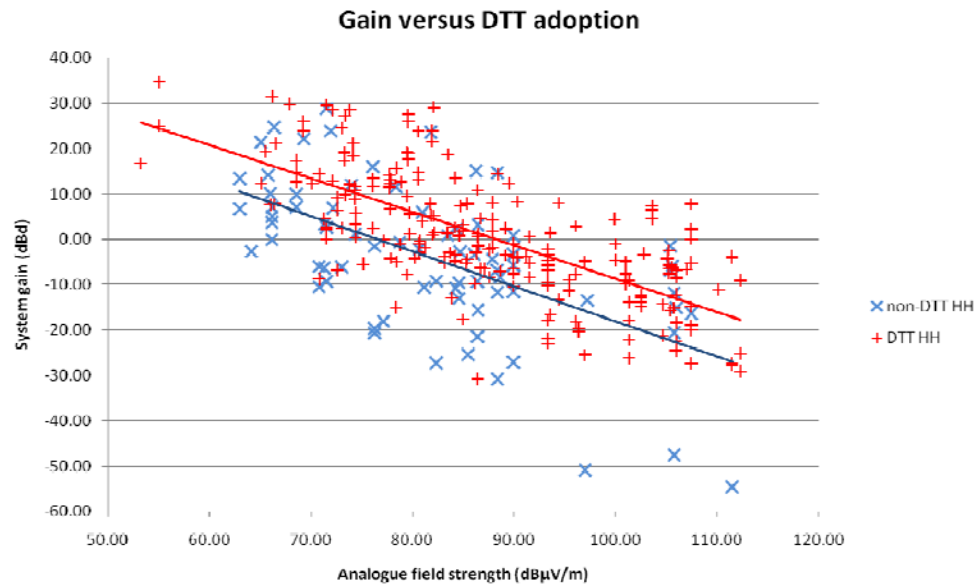


Figure 4.9: Comparison of DTT and non-DTT households.

4.1.3 Gain vs. bandwidth

It proved possible in the course of the survey to determine the grouping of the vast majority (91%) of the domestic aerials (see Table 4.1 in Section 4.2). Of those that could be identified, 74% were grouped, with only 26% wideband. DTT households were significantly more likely to use wideband aerials (28% vs. 19% for analogue only households).

The primary advantage of grouped aerials is that, for given dimensions, the achievable gain is somewhat higher than for a wideband device. It was therefore slightly surprising to find that there was no statistical difference in the installed performance of the two categories (see Figure 4.10). The divergence at the 'high field strength' end of the distribution is probably an artefact of the sparse sampling in the wideband case.

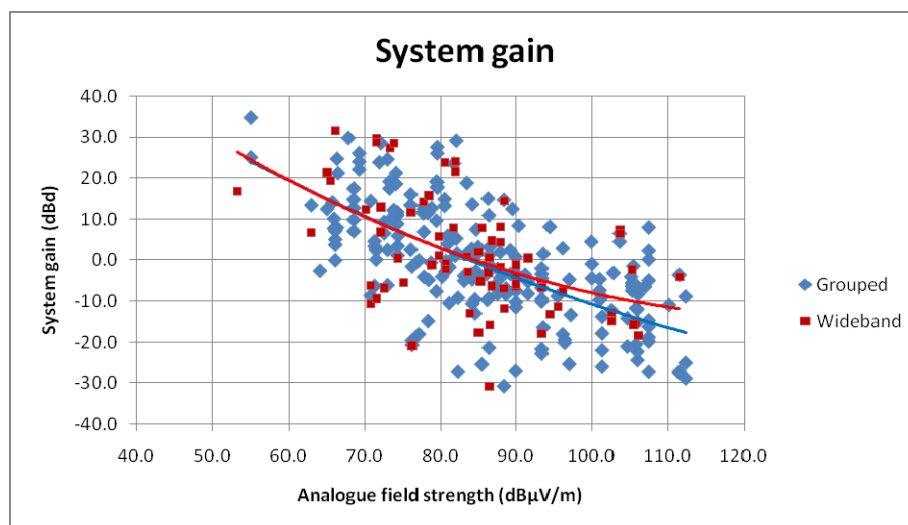


Figure 4.10: Overall performance of grouped and wideband aerial systems

4.1.4 C/N ratio and MER

In the course of the survey, measurements were made of the C/N ratio (analogue channels) and of the MER (digital channels) both indoors and using the survey vehicle.

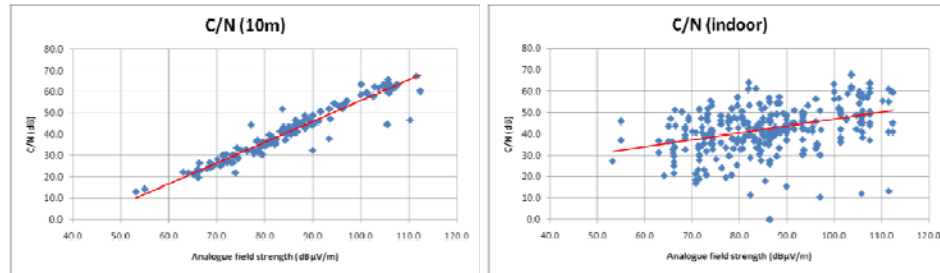


Figure 4.11: Outdoor and indoor C/N ratio

As might be expected the C/N measured using the survey vehicle increases in direct proportion to the received field strength, suggesting that levels of man made noise are generally insignificant⁴. The correlation is much less strong for the in-home measurements, showing that the majority of receiving installations introduce significant amounts of noise into the system.

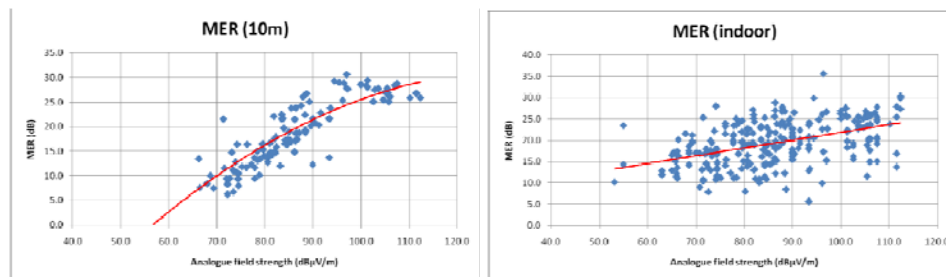


Figure 4.12: Outdoor and indoor MER

A similar effect is seen for the MER measurements; the spread in the vehicle measurements is somewhat greater here, largely because the power of the digital multiplexes is not always at the same offset with respect to the analogue transmissions. Furthermore, the asymptotic trend towards a limiting value around 35dB can clearly be seen. Again, the dependence on field strength is less clear for the domestic case.

4.1.5 System performance - amplifier / no amplifier

The BERR measurements identified households where amplifiers are used in the aerial system. Overall, some 29% of households used some form of amplification, either at the masthead (for fringe areas) or in the form of distribution amplifiers (for feeding multiple sets, or long cable runs). In DTT and analogue-only homes the figures were 33% and 19% respectively, reflecting the efforts being made to receive the current low-power DTT services. Roughly equal numbers of the two types of amplifier were found, with 20% of amplified households using both.

⁴ No significant difference in noise level was found between the London and Warwickshire measurements

Figure 4.13 plots system gain separately for households with no amplifiers, with masthead amplifiers and with distribution amplifiers.

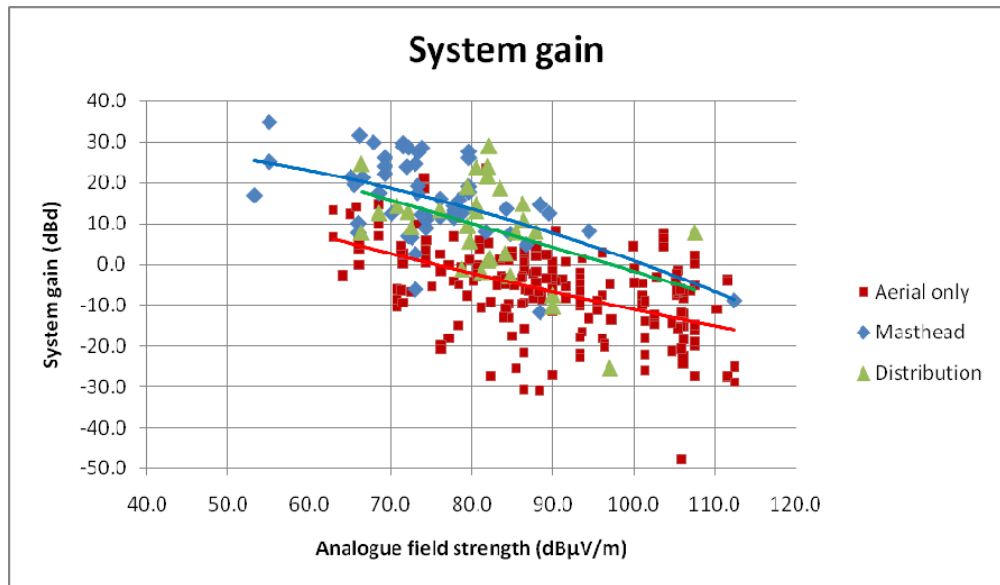


Figure 4.13: Impact of amplifiers

With no amplifier, the trendline suggests that the 7dB value assumed in planning is actually the highest value attained in practice by unamplified systems. Very significantly higher system gains are, however, achieved where masthead or distribution amplifiers are used.

The C/N performance was compared between aerial systems including amplifiers (masthead or distribution) and splitters, and systems with no such additional elements. Somewhat to the surprise of the author, it appears that the performance of systems with amplifiers is generally better than those without; Anecdotally, amplifiers have often been accused of causing more problems than they solve, and these results suggest that the quality of these devices, and the skill with which they are selected and fitted may be improving.

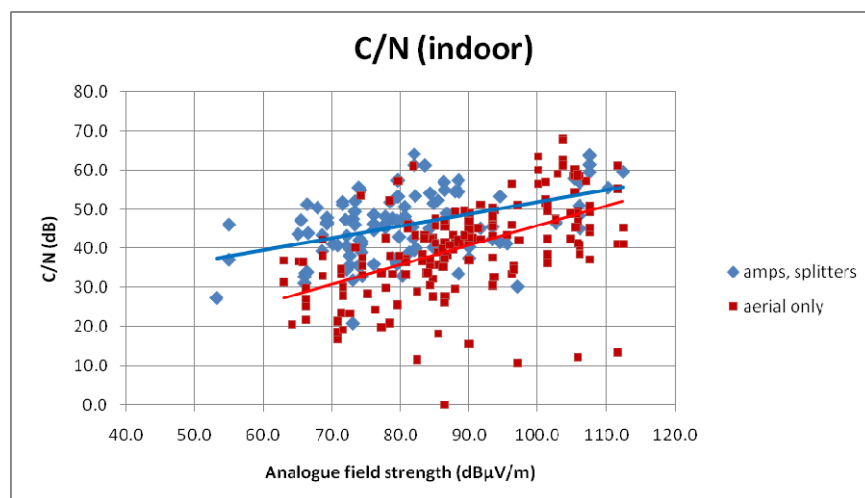


Figure 4.14: Impact of amplifiers on C/N

The impact of amplifier systems on the MER performance is similar, though somewhat less pronounced, as shown in Figure 4.15.

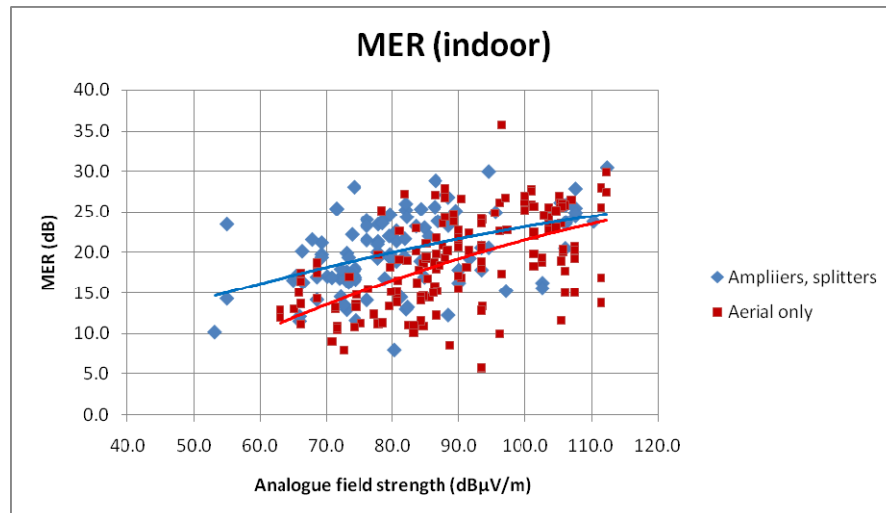


Figure 4.15: Impact of amplifiers on MER

4.1.6 Age of system

The survey measurements included an assessment of the age of the systems

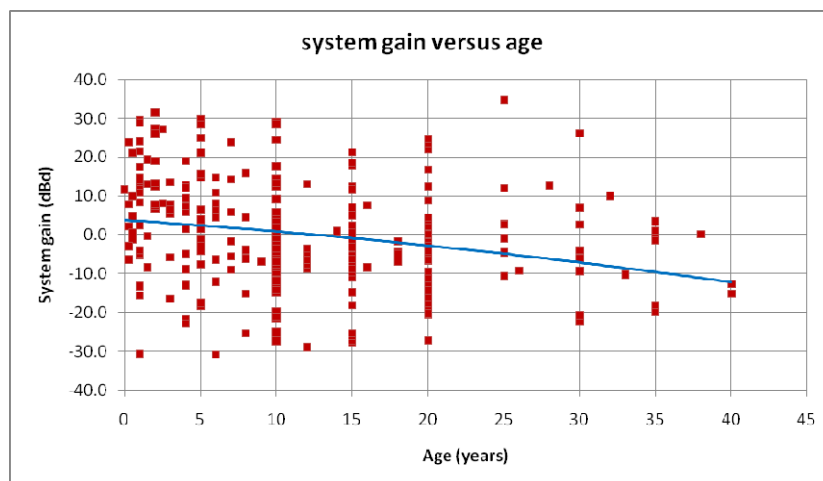


Figure 4.13: Aerial system gain versus age

While not a strong trend, it can be seen that the average gain of a 30 year-old installation is some 10dB below that of a new system.

While the statistics might also reflect a tendency for more recently-installed aerials to exhibit higher gain, it is more likely that the difference is largely due to ageing of the aerial and feeder, particularly due to corrosion and water ingress.

5 SYSTEM BANDWIDTH (GROUPING)

As noted above, an understanding of the bandwidth characteristics of the installed UK base of domestic aerials is of importance to system planners. It is intended that the majority of post-DSO services will be accommodated within the nominal bandwidth of the analogue services that they replace, but this cannot be the case for all sites.

To understand the numbers of households affected, two statistics must be determined. Firstly, the ratio of households with grouped aerials must be assessed, and secondly, the frequency response of actual aerials must be characterised.

The present analysis can inform both statistics, directly and indirectly. An impressive outcome of the BERR work was that the contractors were able to categorise the majority of domestic aerials as 'grouped' or 'wideband' by visual inspection. Analysis of this information gives the statistics in Table 5.1.

Table 5.1: Population of grouped aerials

Household	grouped	wideband	unknown	% grouped*
DTT	146	56	9	72.2 %
No DTT	54	13	6	80.6 %
Total	200	69	15	74.3 %

** of those categorised*

The table shows that DTT households are significantly more likely to have wideband aerials installed. It is not possible to tell whether this is a deliberate choice of wideband aerial, or whether DTT households are more likely to have recently-installed aerials and that there is a growing trend for riggers to fit wideband aerials as standard.

5.1.1 Aerial system frequency response

While no explicit attempt was made to examine the frequency response of aerials in the course of the BERR study, some information can be gleaned indirectly.

The majority of the sites examined transmit five analogue, and six DTT services, often covering a substantial frequency range. As the derived values for 'system gain' inherently correct for the different powers used on the different frequencies, the measurements can be used to sample the aerial frequency response, albeit crudely.

The results of these analyses are shown in Figures 5.1-5.8.

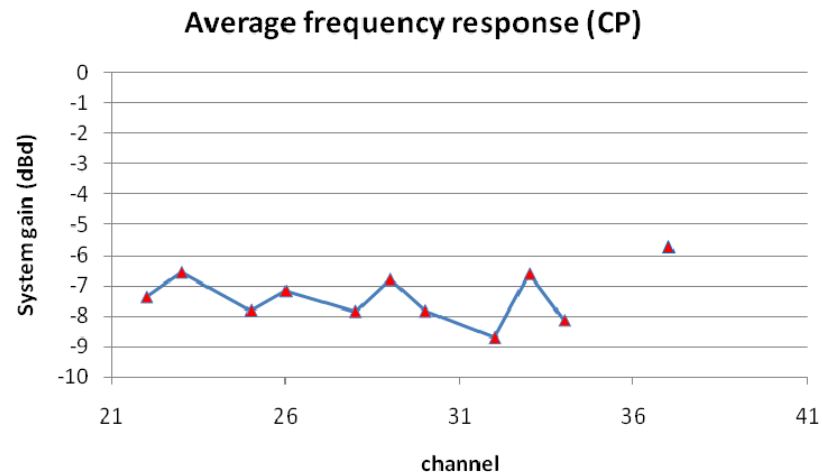


Figure 5.1: Frequency response of aerials in Crystal Palace service area

The averaged response of aerials in the Crystal palace area (Group A) is rather flat, with some evidence of increasing gain at the high frequency end of the group.

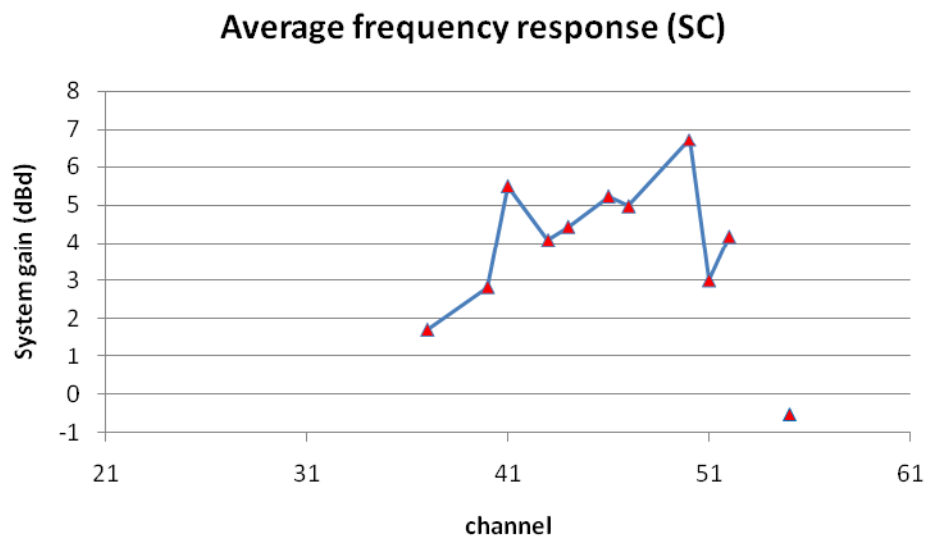


Figure 5.2: Frequency response of aerials in Sutton Coldfield service area

Sutton Coldfield aerials (Group B) appear to exhibit the typical tilt towards the upper end of the design bandwidth, followed by a relatively sharp cut-off

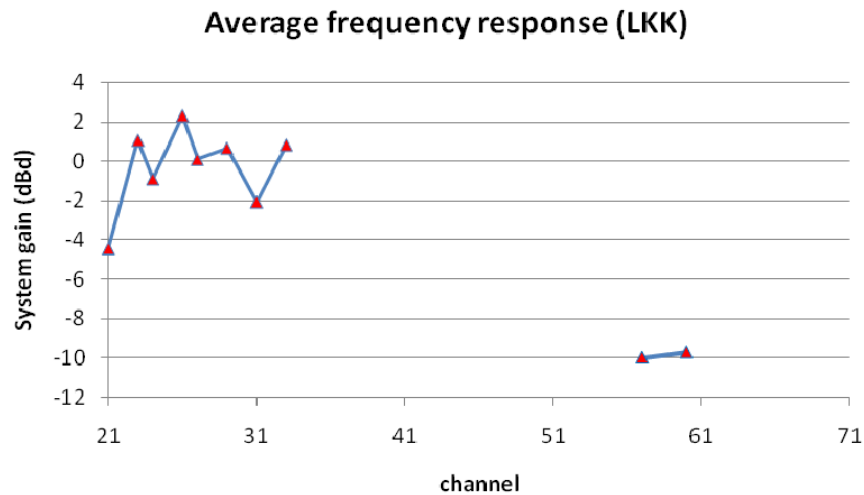


Figure 5.3: Frequency response of aerials in Lark Stoke service area

Lark Stoke transmissions cover an unusually large range of frequencies. It is unsurprising that the performance of most of these (nominally Group A) aerials perform poorly at the higher channels.

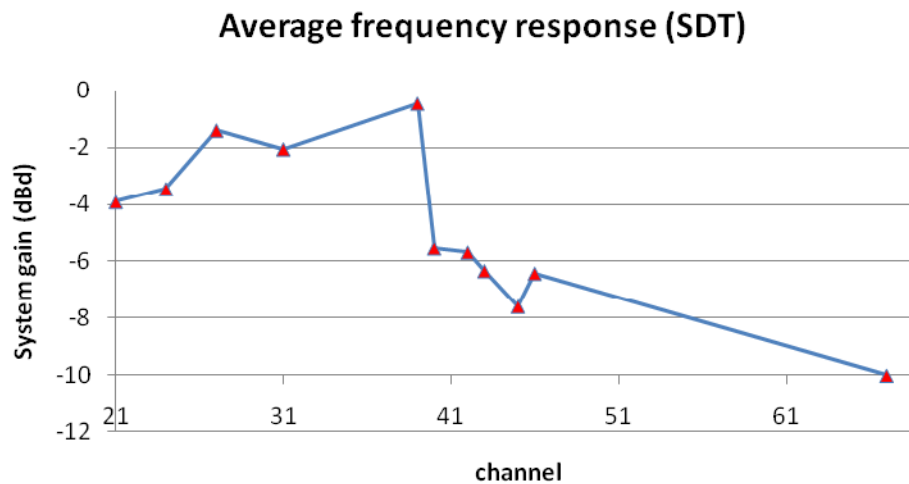


Figure 5.4: Frequency response of aerials in Sandy Heath service area

Sandy Heath is another Group A transmitter, and again the 'tilt up' in gain followed by a steep cut off is clearly seen

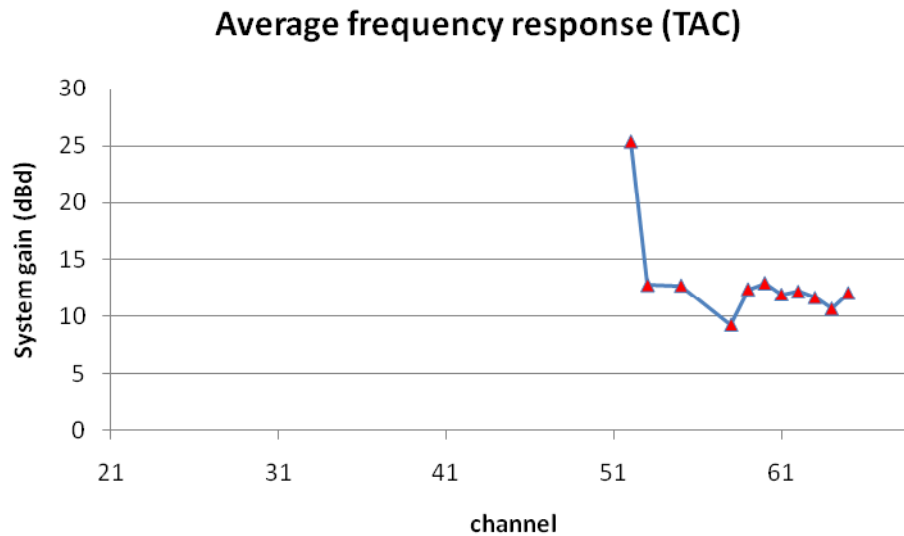


Figure 5.5: Frequency response of aerials in Tacolneston service area

The Tacolneston response shows an anomaly high gain value at channel 52; examining the measurement data, this appears to be due to a standing wave null in one of the two outdoor measurements on this channel. Otherwise the average response in this Group C/D area is fairly flat.

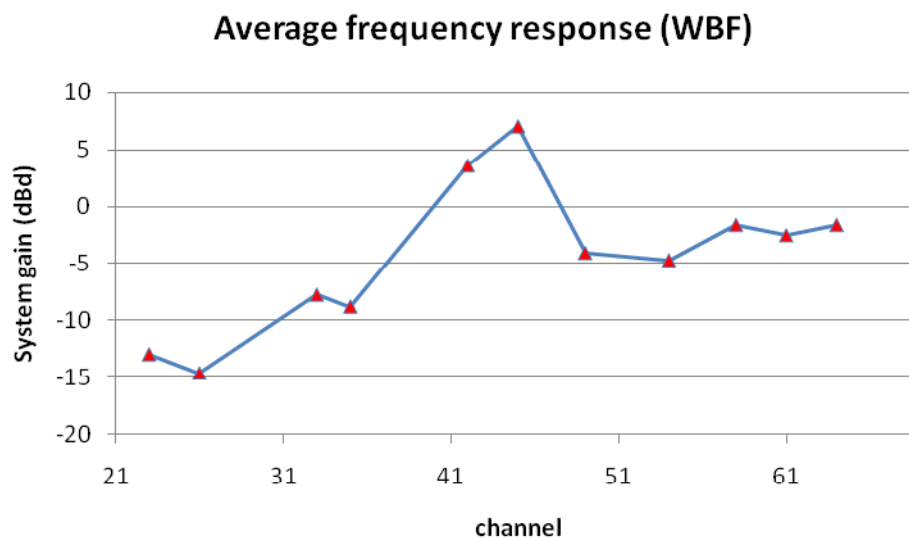


Figure 5.6: Frequency response of aerials in Waltham service area

Waltham is a Group C/D site for the analogue transmissions, but now has DTT services extending to channel 23. The response is distorted by multipath nulls on channels 42 and 45 in one of the two outdoor measurements made. Otherwise, the average gain appears to rise with frequency, as would be expected.

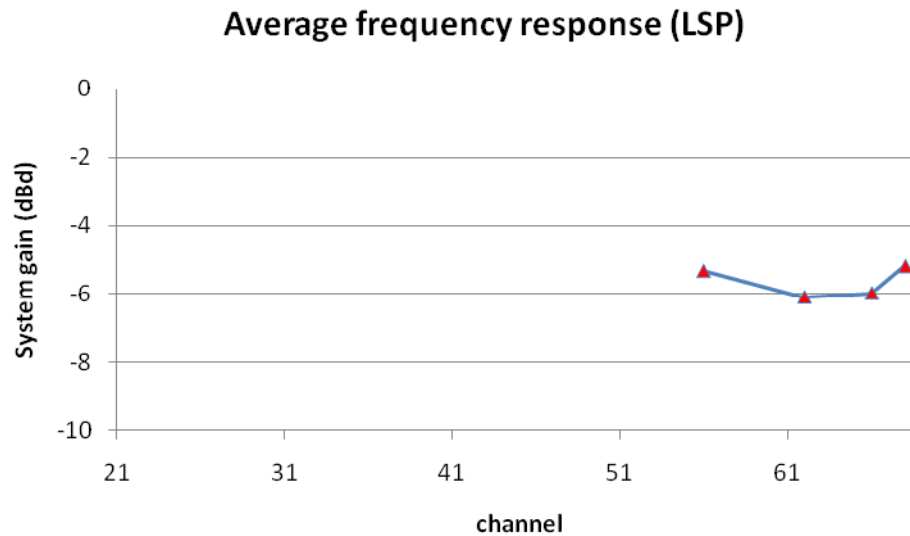


Figure 5.7: Frequency response of aerials in Leamington Spa service area

This relay transmits only four analogue channels. The response across Group C/D seems fairly flat.

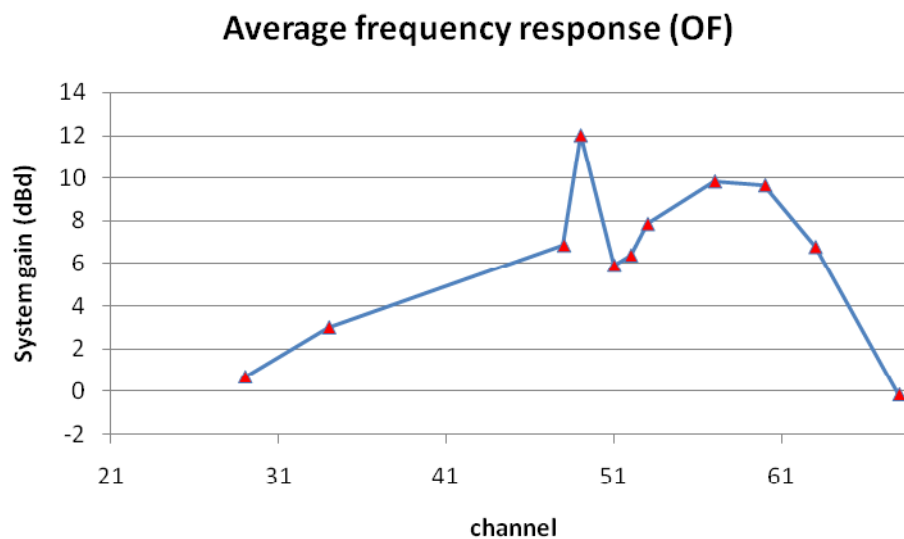


Figure 5.8: Frequency response of aerials in Oxford service area

The spurious response on channel 49 (the lower power 'Five' analogue service is unexplained), does not appear to be caused by a multipath null. The analogue service is Group C/D, but the response on channels 63 and 68 seems rather poor. It must be borne in mind, however, that with the exceptions of Crystal Palace, Sutton Coldfield and Lark Stoke, the number of measurements averaged in these plots is rather few.

6 CONSUMER RESEARCH METHODS

6.1 Quantitative research: questionnaire/survey

6.1.1 Rationale

The purpose of the questionnaire/survey research was to provide additional data on the households sampled in the BERR 2009 study to assist with the technical analyses conducted within this project, and to extract key consumer insights.

Sample

There were 114 completed questionnaires received (of 250 sent: 46% return rate). There were 61 males (53.5%) and 53 females (46.5%) in the sample, aged between 24 and 97 years (mean age 63 years). The survey therefore revealed that sample was skewed to the older age groups: over half the sample was aged over 65 years, and 79% were over 55 years. Consistent with the age skew, around 70% of the sample either lived alone (20%) or with their partner/husband/wife (50.5%). Just under a quarter of the sample (23%) lived as a family with their children. In terms of household income, 33% chose not to answer this question. Of those who did respond, there was a skew towards the lowest income brackets: 36% reported an income under £13,500 and for 13% income ranged between £13,501 and £24,999.

6.1.2 Procedure

Consumers who were recruited to take part in the BERR research were asked if they would complete a one-page survey about their household television circumstances and experiences relating to their television aerial systems. Respondents completed the questionnaire in their own time (after the engineers had completed their data collection) and were asked to return the questionnaire in the pre-paid self addressed envelope.

The questionnaire tapped the following areas:

- Background information (age, sex, living arrangements, household income)
- Television circumstances (e.g., number of sets, type(s) of television signal, age of terrestrial system)
- Reception experiences (e.g., quality of signal, aerial system work conducted, sources of information/advice)
- Interest in future services

6.2 Qualitative research: focus groups

6.2.1 Rationale

Focus groups were selected as they are useful for efficiently eliciting a wide range of information and themes – touching on each participant's broad experiences and needs. They enable participants to discuss themes relevant to them, exposing views and experiences that may contrast with their own.

6.2.2 Sample

18 members of the public participated in the focus groups. The groups contained equal proportions of people with DTT only, and those with both pay TV and DTT. Including both types of household television conversion produced a more ecologically valid sample and enabled an exploration of issues that might be more or less relevant to people with one vs. two platforms. The three groups were recruited to 3 criteria (age, digital television platform(s) at home and presence/absence of children in the household):

- Older age group (target 60+ years) (n=6) – mixed sex; half with free to view DTT only, half with pay TV in addition; average age = 68 years (range: 62-73 years)
- Middle age group (target 35-59 years) (n=6) – mixed sex; with children at home; half with free to view DTT only, half with pay TV in addition; average age = 42 years (range: 35-47 years)
- Young age group (target 18-34 years) (n=6) – no children at home (pre-family); half with free to view DTT only, half with pay TV in addition; average age = 22 years (range: 18-29 years)

Specialist face-to-face recruitment was conducted in the days before the focus group sessions to recruit participants meeting the specifications supplied by i2 media research. None of the groups had people with strong affiliations to any switchover related organisations in the area. The focus groups were conducted four weeks after the Beacon Hill switchover.

6.2.3 Procedure

The discussion guide was constructed to address the following topics:

- General attitudes to television (warm up)
- General views on the switchover process
- Expectations for switchover and the extent to which expectations were met
- Awareness, knowledge and understanding of different digital television platforms and any considerations thought to be relevant to platform and product choices
- Explicit, prompted evaluation of switchover related communications and aerial information (leaving the opportunity for unprompted views to be elicited earlier in the discussion) and their information resources. Stimuli used were:

- Digital UK information leaflet, similar, but not identical, to those distributed in this switchover area
- PowerPoint slides showing six hypothetical households (see below). Participants were asked to judge whether the switchover related information provided sufficient information for those households to make informed switchover-related purchase decisions
- Issues of fairness and choice

A series of six hypothetical households was generated to elicit a general discussion in which participants could draw on their personal experiences and understanding of switchover to identify the choices that each hypothetical household could make to view television after switchover. The hypothetical households were designed to encourage participants to discuss what factors might be more or less important in influencing their purchase decisions (i.e., moderating factors such as existing equipment, desired functionality and cost). Specifically, participants were asked to consider the following for each hypothetical household:

- Are they able to watch television after switchover?
- What are their options for getting fully converted for switchover?
- What information about how to receive digital television should be included in the leaflet?

Each session lasted approximately 90 minutes, and each participant was paid an incentive of £35.

7 CONSUMER RESEARCH RESULTS

The consumer research results are presented here in relation to the research questions specified in chapter 1.

7.1 Background insights: experiences of switchover

Whilst not the main focus of this study, valuable insights were obtained from the groups pertaining to consumers' experiences of switchover. Most worthy of mention was that the research groups reflected acceptance of switchover and low concern, with no burning issues raised. This response may not be typical across the UK; the responses in these Torquay focus groups differed from those obtained in related research in the Scottish Borders earlier in the year.

Second, and possibly related to the low concern, in general participants were prepared well in advance of switchover (with at least partial household conversion to digital). Related to this insight, there was generally a low level of reported expense associated directly with switchover, and some participants felt that switchover had saved them money because they were getting better value from triple play (TV, broadband and phone) deals. Interestingly, participants tended to report low use of aerial checker information, and where it was evident it had been done within the 3-6 months lead up to switchover.

Consumers readily discussed the positive outcomes of digital television switchover. The themes that emerged related to improved service, potential for new services, general progress, and household improvements. A few participants noted the benefits of having removed the analogue broadcasts to free up spectrum space for other potential services and uses, and the benefits of simply updating and improving their homes with new aerial cabling. Many acknowledged that in some way everyone (consumers, manufacturers, service providers, Government) was able to benefit from the switchover.

Some negative themes emerged, including concerns about the cost of switching, the complexity of the process, a sense of coercion and exploitation, inconvenience, poor quality content, and environmental-related concerns. Other themes identified in previous research were raised again, including: the inconvenience of needing to use two remote controls, difficulties recording digital television, intentions to stop using some sets (partial household conversion), and the importance of word of mouth as an information source. Consistent with previous research, there were generally low levels of reported complaints to service providers or manufacturers; participants were fairly passive and many would accept the service they were given without formal complaint (but with informal grumblings).

Interestingly, middle-aged participants (35-54 years of age) tended to be the best informed about switchover in our study, with the youngest focus group the least informed, but most flexible, in their approach to dealing with switchover. The older age group appeared most confused of the three and were the most negative and

concerned. Fear of using and experimenting with their digital equipment (fear of breaking equipment and losing channels) was commonly reported either implicitly from talking about their experiences or in describing other older people's experiences of switchover.

"There's a chap down the road from us. Unfortunately he died last night, but he was in absolute chaos over his television – still got a black and white television – and you know they come round and said we're going to do it, and walked away from him and he said ' yeah they told me, showed me, but what do I do?' Absolute[ly] in his own little world." (FG1: Older age group, P3, male, 67 years)

7.2 Switchover and television reception experiences

Several key insights emerged from the warm-up sections of the focus groups, which were directly relevant to participants' experiences of television reception at and after digital television switchover.

7.2.1 'Getting by' with 'good enough' (but not optimal) reception

Extensive indoor (set top) aerial use was reported by participants across the three focus groups. They were perceived as a cheaper alternative to roof or loft aerials, and an opportunity to test at low cost the signal they received. Participants' expectations of set top aerials were relatively high. Some possibly over-estimated set top aerial performance and considered new models to be much improved on more dated set top aerials. However, some reported having made multiple set top aerial purchases and a better value-for-money solution for the longer term, may have been to install a new roof/loft aerial at the outset.

"If an indoor aerial on top of the set will receive the signal it might be fine." (FG1: Older age group, P2, male, 69 years)

"[Set top aerials] are far superior to what they used to be; they are no longer coat hangers." (FG1: Older age group, P3, male, 67 years)

Respondents perceived that their reception could be improved by using 'digital aerials', using aerial 'boosters' or extremely large roof top aerials, and by elevating the set top box. Participants felt they should be able to return products that did not work.

[to P1] "Have you tried putting the box on top of something? [...]
It does make a difference, it does. [...] Well on certain channels, if you just higher *[sic]* the box slightly, for some reason you get clearer picture." (FG3: Middle age group, P2, female, 42 years)

7.2.2 Participants were not always aware of the transmitter they used

The experiences of several participants in the older age group and the ensuing discussion revealed that many participants were not aware of the transmitter they used for their television signal.

“Ironically we’ve got a little television in my partner’s study, it isn’t digital and we can still get it. I don’t understand
[Interviewer: Is that with a set-top aerial?] Yeah with a [draws in the air] indoor aerial. I don’t understand.” (FG1: Older age group, P6, female, 62 years)

“[P1, male, 68 years: No problems, on switchover, on the 8th of April. I retune it all. I didn’t touch it at all and I haven’t touched it since. I’m on [free to view digital terrestrial television] [and was before switchover] and also I think now that I can’t get channel, I can get 1, 3 and 4 on me terrestrial still and the rest of them but I can’t get 2. So to get to channel 2 I have to go onto [free to view digital terrestrial television] for that] [P2, male, 69 years: We happen to be neighbours. When he showed me, what I thought it was, is the channels that he was getting was analogue and he’s lost BBC2 which is analogue, but for some reason he’s still getting analogue on 1, 3 and 4. Is that possible?”] [P3, male, 67 years: It is if he’s facing the wrong way with his aerial. But some people are facing the Isle of Wight.]” (FG1: Older age group)

Asking the public to check the direction of their aerial against their neighbours might also be difficult for some people, as illustrated in the continuation of the above discussion.

“[interviewer: Are your aerials pointing the same direction?] [P2: I don’t know, I never... Well in actual fact I don’t know anyway because we’re bungalows *[sic]*. None of the bungalows around our vicinity have got aerials showing. [The] aerial’s in the loft.” (FG1: Older age group, (previously DTT) pay TV, male)

Some participants from the middle aged group were more aware of the different transmitters and could explain the changes they experienced in their television service.

“I think we had a spare [television] from my daughter in Swansea, but the first night we got BBC1, BBC2 and nothing else. Second night we got 3, 4, and 5 and nothing else, third night, all three tellys, absolutely every channel and it’s not just getting the channels, it’s the crystal clear picture. On the first night of switchover we got ours [signal] from Stockland Hill which doesn’t change until a couple of week’s time so some

people are probably still receiving an analogue signal from Stockland Hill because it comes straight across the bay, [Interviewer: how did you go about changing that?] We didn't. We didn't do anything with our aerial or anything; it just, shall we say, found it, because the signal is stronger from Beacon Hill than it is from Stockland Hill so it overrides the signal. [...] the aerial is actually pointing at Beacon Hill but because the signal wasn't particularly good on the first or second night we were getting it on the bounce back." (FG3: Middle age group, P4, male, 47 years)

7.2.3 Perception that pixelation on DTT pre DSO indicates a need for a new aerial

The message that aerials might need replacing was well received although possibly a little late (as many had already made new television equipment purchases) and through sources which were not always accurate (e.g., the local press rather than Digital UK). Participants felt that on reflection, the message was over-cautious. They reported that the messaging had led some people (not present in the groups) to make unnecessary new aerial purchases.

A commonly reported 'sign' that a new aerial may be needed was that of pixelation – a common experience of digital terrestrial reception pre-switchover. Some participants reported that the some of the public had responded with installations of very large aerials which were perceived as unnecessary.

"A lot of people panicked about the aerial – an issue with [free to view digital terrestrial television] boxes because the signal strength was considerably lower on it than it is now, so there was a lot of people getting pixelation – I think that's the word – and loss of channel while they're watching it during the course of a programme. It would just disappear off and the signal level would drop below a receiving point." (FG1: Older age group, P3, male, 67 years)

Some participants felt that the information they received about aerials could be misinterpreted and open to abuse by those wanting to exploit people's fear of losing television.

"Well I think one of the dangers were, that I understood and I think most people can see that our aerials were going to be useless for the new system which allowed an awful lot of people to jump on the bandwagon and come round and put monster aerials up and say that's what you need when in fact as soon as the signal was boosted to the level which I think sadly was not something we were told, or early enough, that our normal aerial is quite adequate when the signal strength got up to the level we're receiving now." (FG1: Older age group, P3, male, 67 years)

7.2.4 Signal strength indicators via the set top box used as a measure of reception

Very few people reported awareness and/or use of any technical tests for aerial reception. The local newspapers were a major source of information about aerials. More commonly reported in this context and at other times during the discussions was use of the signal strength indicator on DTT set-top boxes.

“...I’ve noticed that I’m not getting the full 100%. It’s always between 60 and 80% [of the signal strength].” (FG1: Older age group, P4, male, 70 years)

“[free to view digital terrestrial television] boxes also can do [aerial check] can’t they? The box themselves, most of them have got a signal strength monitor on the bottom of the picture. But that was I think a very sad thing, the amount of people who have bought aerials unnecessarily [...] People who had [free to view digital terrestrial television] boxes prior to the switchover were suffering from fluctuations in signal strength and they were saying, ‘oh my, my aerial is not up to it’.” (FG1: Older age group, P3, male, 67 years)

Some were only recently aware of this on-screen signal strength indicator.

“I didn’t know about it until yesterday when I was at someone’s house and they had [pay television] and saw about the aerial strength.” (FG1: Older age group, P5, female, 73 years)

On-screen signal strength monitors, pre-switchover, were considered by some participants to be a useful guide to post-switchover reception, many said they would have valued reassurance that signal levels would be increased at switchover.

7.2.5 Retuning issues noted as confusing for some

The digital terrestrial re-tuning process was perceived by many to be a complex and confusing process, particularly for older people. Some participants who had understood the process had helped others less able than themselves. Some participants in the young focus group were not aware of the need to re-tune at switchover, but others had informed them or resolved it for them.

“But the box that she’d got, although I could tune it, it was a bit confusing, because when I tuned it in, because BBC1, 2, and 3 and 4 didn’t appear when I – I had to tune it about 3 or 4 times – when I scrolled through all the lot, BBC1 was ‘824’ so I thought well that’s a bit confusing, especially for older people. In the end, her son, two sons bought her a new telly with its own tuner.” (FG1: Older age group, P2, male, 69 years)

7.2.6 Observations of television anomalies

There were many reports of irregular television performance that included digital reception problems, out of synch picture and sound, picture break-up, and failed set top boxes.

“But nobody at all told any of us that during the wind up to this happening, we would get interruptions in picture, double takes, and I’m sure we’ve all been watching something like, say the news, and the chap finishes what he says and then says it again! ... well let’s put it this way, I’ve got four televisions in my house and they were all doing it and that certainly isn’t the television.” (FG1: Older age group, P3, male, 67 years)

“We got [pay television] in the lounge so we didn’t have to do anything with that one. [We have a] [free to view digital terrestrial television] box in the bedroom. A problem we have which seems to be ongoing is trouble to pick up channel 5 so we keep doing the installation process and then [...] when you flick through it, it seems to go again. So I don’t know if that’s a case of different regions...” (FG3: Middle age group, P1, male, 35 years)

“Little squares and that, I get a lot of that on channel 5.” (FG3: Middle age group, P5, male, 41 years)

Failed equipment (set top boxes and integrated digital televisions) were widely reported by the local media around the time that the research was conducted therefore some of the anecdotes elicited may have been based on media reports. Nevertheless, there were several participants with direct experience of equipment that failed at switchover.

“You are aware that a considerable amount of [free to view digital terrestrial television] boxes that were purchased some time ago no longer have sufficient room on them to take the channels and spend all their time on them scrolling trying to get themselves set up. Nobody got the money back from them.” (FG1: Older age group, P3, male, 67 years)

“Well we had one of the original monkey boxes [OnDigital] – I don’t know if anybody remembers when the monkey came out [...] that completely died on the first night of switchover.” (FG3: Middle age group, P4, male, 47 years)

“I had a [consumer electronics manufacturer brand] telly; it’s probably about six year’s old and after switchover that was just completely ‘kaput’. It doesn’t matter what you do with it, top set box or anything.” (FG3: Middle age group, P3, male, 45 years)

7.3 Evaluation of aerials messaging approach

7.3.1 Aerial information in the Digital UK leaflet shown to participants was judged to be broadly appropriate

7.3.1.1 *Scope to more strongly allay fears and reassure*

Participants reported that the information could be improved by reducing unnecessary concern as much as is justified. For instance, many reported that they thought that seeing pixelated DTT pre-switchover meant they would have a problem post-switchover, especially combined with the message in the leaflet, 'What if I need a new aerial?'. Others used the signal strength indicators on their set top boxes and some were concerned at the pre-switchover signal levels they received.

"It does say in this one [Digital UK leaflet] that you can [test the strength of your aerial] on the Teletext. To me, I do believe it would be far better if I they said if you are receiving programmes now, you will receive them after switchover. Not questioning whether you have the right aerial or not. [...] They don't tell you that prior to switchover, the output of digital is at a low level, which if you looking and digital is low through your aerial, you are going to automatically think you're aerial is inefficient. They are not saying, 'wait until the full power is on'." (FG1: Older age group, P3, male, 67 years)

"I think it contradicts itself. It says what [P3] said, then asks, 'what if I need a new aerial?' Which you won't know until switchover has happened." (FG1: Older age group, P6, female, 62 years)

7.3.1.2 *More emphasis on increased power of DTT at switchover*

Participants in the older group in particular identified scope to highlight more clearly the increased power of DTT at DSO. Some felt that the information about increased signal power at switchover was either received by the public too late, or was received through word of mouth.

"Nobody cannot say that, they haven't heard there will be problems with some of the aerials that they are not able to conform to the needs of this [free to view digital terrestrial television] box. [...] I'd be watching something, then all of a sudden, loss of signal. I thought, I've got to do something about this aerial. Nearer the time I heard that [...] you do realise that we're only putting the digital signal out at 10%, that then changed the whole of my thinking'." (FG1: Older age group, P3, male, 67 years)

"I was under the impression - correct me if I'm wrong - that a certain signal strength would increase after the switchover, like

with specific [free to view digital terrestrial television] reception.
 [...] Yeah because before it was quite poor.” (FG2: Young age group, P6, male, 29 years)

7.3.1.3 *Wait and see approach favoured*

‘Wait and see’ was participants’ favoured approach for how to advise people switching in the future – as most people will be fine. This included reluctance to call out an aerial installer for advice.

“More information should have been available - you don’t really need a new aerial. Don’t let people go out and spend money unnecessarily [...] There’s so much different information lying about, you don’t know who to believe. But when you have something like this coming through your door explaining you don’t have to go through the unnecessary expense...” (FG1: Older age group, P1, male, 68 years)

“Just reading about the aerial would have been much better on something like this [refers to the Digital UK leaflet]. For instance, don’t change your aerial until the system has changed, and then if you have problems go to the dealer.” (FG1: Older age group, P3, male, 67 years)

“[Interviewer: would you recommend the persona call an aerial installer out?] No because of the money really. I’d get them to speak to Digital UK and wait and see.” (FG1: Older age group, P6, female, 62 years)

7.3.1.4 *Leaflet reported as most ‘useful for people without [satellite, cable or IPTV]*

Participants with an alternative platform (e.g., satellite, cable or IPTV) in addition to digital terrestrial television felt the Digital UK leaflet was most applicable to those without an alternative. Participants with an alternative platform appeared confident that their needs could be met by their suppliers.

7.3.2 **Poor recall of receiving similar detailed leaflet from Digital UK**

When shown the stimulus leaflet supplied by Digital UK, most participants did not recall having received such a leaflet. Only a 2-page leaflet could be recalled by some, whilst others admitted that they may have inadvertently thrown leaflets away.

“If they printed [Digital UK leaflet] and put them through the door, they made an effort to show people what is happening. One we had was two pages. Switchover on the 8th of April and that’s it.” (FG1: Older age group, P1, male, 68 years)

[P4, female, 20 years] “For people who don’t go into town, don’t really watch the TV, or listen to the radio, there wasn’t anything else, like distributed, nothing through the door or anything, not that I received anyway. It may have been better to put through

people's doors, a hand-out might have been a better idea so that you can sit down at your leisure. [Interviewer: Anybody else get any leaflet?] [all shake head, no]" (FG2: Young age group)

"[Interviewer: Do you recognise the leaflet?] [P6, female, 37 years: I recognise the front bit, but not all that [content] [P5, male, 41 years: [I recognise] the robot] [P1, male, 35 years: If I'm being honest I think anything we got just went straight in the bin]" (FG3: Middle age group)

7.3.3 Low awareness and use of any technical tests to evaluate aerial quality

There were generally low levels of awareness of the available technical tests to evaluate the quality of a household's aerial installation. No one was aware of the handheld aerial checker and there were just two respondents who reported having used the teletext test. Other indicators that respondents reported using and considered valid were set top box signal strength monitors and on-screen pixelation as indicators of aerial reception quality.

"I can't remember what number it was, but I read somewhere in a paper or somewhere something that you could, on um, teletext you could put in a number and you could test the strength of the aerial which I did and I could see that my aerial was fine, but I don't think many people actually knew about that." (FG1: Older age group, P2, male, 69 years)

"Yes I heard you could test the [aerial reception via teletext test] [...] my partner did [check it]." (FG1: Older age group, P6, female, 62 years)

In the context of one of these discussions (FG1), the generally low awareness of technical tests such as the teletext test led one participant to wonder whether information had been deliberately held back although they did not expand on why this might be. One participant reported finding out about ways of checking aerial quality through their local newspaper. Overall, the group felt the awareness of the tests should have been raised without unnecessarily worrying the public. Participants were firm that people should not be encouraged to spend money unnecessarily.

[P1, male, 68 years: "well it's lack of information again wasn't it"]
[P3, male, 67 years: "or there was perhaps selective information." [P5, female, 73 years: "makes you wonder if they kept back a little bit..." (FG1: Older age group)

"That nonsense about the checking the strength of your aerial signal, that was very quiet. I read in the paper by chance, I haven't heard about it then, and I haven't heard it since." (FG1: Older age group, P2, male, 69 years)

7.3.4 More clear messaging about indoor aerial use may be required

Extensive indoor aerial use was reported, and purchasing new 'digital ready' indoor aerials was reported by several participants as a first step in meeting their household's digital television requirements. This was selected even though the outcome was sometimes found to be sub-optimal. The lower immediate cost overrode a longer term, better quality solution. This supports the insight discussed above, that participants made efforts to obtain reception 'good enough' for their needs.

7.3.5 Relatively low awareness of sources of reception problems

There was limited awareness of other sources of reception difficulties such as time varying interference, marginal reception or regional differences determined by receiving transmitter. Participants only reported instances of bad weather affecting satellite and digital terrestrial reception.

"With [satellite], if there is heavy rain or a storm, you can get picture distortion." (FG1: Older age group, P2, male, 69 years)

"I've experienced [reception problems] with a thunder storm through the terrestrial aerial." (FG1: Older age group, P3, male, 67 years)

Some comments in the groups and their general readiness to change aerials indicated that a new aerial is sometimes perceived (incorrectly) as a catch-all solution (particularly for consumers who are already confused by the volume and complexity of information). Consumers reported that information on area specific reception difficulties would be useful where applicable (e.g., areas affected by regional overlap). This might also steer consumers away from thinking a new aerial will always solve any reception problem.

Within the groups, there were also references to positives of digital reception (e.g., no ghosting with digital terrestrial reception).

7.3.6 Mixed understanding of some aspects of switchover

Many participants demonstrated a relatively poor understanding of switchover and their options for television reception after switchover. People seemed to 'get by' with the information they had but it is possible that some might have spent their money differently if they were more aware of their options for getting digital television.

The middle age focus group appeared most informed about ways of receiving digital television.

"[Interviewer: What do you think are the differences between the different ways you can get digital TV?] [P5, male, 41 years: Areas. There's like certain areas where you can't get it. It's like mobile phones and all that.] [P1, male, 35 years: You can get

some good package deals with phone...]" (FG3: Middle age group)

Questions that were raised or answers that were not known by participants in the research included why the switchover was a two-stage process and why switchover is happening. There was some evidence of confusion in relation to terminology, for instance, loft aerials being referred to as indoor aerials, variants on set-top box, and confusion of over the names of different platforms.

"I have an indoor aerial, but mine is in the loft." (FG1: Older age group, P2, male, 69 years)

"... the aerial wasn't strong enough to give us all the channels but when they switched over, we have every channel now, so it's brilliant for me" (FG3: Middle age group, P6, female, 37 years)

"These free *[sic]* top boxes are quite a few years old now aren't they to be honest." (FG3: Middle age group, P1, male, 35 years)

7.3.7 More engaging information appealing to some

In terms of the adequacy of the provision of switchover-related information, participants' responses were mixed.

Some perceived that there was too much information and it was both reported and observed that some participants were confused by the options available. Some participants were able to report, and others implied, that information that was important to their decision making was lost amongst a large volume of other information

Others felt grateful for having a friend, neighbour or family member who was sufficiently technologically competent to digest and act for them on the information provided.

In the young focus group, one participant reported that whilst he felt sufficient information was available, some people still ignored it. Other comments raised in the groups suggested that for some, the information was thrown away, either mistakenly (e.g., perceived as 'junk mail') or intentionally (e.g., perceived as irrelevant or unnecessary for some customers with a non-terrestrial television platform). Whilst it was not made explicit in the groups, those who are more fearful of change may find that ignoring the information makes them feel less responsible for not taking appropriate action. As noted earlier, a more reassuring message may allay some fears and make it easier for consumers to deal with the changes effectively.

"I don't think enough people were sort of taking advantage of the information they were being told. For example, people were just sort of letting it fly by them, sort of ignoring it. That's what I've heard by people anyway. You know people waited until the

very moment that it happened and thought ‘oh now I need to do something about it’, yeah [Interviewer: was that a problem for people?] I’ve heard a lot of people complaining whereas they could have done something. [...] I think they needed something to actually get them to do something rather than just being told about it.” (FG2: Young age group, P1, male, 18 years)

In the middle age focus group all felt they were well prepared, reported facing no surprises, and felt that the information provided was sufficient. As noted above, this age group felt most responsible of the three age groups for dealing with the changes to television brought about by switchover. This supports the notion that digesting switchover related information is most likely amongst consumers who see preparations for the switch as their personal responsibility.

“[P4, male, 47 years: It was well advertised] [P6, female, 37 years: Very well advertised] [P4: I think there was enough information that people knew it was going on, but the information was given out but it wasn’t, ‘this is what you’ve got to do to get digital; this is what you’re going to get when you go digital’. There was enough information to make people who didn’t have it, curious, but not enough to bore the people who already know.” (FG3: Middle age group)

7.4 Consumer information requirements for post-DSO TV reception

7.4.1 Expectation management

There were some reports of participants feeling that their expectations had not been met. For instance, some participants felt misled by the general message that switchover is easy.

“They kept saying, ‘it’s easy you just do this and do that and it’s done’ but I don’t think it was quite like that. I pressed menu and thought where do I go from there?” (FG1: Older age group, P5, female, 73 years)

In general, participants had little understanding of why switchover is happening. Some were more accepting of the circumstances when the issues of UK terrestrial coverage were explained within the groups.

Responsibility for initiating switchover was generally not known (one ‘young’ participant noted government; other suggestions included pay television companies, Ofcom and Digital UK).

“[regarding who’s been dealing with DSO] [P1, male, 68 years: That’s all up in the air at the moment, nobody seems to know who’s behind it all.] [P2, male, 69 years: Digital UK?] [P3: It’s Ofcom isn’t it?] [P6, female, 62 years: It’s people like [pay TV

company] and probably some combined... I don't really know.]" (FG1: Older age group)

"[Digital UK] are a fronting company for Ofcom aren't they. Well Ofcom have [*sic*] put this company forward to run the digital changeover, I believe." (FG1: Older age group, P3, male, 67 years)

Whilst most participants felt that switchover was now over or they were not sure (likely because it was raised as a question by the moderator), a few participants believed that switchover in their area was still in progress.

"There's going to be something else in December - another change. [Interviewer: Where did you hear that?] From my friend's house that I went to yesterday." (FG1: Older age group, P5, female, 73 years)

"[P1, male, 68 years: No [switchover is not over], because there's still things to do, it's early stages yet. They're going to come through with something different again and upgrade it all further.] [P2, male, 69 years I thought it was all over for this area. You've just told me something new.] " (FG1: Older age group)

"All of us in this room are passed middle age and tend to watch more television than some time ago. We all are looking for the best, so I assumed there will be changes. The flat screen televisions are causing people to think differently." (FG1: Older age group, P3, male, 67 years)

Some were concerned about the cost implications of receiving high definition content and indicated apathy to future changes.

"[P3, male, 67 years: Are you aware that there will be a time potentially when they turn off the standard picture to HD?] [Interviewer: Is anyone else aware of that?] [Group unaware, shake heads] [P2, male, 69 years: To be honest I have no idea what he's saying] [Interviewer: How will you react to future changes in [digital terrestrial television]?] [P3, male, 67 years: It worries me about high cost implications if that happens] [Interviewer: How would it make you feel, if in the next five years, some of the channels available changed?] [P1: You would get to a stage where you be like, I can't be bothered with it all, I'll make do with what I got.]" (FG1: Older age group)

7.4.2 Interest in using the personas as a communications tool

Interest was expressed in all the groups, unprompted in two of the groups, in using the personas as a mechanism to communicate pros and cons (costs and benefits) of the various options to prepare for switchover for people in different situations.

Particular value was envisaged in the persona approach being tailored to demonstrate options for people to deal with coverage/reception issues specific to their locations (e.g., regional preferences in overlap areas, channel availability). Note that most participants did not exhibit particularly good knowledge, if any, about how television is transmitted and received.

Relevant considerations identified by participants included: cost, competitive pricing, good deals (triple play, 'money saving' through switchover), channels available (including packages - flexibility), importance of TV, functionality (including recording), convenience, consistency with services already in households pre-switchover, simplicity/ease, aversion to particular platforms, equipment, platform availability, regional broadcast preferences, terrestrial signal strength, and aerial requirements.

7.4.3 Interest in impartial advice

Some participants wanted to access a source of impartial advice (note awareness and understanding of the role of Digital UK was variable). Some suggested that it would be useful to have an easy to use, navigable website on which to compare deals and prices, along the lines of 'gocompare.com'. A similar suggestion was also raised in focus groups conducted early in 2009 after the Scottish Borders switchover.

7.4.4 Interest in post-switchover communications

The idea of a leaflet/info source post-switchover e.g., "What to do if you're having problems (troubleshooting)" arose in one group unprompted, and was well received when prompted in the other groups.

7.4.5 Interest in a pre-recorded 'troubleshooting' phone line

Participants expressed a need for impartial advice in print and online, and on a pre-recorded phone line (with instructions for what to do in typical situations). They reported that such a pre-recorded service would make it easy to listen to the same material over again, which they felt some people needed.

"I know it sounds stupid but maybe it would have been a great asset if there was a phone number that you could dial up and that phone number said right, 'this is what you do' and slowly go through it and if you haven't absorbed it by the end of this phone call, press for a re-run. And you could actually stand with that phone in your ear doing what the controller needs to be given. And unfortunately people are looking at the controller and thinking, as you said down there young man [to P1] that

there are people who didn't touch a button. 'What have I done!
It's all gone!'" (FG1: Older age group, P3, male, 67 years)

7.5 Consumer expectations of information availability

7.5.1 Information sources expected across media and format

Cited sources of information included media (e.g., local newspapers), formal sources (e.g., television suppliers, information stations in town) and informal sources (word of mouth).

In terms of media, participants recalled receiving information through the television, and some remembered the Digital UK advertisements ("little metal bloke"). Radio and print media (particularly local newspapers) and the internet were also noted as sources of information.

"I think I just put 'digital switchover' in Google, no idea of the actual website." (FG1: Older age group, P6, female, 62 years)

Some participants expressed a preference for televised information, citing it as the obvious source of information for the public being expected to make changes to television.

"I thought there would be more TV coverage because obviously it's about the TV so if they watch the TV enough to complain about it or they want to actually do something, there should be enough on the TV for them to actually take notice." (FG2: Older age group, P1, male, 18 years)

Some respondents had discussed some of the issues around switchover with their pay television supplier, or with in-store electrical retail staff. Others were aware of information stations in the town centre providing switchover and television service information (including the count-down clock) but were not specific about whether they were commercial or provided impartial advice.

"[Interview: where did you hear that from – that you have to get rid of old TV sets?] Just by generally discussing it with our television supplier" (FG1: Older age group, P3, male)

"Yeah there was a lot of informative stations out, in town, on the weekends and stuff. So if there was anyone having real problems they could have gone and asked them. Personally myself I didn't speak to them about it; I just found out what was going on through the grapevine. You hear little rumours going round and stuff from the radio you hear going on. It was quite well advertised so everyone knew it was coming." (FG2: Young age group, P4, female, 20 years)

"I work in town and I always see some signs, these bus stop signs, adverts and that. And there's one on the top of town

which was like counting down. And I thought that was really useful.” (FG2: Young age group, P1, male, 18 years)

Overall participants expected that all media forms (print, broadcast, online, telecoms) should present information about the switchover to reach as many people as possible. Ultimately, communities communicate and word-of-mouth about personal experiences was as, if not more, trusted as information sources. Ensuring that people have the correct information to hand to be able to deal with all eventualities that are anticipated and possible with switchover was expected to be available by participants. Participants expected the level of detail provided to be appropriate to their needs (including regional specific information) and to err on the side of ‘wait and see’ to avoid consumers spending money needlessly.

7.6 Variables influencing satisfaction with messaging approach

7.6.1 Getting the most for your money

For some participants choosing between the different platforms and products was a matter of value for money. Most people were already aware that set top boxes could be bought for less than £20 (e.g., via supermarkets), and many people opted for the cheap boxes. No one mentioned the relevance of the digital tick. Even those who opted for pay television were aware of the value for money aspect and were keen to get what they wanted for the best deal available, whether that was driven by particular content (channels) or by bundling with other services.

“[I looked for what offered] Most channels for the cheapest price.” (FG3: Middle age group, P5, male, 41 years)

“The reason I went for [pay television provider] is because [it] has the monopoly on sports. Then [other pay television provider] got on board but they don’t offer you much for your money to be honest.” (FG3: Middle age group, P1, male, 35 years)

“We already had the [digital terrestrial television] boxes so we wanted as little expenditure as possible, so we carried on with what we’d got. Retune and go.” (FG3: Middle age group, P4, male, 47 years)

7.6.2 Desire to maintain a basic broadcast television service

For some participants, particularly those who had switched to digital only because they had to, their needs were simple – to continue watching broadcast television after switchover. For some of these people, the wealth of information available was overwhelming and confusing. These participants simply needed to know how they could keep what they had.

“Just [want] the television set. There were no underlying things going on. Just watch the sport, news. [Interviewer:

Keeping what you have] Yeah absolutely.” (FG1: Older age group, P1, male, 68 years)

“I’m just confused with all of this. [free to view digital terrestrial television] and [pay television provider], it’s all the same to me, I don’t know what the difference is. I just added the box, and that’s how it is. [Interviewer: Did you see that as the simplest way for you to do it?] No, doesn’t make any difference. [Interviewer: Was it just about keeping what you had?] [he nods]” (FG1: Older age group, P4, male, 70 years)

“I had to choose a way of upgrading and [free to view digital terrestrial television] was my way. [Interviewer: because?] [With pay television provider], there were too many channels.” (FG1: Older age group, P5, female, 73 years)

7.6.3 Desire to have more choice of programme content

For others participants in the group, their digital television equipment decisions were based on awareness of services that afforded more choice. For most participants, popular pay television providers were top of mind and well-known and established brands. Based on what participants discussed in the groups, it appeared that they often did not make fully informed judgements and were not always actively in control of their purchase decisions; they were often in the right place at the right time for television provider sales staff to make a sale. Sales staff were often successful in winning over consumers by presenting their offer as a simple, one-stop shop. Bundled services were desirable to some participants. As illustrated in the second quote below, participants indicated that people are not comfortable with querying sales staff and could benefit from knowing the right questions to ask that are relevant to the households’ needs (e.g., recording preferences).

“I chose [pay television provider] because I like certain channels [...] We could tailor to how we wanted, they were not going to go down, like other companies. I thought they have more competitive prices as well.” (FG1: Older age group, P6, female, 62 years)

“I think what the problem is: we’re not comfortable at challenging the competitors at what they can offer us. I think if I go to them, they are going to offer me this, if I go to them they are going to offer me that. So we actually don’t bother, we just wander on accepting what we have. I have [pay television provider], when we moved in, that’s what we had, until we found [other pay television provider] better and cheaper. [...] it wasn’t until I ‘ummed’ and ‘arrghed’ I realised how easy it was to get.” (FG1: Older age group, P3, male, 67 years)

“I’d go under one system under [pay television provider].

[Interviewer: Why would you advise her to go for that?] Choice of more programmes, it’s just one system.” (FG1: Older age group, P1, male, 68 years)

7.6.4 Desired functionality

Many participants had clear functionality requirements (e.g., recording) and made purchase decisions based on their awareness of the availability of desired function(s). Some participants were only aware at switchover of how their new television experiences were different to their old experiences, and were in the process of resolving them either before or after they had made significant digital television related purchases.

“I tend to watch [pay television provider], because I’m able to freeze frame, pick up again, cancel all the advertising on the television.” (FG1: Older age group, P3, male, 67 years)

“I knew I would have to do something because I wouldn’t be able to record.” (FG1: Older age group, P2, male, 69 years)

7.6.5 Simple, contract free

Convenience and simplicity were important drivers for some participants.

“[free to view digital terrestrial television], it’s one price, no messing about with phone lines or anything like that.” (FG3: Middle age group, P4, male, 47 years)

7.6.6 Replacing equipment

For some participants, the discussion around the personas raised considerations that were perceived as relevant to decision making. For instance, some reported preferring to use switchover as an opportunity to update old television equipment rather than buying a set top box add-on. For some, notably more elderly consumers, a new integrated digital television may be the simplest, least hassle, and most easy to use option.

“[Her television] is that old, she could just buy a new one.”
(FG1: Older age group, P5, male, 73 years)

8 CONCLUSIONS

8.1 Technical research conclusions

This study has analysed new data made available following a survey of domestic TV aerial system performance, conducted externally to this project on behalf of BERR in the first quarter of 2009.

The key findings are:

- The statistical performance of the domestic aerial is very similar to that determined in previous studies (1995 and 2003).
- As before, aerial system gain was found to be inversely proportional to available field strength.
- A trendline fitted to the data showed a dependence of -0.1 on the available analogue field strength.
- From this trendline, the assumed system gain of 7dBd is generally only achieved in locations where the available analogue field strength is 75dBµV/m or less.
- 29% of households have some form of amplification in the system (33% for DTT, homes, 19% for analogue only homes).
- Where amplification is used, it improves both the system gain and the C/N or MER.
- Older installations exhibit somewhat lower system gain - a 30 year old system has an average gain some 10dB below a new installation.
- Some 75% of households have grouped aerials.
- There is no difference in overall gain between systems with 'grouped' and 'wideband' aerials.
- Some 3.4% of households will require an aerial upgrade to receive PSB services, post-DSO. For reliable reception of all multiplexes, this figure rises to around 9.6%.

8.2 Consumer research conclusions

8.2.1 Insights relating to aerials and reception

- a. Most participants were aware that current roof aerials might need to be updated for digital terrestrial reception. Most reported that their awareness had been raised by a range of sources including word of mouth, newspapers and Digital UK. Some participants were aware of others in their community who had installed 'monster' aerials as a precautionary measure. Post-switchover, there was a sense that the significance of the aerial issue could have been down-played and that there was scope to reassure and more strongly allay fears about inadequate aerial systems.
- b. There was little direct experience in the groups of having replaced roof aerial systems, with the exception of some anecdotes about others. Most participants

therefore favoured a communications approach recommending people to 'wait and see' whether they would experience any reception issues at switchover which would need addressing, given the general expectation that the majority of aerial systems should be sufficient for digital terrestrial reception.

- c. A strong view that emerged, from the oldest focus group in particular, was that information regarding increased signal levels at switchover (relative to pre-switchover levels) should have been emphasised more than it was. Many were unaware the signal would be boosted at switchover, giving them improved reception with their current aerial equipment. Those who were aware of the power increase reported that they had been informed by sources such as the local press, sometimes too late for effective switchover preparations. There was mixed recall and recognition of receiving official switchover communications pre-switchover.
- d. The Digital UK leaflets shown to participants in the groups were considered both sufficient and useful, particularly for people without alternative platforms (e.g., satellite, cable or IPTV). Interest was expressed for an impartial advice source available across different media for provision of post-switchover troubleshooting information (potentially available via a pre-recorded phone line providing potential solutions to typical problems).
- e. There was little or no awareness of the formal aerial checkers such as the teletext test and the handheld aerial checker across the focus groups. Instead, participants reported noticing a range of indications pre-switchover, such as the signal strength monitor displayed on their (already connected) set top boxes and pixelation on their television screens, and inferring from these indications whether or not their current aerial installation would be sufficient for digital terrestrial television post-switchover.
- f. There were numerous reports from the focus groups of reception issues including pixelation, allocation of channels to unexpected channel positions, and loss of specific channels. Many participants reported using and persevering with equipment that gave them good enough but not optimal reception rather than fully resolving the issues.
- g. Use of indoor aerials was commonly reported. In fact some participants viewed indoor aerials as a first-stop solution to reception problems – to test or try out terrestrial reception with a low-cost solution. Some participants made repeated indoor aerial purchases, believing that 'powered' or 'digital ready' indoor aerials may improve their digital terrestrial reception. For some, investment in better roof aerials may have been a more effective longer term solution.
- h. Many participants were unaware of the transmitter from which they received their television signal. This was evinced by reports of unexpected loss of BBC2 for some participants believing that had already switched but who in fact were viewing broadcasts from a transmitter between its two switchover dates. There were several references made to loft aerials, and that with these it can be more difficult to identify from which transmitter residents received their television signals.

8.2.2 General insights relating to consumer experiences of switchover

- i. Overall, participants were prepared, often well in advance, for switchover with at least one television set already converted. Their preparedness was in the context of mixed understanding of some aspects of switchover. Post-switchover, many were still preparing for full conversion, whilst others were less bothered about converting non-main television sets.
- j. Direct switchover related expenditure was reported to be low and digital equipment was often purchased with switchover in mind rather than for switchover per se. Most participants opting for terrestrial television bought low cost set-top boxes.
- k. Participants reported that the hypothetical household 'personas' presented in the research groups were thought-provoking. The majority said that communications which incorporated this type of approach would benefit consumers, helping them to identify factors that may be relevant to their own switchover related purchase decisions. Numerous considerations were flagged by participants, prompted with the hypothetical households, as relevant to purchase decisions including cost (competitive pricing, a 'good deal'), service (flexible packages; level of television consumption, regional broadcast preferences), and effort (consistency in platform and functions with existing household services, simplicity/ease).
- l. For the majority of research participants good value for money was of paramount importance. Perceptions of value were variable depending on whether participants wanted just what they had, or more choice.
- m. Most participants were pleased with their new digital television service although some cited commonly reported complaints including poor quality programming, adverts, cost, and having had no choice but to adopt digital television to continue watching television after switchover. The participants most negative about switchover were the oldest. The most informed who felt most in control were the middle aged group, and the youngest participants were most comfortable and least concerned about switchover.

APPENDIX: DTT COVERAGE CRITERIA

DTT coverage criteria

Ofcom

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2106/HAC/R/3.0

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1 INTRODUCTION

This note has been drafted in response to a request from Ofcom for a summary of the coverage criteria applicable to digital terrestrial television (DTT) services, the background to the choice of such criteria, and the practical implications for service planners and those investigating coverage and interference issues in the field.

2 THEORETICAL BACKGROUND

A terrestrial broadcaster, regardless of whether the service is analogue or digital, radio or TV, medium wave or UHF, will undertake to provide a specified field strength (generally given in decibels relative to one microvolt per metre, or dB μ V/m) within an given area.

The choice of this field strength must take into account many factors, a few of which are precisely defined by the laws of physics, but the majority of which relate to the statistics of receiver and aerial performance, or of radiowave propagation. These will generally include:

- The minimum voltage that must be present at the receiver aerial socket for it to provide an 'acceptable' level of service
- An allowance for the loss of the aerial feeder cable
- An allowance for the gain (if any) of the aerial (generally in dB relative to a dipole, dBd)
- The appropriate conversion factor for relating the field strength in which a dipole is immersed to the voltage appearing across the terminals. This depends only on frequency
- An allowance for additional margin required to overcome interference from other services on the same, or adjacent channels
- An allowance for interference from man-made noise
- Allowances for other factors such as multipath and transmitter performance

If all these factors are taken into account, it would be possible to ensure acceptable reception at a specified fixed location. Broadcast services, however, are offered to receivers that will be randomly located throughout an area, and an additional allowance must therefore be made for 'location variability'. It is typically assumed that the minimum required field strength should be provided to between 70% - 95% of locations within an area.

Each of these factors will be considered further, below.

2.1 Minimum terminated voltage

For analogue services it was necessary to determine the minimum required signal at a receiver based on subjective assessment by large samples of 'typical' listeners of viewers. The situation is somewhat simpler in the case of digital services, as the quality of reception will generally degrade very quickly from perfect to non-existent

over a range of a few dB (the ‘digital cliff-edge’). For a given codec (e.g. MPEG-2) the required BER is quite well defined. In turn, for a given modulation scheme and code rate, the carrier to noise (C/N) ratio that will theoretically result in a given BER is also readily defined, although this is complicated for real propagation channels and hardware.

The C/N values required for different code rates and orders of modulation have been determined by simulation, and are given in the current (2009) DVB-T specification (Annex A of reference [1]) and in the DVB-T implementation guidelines (table 41 of reference [2]), For the two current UK modes, the values⁵ are:

Mode	Required C/N
16-QAM, 3/4	13.4 dB
64-QAM, 2/3	17.3 dB

Table 2.1: Required C/N values from DVB-T specification (2009)

These values were determined using the ‘8K’ system, rather than the UK’s pre-DSO ‘2k’ mode. There is no discussion in [1] of any requirement to add ‘implementation’ margins to these values.

The slightly different values assumed in earlier versions of the specification (up to and including v1.5.1) included inaccuracies due to the exclusion of pilot boosting effects. These earlier values were quoted⁶ in the original ‘Chester ‘97’ Agreement [3], in the Report [4] from RRC-04 to RRC-06 and in are also given in Table 9-9 of the 2005 edition of the D-book [5].

Mode	Required C/N
16-QAM, 3/4	13.0 dB
64-QAM, 2/3	17.1 dB

Table 2.2: Required C/N values from earlier specification (also Chester ‘97 agreement, RRC-04 and D-book)

In the Chester Agreement, the accompanying text notes that “...the C/N values [...] do not include any implementation margin. Typical C/N results from laboratory tests are about 3 dB higher than the values given...”. These values were not, however, used directly in the Chester plan; rather, a set of ‘reference reception conditions’ was specified, which assumed an overall C/N requirement of 20dB, which figure was assumed to include any implementation margin.

⁵ Unless otherwise stated, a Ricean channel, representative of rooftop reception, is assumed. The C/N values correspond to a BER = $2 \cdot 10^{-4}$ at the output of the Viterbi decoder

⁶ Table A1.1

Similarly, the D-book makes reference (section 9.13.3) to an implementation margin of 2.5dB.

Although the values above were given in the report of RRC-04 to RRC-06, the Final Acts of the latter conference refers to different values in Table A 3.2-1.

Mode	Required C/N	Δ wrt EN 300 744
16-QAM, 3/4	15.7 dB	+2.3 dB
64-QAM, 2/3	19.5 dB	+2.2 dB

Table 2.3: Required C/N values from GE-06 Final Acts

Though not stated, it appears that these values include some implementation margin (~2.3 dB wrt EN 300 744), but, again, these values are not used directly. The wide range of possible parameter combinations were grouped into three 'Reference Planning Configurations'. Of these, RPC 1 related to rooftop, fixed reception and was based on 64-QAM at either 2/3 or 3/4 code rate, requiring theoretical C/N values of 19.5 or 21.2dB. This was simplified to a 'representative' C/N of 21 dB.

The values adopted [5] by the Joint Planning Project (JPP) are those given in the earlier versions of the DVB-T standard, to which are added an 'implementation margin' of 2.7dB and an 'allowance for 'real' conditions' of 3dB, giving practical C/N values of:

Mode	Required C/N	Δ wrt EN 300 744
16-QAM, 3/4	18.7 dB	+5.3 dB
64-QAM, 2/3	22.8 dB	+5.5 dB

Table 2.4: Required C/N values from JPP

(it is believed that the 3dB allowance caters not only for the degradation due to multipath, but also for the problems encountered with impulsive noise interference to the 2k mode in the original DTT network.)

An ITU-R Recommendation, BT.1368-6 [6], specifies DTT planning criteria. Though mostly concerned with interference protection ratios it quotes (table 44) a value of 20.0 dB as the overall C/N figure required for 64-QAM, 2/3 systems

Finally, the current (7 year old) version of the DTG 'R-book' [9] mentions a 'minimum C/N ratio' of 23dB for 64-QAM reception on p.4, and '...at least 26dB..' on p.8

Source	16-QAM, 3/4	64-QAM, 2/3	notes
EN 300 744 [1997-2004]	13.0	17.1	Original specification
Chester (theoretical)	13.0	17.1	Table A1.1. Noted that practical values are ~3dB higher
D-book	13.0	17.1	Table 9.9. Also refers to 'implementation margin' of 2.5dB, or of '2-3dB'
Chester (practical)	20.0	20.0	Table A1.50. ' <i>representative</i> ' value for initial international planning. Includes implementation margin
GE-06 (practical)	21.0	21.0	' <i>Representative</i> ' value for RPC1
JPP (practical)	18.7	22.8	Includes 2.7dB ' <i>implementation margin</i> ' and 3dB for ' <i>real conditions</i> '
EN 300 744 (2009)	13.4	17.3	Updated values to account for boosted pilots
BT.1368-6 (2006)	-	20.0	No additional margins applied
DTG R-book	22	23 - 26	

Table 2.5: Summary of quoted C/N values

2.1.1 Summary

The JPP assumptions for C/N requirements appear to be 'healthily conservative', in that they include a rather greater margin for practical implementation than suggested elsewhere.

There might be a case for revising the JPP values to reflect the recent changes to the values given in [1]. However, the difference is small (0.2 - 0.4dB), and it would, arguably, be more inconsistent to change the values at this late stage in the planning process.

2.2 Receiver noise

Given the required C/N ratio, the voltage (or power) required at the receiver input can be determined by calculating the noise power in the receiver system.

To determine receiver system noise accurately is not straightforward and would require a knowledge of the gain and noise performances of individual receiver stages, and of any aerial amplifiers and feeder losses. In practice, a 'representative' system noise figure seems always to be used in the present context.

The representative noise figure used in the Chester Agreement and throughout the RRC process was 7dB, assumed to apply throughout the UHF band. The model adopted by the JPP was, apparently, arrived at independently of the Chester / RRC value but is similar in that a noise figure of 7dB is assumed below channel 39, and 8dB at channel 39 and above)⁷

These values are very high by comparison with most other radio systems, largely owing to the assumption of a 7dB feeder loss with no use of masthead amplification. In practice, this is not of great significance, as broadcast networks are invariably interference-limited.

The noise power, P_n in the receiver bandwidth is calculated using:

$$P_n = kTB \text{ (Watts)}$$

Where:

$$K = (\text{Boltzmann's constant} = 1.38 \times 10^{-23} \text{ J/K})$$

$$T = \text{absolute temperature} = (\text{typ}) 290\text{K}$$

$$B = \text{system noise bandwidth} = 7.61 \times 10^6 \text{ Hz}$$

This calculation gives a power of $3.05 \times 10^{-14} \text{ W}$, or -135.2dBW (-105.2dBm). The receive system noise factor must be added to this figure, for example:


$$-105.2 \text{ dBm} + 7\text{dB} = -98.2 \text{ dBm}$$

Adding the necessary C/N (e.g. 22.8 dB) gives the required receiver input power of -75.4 dBm. This can be converted to the equivalent effective voltage by:

$$\text{voltage (dBuV)} = \text{Power (dBm)} + 108.75 \text{ (for a } 75\Omega \text{ system)}$$

thus a domestic receiver requires a minimum input signal of **33.4 dBµV**.

2.3 Aerial system performance

The amount of energy which a dipole antenna can extract from a given electric field will depend on its 'effective length' given by . If a dipole is subject to a field strength of e (V/m) at a wavelength λ (m), the voltage (EMF) across its terminals will be:

⁷ It is noted that this figure is not the same 7dB as used elsewhere, but was agreed at a BBC seminar in 1998. The BBC website (<http://www.bbc.co.uk/rd/projects/dvb-t/060298seminar.shtml>) notes "The noise figure of the tuner was agreed to be better than 7 dB for band IV and 8 dB band V, for 80% of production. There is a need to define a maximum limit although this may be difficult to reach agreement on"



and the terminated voltage (PD) will be half this value.

This can be more conveniently expressed as:

$$V_{pd} \text{ (dB}\mu\text{V)} = e \text{ (dB}\mu\text{V/m)} + 20 \log(95.5/f) - 6.0$$

Where f is in MHz.

2.3.1 Variation of effective aperture with frequency

Thus, at 500 MHz, a field strength of **53.8 dB μ V/m** would be required to give a terminated voltage of 33.4 dB μ V. To attain the same terminated voltage at 800 MHz would require a field strength of **57.9 dB μ V/m**.

For analogue planning, where the degradation of picture quality with decreasing signal is gentle, the useful simplification was made of adopting fixed coverage limits for the whole of Band IV and for the whole of Band V. With the digital 'cliff edge', this is no longer possible, and most planning is undertaken on the basis of calculating the actual effective aperture for each UHF channel, a $20 \log(f)$ dependence.

This is the case for the JPP criteria [6], which is specified at 500 MHz, and corrected for other channels, as was also the case for RRC-06 [8] and for the Chester Agreement⁸ [3]

2.3.2 Aerial system gain

In most cases the aerial will have gain relative to that of a dipole, and will be connected to the receiver by a length of feeder.

Typical values of 10dBd and 3dB are generally assumed for the aerial gain and feeder loss respectively, giving an overall system gain of 7dB. For the example above, the required field strength will therefore be **46.8 dB μ V**.

The 10dBd / 3dB values are widely quoted, with variations:

- The D-Book [5] refers to a system gain of 7dBd (section 9.13.3),
- In the ITU Recommendation [7], the 10dBd / 3dB values are used in Band IV, but in Band V the feeder loss is increased to 5dB, offset by an increase in gain to 12dB. This is purely a matter of presentation as the system gain, which is the parameter actually used in calculations, remains constant at 7dBd⁹.
- In the Chester Agreement [3] and in the DVB-T Implementation Guidelines [2], the same two pairs of values are used for reference frequencies of 500

⁸ In [3], this correction is, wrongly, referred to as an 'empirical' correction (section 3.3.3).

⁹ In practice, if the feeder loss increases, this would have the effect of increasing the noise figure of the system, thus changing the required signal voltage to give the target C/N. This is acknowledged in the JPP assumption of a 1dB degradation in noise floor at the higher frequencies.

MHz and 800 MHz. An 'empirical correction' is also introduced to allow the assumed antenna gain to vary across each band. This correction is of the form $10\log(F_{\text{actual}}/F_{\text{reference}})$. It is not known if this correction was applied in practice, but it seems unsatisfactory as the feeder loss will also vary in a similarly smooth way across the band, and a correction should either be applied to both values, or to neither.

- The Report from RRC-04 [4] included the same correction as in [2] and [3], but this does not appear in the RRC Final Acts [8], which simply uses the 10dBd / 3dB values in Band IV and the 12dBd / 5dB in Band V.
- The JPP adopts the pairs of values as in the Chester Agreement, but without reference to the aerial gain correction.
- The R-Book [9] refers to the two pairs of values used by the JPP, noting that these are the *maximum values* expected to be necessary.

The current study has confirmed the previous finding that the actual aerial system gain in domestic installations tends to be related to the typical field strengths in the area. Overall system gain figures of 7dB are generally only found where the analogue field strength is close to the coverage limit. Where excess field strength is available, the aerial systems are generally correspondingly poorer.

2.4 Location variability

Following the steps detailed above, it is possible to specify the minimum field strength that would be needed at a specific location to allow a DTT receiver to work. In broadcasting, however, it is not possible to deal with specific locations, but only with statistical generalisations. At UHF frequencies, field strengths can vary by tens of decibels over short distances. What is required, therefore, is a criterion by which it can be ensured that a given proportion of receivers within a nominal coverage area will operate correctly.

When multipath effects are averaged, field strength is found to vary according to a lognormal statistical distribution, over areas across which there is no significant difference in the median field strength. This variation is due to local diffraction losses from nearby buildings, trees and other clutter. In planning analogue services, a standard deviation for this variability of 8dB was often assumed, but this included an element of multipath fading. Several sets of measurements have suggested that a standard deviation of 5.5dB is representative of the location variability experienced for wideband signals such as DTT. This figure was adopted for the Chester Agreement, and has been used at RRC-06 and in the JPP criteria

The assumption of lognormal fading with a standard deviation of 5.5 dB implies that, if 70% of households in an area are to receive a field strength above the minimum value, the median field strength in that area must be 2.86 dB above the minimum value. For other percentage-locations the values are:

locations	Median value w.r.t. minimum FS
50%	0.00 dB
70%	2.88 dB
90%	7.05 dB
95%	9.05 dB
99%	12.80 dB

Table 2.6: Location variability correction

The 'reference planning configuration' adopted in RRC-06 for rooftop reception (RPC1) assumes that 95% of locations will be served, implying a *median* field strength in an area of ~9dB above the minimum value required by a specific receiver.

For the 64-QAM, 2/3 variant, with a C/N requirement of 22.8dB, a median field strength of **53.8 dBµV/m** is required to assure reception at 90% of households within the area.

The JPP [6] originally planned DTT services on the basis that a 100m x 100m pixel was classed as 'served' where the median field strength met the 90% location correction value. The Digital UK postcode checker currently counts pixels meeting the 70% criterion as served, an effective reduction in the coverage limit by ~4dB.

2.5 Interference

The discussion above has made the implicit assumption that no interfering signals are present, i.e. that the service is '*noise limited*'. While this condition is normal for some radio services, such as satellite downlinks, it is very much the exception for broadcast planning.

The high density of terrestrial broadcast transmitter deployment generally means that significant co-channel power is present from unwanted transmissions. The impact of such interference is to raise the minimum field strength required from the wanted transmitter, so as to preserve the required carrier to interference (C/I) ratio¹⁰. It is usual to refer to the field strength required to meet both the noise limit and to exceed the C/I requirement as the 'protected field strength' (PFS).

It might seem that it would only be necessary to add the required C/I margin to the measured or predicted interferer field strength; however, the interfering signal will exhibit location variability in the same way as the wanted signal, and their *joint* statistics must be taken into account.

¹⁰ Actually the carrier to noise and interference ratio, C/(N+I)

The location variability of the ratio of two uncorrelated, log-normally distributed signals is given by:

$$\sigma_{\text{ratio}} = \sqrt{\sigma_{\text{wanted}}^2 + \sigma_{\text{interference}}^2}$$

Thus, if it is assumed that the wanted and interfering signals have the same location variability of 5.5dB, the joint distribution will have a location variability of 7.8dB.

In practice, the overall interference is likely to be the sum of several contributing signals, and in this case determining the statistics of the overall interference distribution is no longer straightforward. In the UKPM the well-known Schwarz and Yeh algorithm [10] is applied. This estimates the overall distribution of the sum of a number of interferers from their individual median values and standard deviations. It is assumed that the latter is always 5.5dB, and that all contributions are uncorrelated.

Before calculating the overall interfering field distribution, receive aerial directivity and polarisation discrimination must be applied to each contribution. ITU-R Recommendation P.419-3 [11] gives the directivity shown in Figure 2.1 below, with a discrimination of 16dB available from the use of orthogonal polarisation.

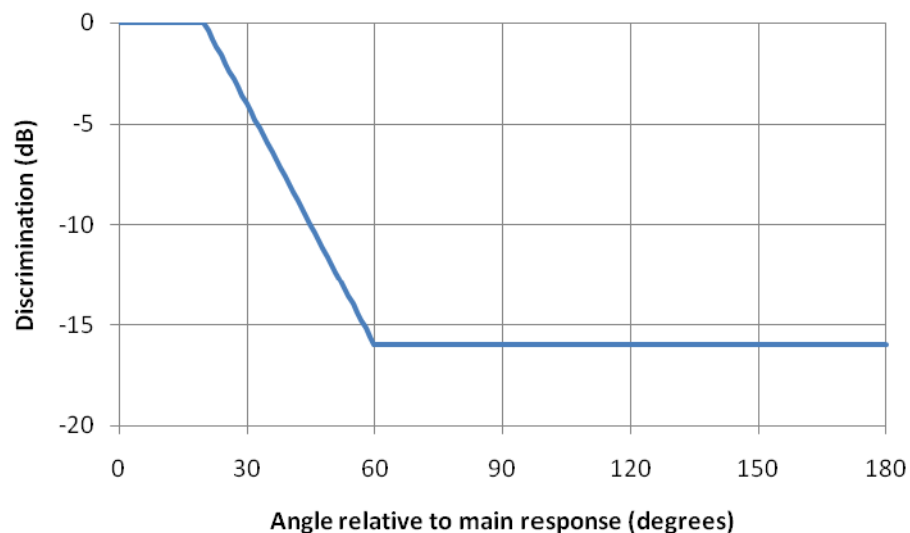


Figure 2.1: Domestic aerial directivity assumed in UK planning (from BT.419-3)

The total discrimination from both mechanisms is capped at 16dB. These values are adopted in UK planning.

3 PRACTICAL IMPLICATIONS

3.1 Field strength survey vehicles

Survey vehicles are often used to determine if the coverage in a given area matches that predicted. Such vehicles will be equipped with a pneumatic mast allowing the

measurement aerial to be positioned at the 10m height above ground assumed in planning.

3.1.1 Location variability

In making such measurements it is necessary to take account of the location variability of the wanted signal, which arises from two distinct mechanisms. In most areas, the received field strength will vary over small distances (a few metres) due to differences in diffraction loss around local objects (roofs, chimneys, trees, etc). This variation is largely independent of frequency across a typical grouping of TV channels, and is generally well described by a log-normal statistical distribution.

Superimposed on this diffraction fading will be a variation due to interference between the direct wave and one or more reflections. In an open area, only a single ground reflection may be present, while in urban areas a complex set of reflected waves may be present, and there may be no direct component. Such fading will exhibit peaks and troughs on the scale of a wavelength (i.e. 40-60cm), and will be have a Ricean or Rayleigh distribution. An impression of such fading is given by the simulation shown in Figure 3.1, representing Raleigh fading over an area with sides of 3m.

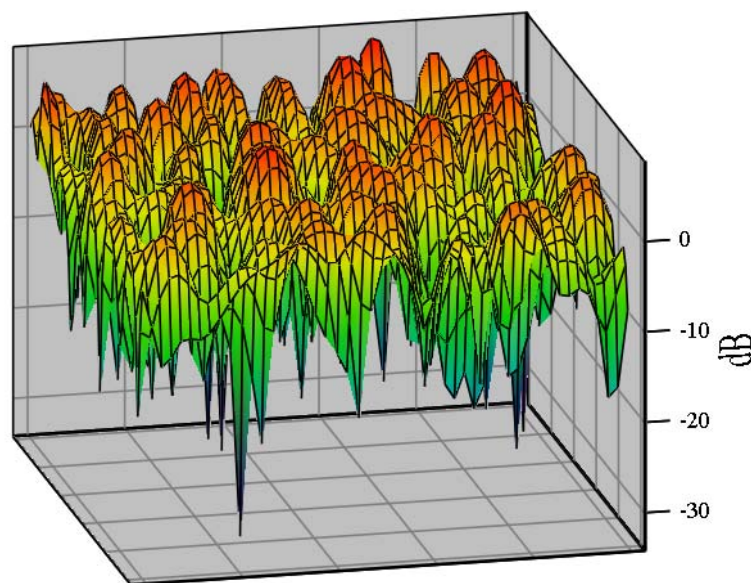


Figure 3.1: Rayleigh fading over an area of $6\lambda \times 6\lambda$

Because of these effects, it is generally necessary to make a number of measurements to establish the local median field for comparison with predictions. In most cases the reflection fading can be averaged by making measurements in one location, but on a number of channels - indeed, for most reflection geometries, the frequency averaging across a single DVB-T channel may be adequate¹¹. The time-

¹¹ This is not the case for analogue signals, where the relatively narrowband energy around the vision carrier is often subject to pronounced multipath fading, necessitating multiple measurements.

or frequency domain displays of measuring receivers such as the Rohde & Schwarz EFA can be useful in revealing longer-delay multipath problems.

Averaging the diffraction fading is less simple, and is likely to require a number of measurements within an area corresponding to the prediction pixel size.

3.1.2 Interference

As noted above, the presence of a field strength above the coverage threshold does not imply that broadcast coverage ought to exist at a given point. It may well be the case that the service has been planned in the knowledge of high levels of co-channel interference, in which case the required field strength (the 'PFS') may be significantly higher than the threshold value.

If a detailed prediction, showing the expected levels of interference, is not available it is generally possible to infer the presence of such interference from the Modulation Error Ratio (MER) measurement available on most test receivers. This is a metric which captures the degree to which constellation points are displaced from their ideal positions whether due to noise, interference or transmitter phase or amplitude distortions. Some receivers can display the MER for each carrier in a DVB-T ensemble, allowing narrowband interference (e.g. from a PAL vision carrier) to be identified.

A less straightforward situation may occur where an area is classified as un-served, but where a perfectly adequate signal appears to be available, with no interference. Such situations may arise where short-term interference is predicted to limit the service, and will most often (though not exclusively) be encountered in coastal areas. It may be worth undertaking further measurements during a period of established high-pressure weather, when the stratified atmosphere giving rise to ducting propagation may occur.

3.2 Wall-plate measurements

When investigating reception problems reported by the public, it is often necessary to make measurements of the voltage available at the wall plate, or coaxial fly-lead.

The DTG R-book recommends that a voltage (PD across 75Ω) of 45dBμV should be available from the wall plate. It is important to appreciate that this is a pragmatic recommendation, intended to minimise problems and installer 'call-back', and to allow for aging and interference. As derived in section 2.2, installations providing only around 35dBμV may work satisfactorily if interference, multipath and man made noise levels are low, and such levels should not, necessarily, be taken to indicate coverage problems.

As for the vehicle survey case, it must be borne in mind that knowledge of the voltage available at the receiver is not sufficient to be able to predict reception quality - it is also necessary to know the PFS required to overcome interfering signals (which may be time-varying).

4 ACKNOWLEDGEMENT

The author wishes to thank John Salter of BBC Research & Development for his help and contributions.. Any errors are the author's own.

4.1

A ANNEX A: GLOSSARY

BER	Bit Error Ratio
C/I	Carrier-to-interference ratio
C/N	Carrier-to-noise ratio
Codec	C oder- D ECode
dB μ V	Decibals relative to 1 microvolt (a voltage, e.g. at a wall socket)
dB μ V/m	Decibals relative to 1 microvolt per metre (a 'field strength' in the air)
DTT	Digital Terrestrial TV
EMF	Electro-motive force
JPP	Joint Planning Project (UK)
MER	Modulation Error Ratio
PAL	UK analogue colour TV standard (Phase Alternation, Line)
PFS	Protected Field Strength

B ANNEX B: REFERENCES

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