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**700MHz Clearance**

**700MHz High Level Estimate**

**Single Hop & PSB MFN/COM SFN Plans**

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## Document Details

General Detail	
Abstract	<p>In order to prepare a Cost Benefit Analysis relating to the implementation of a 700MHz Clearance programme, this document has been prepared to provide a High Level Estimate in respect of the 'Single Hop Plan' / 'PSB MFN COM SFN Plan'.</p> <p>The figures herein are provided for the sole purpose of informing the Cost Benefit Analysis programme and are based on a large number of assumptions which shall be subject to change.</p> <p>This document is not a quotation and the true cost of Clearance shall be subject to a detailed programme of analysis and consultation between stakeholders and shall depend upon the final details of the frequency plan and clearance rollout schedule.</p> <p>This document has been produced to provide interested parties with an overview of the impact of 700 MHz Clearance on the Digital Terrestrial Television network.</p>
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## Disclaimer

This High Level Estimate (HLE) for a potential future 700 MHz Spectrum Clearance Programme is provided by Arqiva Terrestrial Broadcast for Ofcom, and subject to the following disclaimers:

- This document purely indicates the technical design challenges that would need to be overcome in order to clear that spectrum based on two potential future frequency plans. This report does not imply Arqiva's support for any 700 MHz Clearance requirement.
- The issues raised are based on a high-level review, drawing on the experience of the Arqiva Network Design Group with DSO and 800 MHz Clearance. In order to provide a comprehensive analysis for 700 MHz Clearance, far more detailed work would be required. An overview of the type of work that would need to be undertaken is provided in this document.
- The scope and detail of the potential 700MHz Clearance Programme is subject to change and the High Level Estimates reflected herein relate solely to the scenarios modelled based upon information available in Summer 2013.
- The HLE presented in this document relates ONLY to two of the possible frequency plans under consideration by the DTT Frequency Planning Group (DFPG) as of November 2013 known as the Single Hop Variant A (Ch. 29-37) plan and the PSB MFN/COM SFN plan that were provided by Ofcom to support this study. Alternative frequency plans will generate different impact on the DTT network, and thus will result in variations to scope, cost and timescales to implement.
- The Reduced SLA approach described within this document, utilising a Single Mast solution, has not been agreed with the Multiplex Operators. In the absence of detailed site by site analysis, it is recommended that the costs related to the Standard SLA Solution should be used within any Cost Benefit Analysis.
- The production of this HLE is purely to advise Ofcom's Cost Benefit Analysis related to the potential Clearance of 700 MHz spectrum. This does not represent an offer by Arqiva in respect of design and implementation of any 700 MHz Clearance Programme.
- This version of the document is confidential between Arqiva and Ofcom. The prior agreement of Arqiva is required prior to sharing this document with third parties.

## 1 Executive Summary

### 1.1 Scope of Study

In order to allow Ofcom to conduct a Cost Benefit Analysis (CBA) related to a potential 700MHz Clearance Programme, Arqiva Terrestrial Broadcast was requested to provide a high level estimate (HLE) in respect of two potential Clearance Plans: the Single Hop Plan and the PSB MFN/COM SFN plan.

The Single Hop plan is based upon the relocation of DTT services from RF channels above Channel 48 to channels lower down the band (including channels 31-37).

The PSB MFN/COM SFN plan is one in which the PSB multiplexes are operated as a Multi-Frequency Network (MFN) requiring approx. 6 RF channels to support each multiplex across the country, and each COM multiplex is realised as a number of regional Single Frequency Networks (SFNs). The use of SFNs on a regional basis leads to a requirement for the COM multiplexes to utilise the DVB-T2 modulation standard.

This HLE has been produced solely to inform the CBA process and is the result of limited technical analysis and does not constitute a quotation in respect of the Clearance Programme.

The following elements have been taken into account:

- Clearance of the High Power Multiplexes
- Local TV Network Re-Engineering
- New 600MHz HD Multiplexes Service Continuity
- Northern Ireland Multiplex Re-Engineering

It is currently unclear whether conversion of the entire DTT platform to DVB-T2 will be required as part of the 700MHz Clearance Programme. The use of DVB-T2 will provide additional flexibility to the International Co-ordination process and is expected to mitigate any potential impact on coverage.

For the Single Hop plan, where current assumptions do not include conversion of the current five DVB-T multiplexes to DVB-T2, a separate additional 'delta cost' is provided to cover such a conversion at Clearance (in case it should be required).

For the PSB MFN/COM SFN scheme, conversion of the COM muxes to DVB-T2 is an intrinsic part of the frequency plan. In addition to the HLE for Clearance based on the PSB MFN/COM SFN plan, an estimate is also provided herein relating to the additional cost of converting the PSB DVB-T multiplexes to DVB-T2. This is provided as a 'delta cost' since it is not an intrinsic requirement of the current PSB MFN/COM SFN plan

The costs provided herein are indicative only and, as is the case with the 700MHz Clearance programme itself, further analysis and discussion shall be required with Stakeholders to allow implementation plans, a programme of works and detailed costs to be developed.

The DVB-T2 cost estimates herein relate solely to the modifications which are required at Arqiva transmitter sites and, unless otherwise stated, do not include costs associated with compression or distribution system upgrades.

It should also be noted that the HLE herein relate to Arqiva costs only and does not include any provision in respect of costs associated with administration of the overall Clearance Programme (such as those which may be incurred by Digital UK), a public help scheme, consumer communication programme or domestic receiver or aerial upgrades

## 1.2 Comparison of the Two Plans

If the Single Hop Plan is considered to represent a 'Baseline Solution' then the key differences between it and the PSB MFN/COM SFN Plan can be summarised as follows:

- Additional Main Station Upper 50 antenna replacements have been identified at three sites.
- Removal of requirement to replace antennas at four Main Station Lower 32 sites.
- Additional line feeds and equipment associated with SFNs at three sites due to requirement for these sites to form part of an SFN.
- Costs for upgrading COM multiplexes to DVB-T2 as required by frequency plan, and labour associated with implementation of DVB-T2 for three multiplexes at 80 sites.
- Combiner units added to existing chain (as per 800 MHz Clearance) at two sites.
- New permanent combiner chains at three sites.
- An additional Transportable Transmitter is expected to be required to deliver the proposed roll out plan compared with plan proposed against Single Hop Variant A frequency plan.
- GPS, T2 Gateway and TSA costs added to transportable transmitter requirement to cover for COM DVB-T2 SFNs.
- The number of public events is reduced but overall timescale remains the same due to additional time between large events involving setting up SFNs.

Arqiva estimates that the change of scope between the Single Hop Variant A plan and the PSB MFN/COM SFN plan results in an incremental cost of approximately £60M.

## 1.3 High Level Estimate – Based on 2013 costs

In respect of the High Level estimates in this section, it should be noted that:

- a) All figures are presented in 2013 real prices; costs will inflate over time, such effects have not been included in the figures presented due to the uncertainty of the timing of any decisions/works but will apply at the time.
- b) The labour rate used to produce the estimate is in line with the current agreed 800MHz Clearance programme – this is subject to change and will be confirmed at the time of the works.
- c) This is an HLE which excludes all levies and taxes and should not be construed as an offer which is capable of acceptance; the costs exclude VAT which will be applied at the current rate.

- d) The Ofcom grant application, reconciliation and reporting requirements being the same as 800MHz Clearance, noting that no decisions on funding or funding mechanism have been made by Government.
- e) No DigitalUK, Broadcaster, Ofcom or Consumer costs are included.
- f) The cost estimate is based on comparison of the likely 700MHz scope to the actual costs incurred for similar work on DSO and 800MHz Clearance.

### **Clearance Activities Only**

Based on the initial studies, High Level Costs for clearance have been prepared for each of the two potential frequency plans with the intent to minimise impact on existing services.

The 'Standard SLA solution' is proposed to minimise impact on capabilities of each station (performance and redundancy) to ensure minimal impact on the contractual SLAs between Arqiva and the Multiplex Operators.

To provide the 'Standard SLA solution', temporary mast and antenna systems would need to be deployed at all Main Stations where any antenna works are required. The nominal baseline solution would be to adopt this 'Dual Mast Approach' to minimise the impact on service. Where the provision of a temporary mast is simply not possible, Arqiva has considered a 'Single Mast Solution' (where issues may exist to prevent deployment of a temporary mast) but there would be an inevitable risk to service.

As a baseline for the analysis herein, it has been assumed that the 'Dual Mast Approach' can be deployed wherever antenna works are required leading to an overall 'Standard SLA solution'.

The Standard SLA solution, based on current assumptions, would require a significant number of temporary mast / antenna systems to be provided at the Main Stations. In the absence of detailed site by site analysis, Arqiva recommends that the costs related to the Standard SLA Solution should be used within any Cost Benefit Analysis as they represent the upper end of likely cost outcomes for the options considered.

The 700MHz Clearance Programme 'High Level Estimate' is made up of the following elements:

- Main station antenna works, including temporary masts and antennas.
- Main station groundworks (civils, power, system integration and RF feeders)
- Main station temporary transmitters (transportables)
- Main station temporary combiners
- Relays – transmit antennas; RBL antennas and site modification works
- Service continuity provision
- Transition issues and consequential works
- Other scope (Legal fees; IT development; Test equipment logistics; On-site security)

- Design assessment costs (Antenna assessments – helitests, modelling and works tests)
- Arqiva Commercial & Finance and Technical Labour

Transition from DVB-T to DVB-T2 for COM multiplexes is also required as an intrinsic part of the PSB MFN COM SFN plan.

Standard SLA Solution	Total (£M)
SINGLE HOP	410
PSB MFN COM SFN	470

*NB. All figures are presented in 2013 real prices; costs will inflate over time*

These figures assume no change of DVB mode for PSB multiplexes but, for the PSB MFN COM SFN plan, include a change in mode as required for the frequency plan for COM multiplexes.

Based on the high level assumptions contained herein, it is envisaged that Clearance events would take place during the period 2019 to 2021. In order to achieve these dates we strongly recommend that, planning and preparatory works commence in 2014.

**It should be noted that Arqiva cannot commit to a defined timetable until the spectrum plan, roll-out order and key assumptions regarding the scope of work e.g. number of temporary masts and antenna builds are better defined.**

### **Alternative Approach – Reduced SLA**

In circumstances where antenna replacement is required, the provision of a temporary mast (the Dual Mast Approach) will minimise impact on service and allow the ‘Standard SLA Solution’ to be provided.

However, in the event that this approach is not feasible, alternative schemes will need to be considered. Under certain circumstances, and only where the potential impact to service can be maintained within limits acceptable to Multiplex Operators (which shall vary depending on the specific implications at a station) then an alternative ‘Single Mast Approach’ could be considered.

The Single Mast approach would avoid the requirement to provide a temporary structure through the reconfiguration of existing antennas. However, this approach would almost certainly need to a compromise on coverage under certain circumstances which would have to be considered in detail on a site by site basis. The feasibility or otherwise of a ‘Single Mast’ (Reduced SLA) solution cannot be assessed at this time and, as a result, the Dual Mast (Standard SLA) approach should be considered as the preferred approach in respect of any main station antenna replacement.

Transition from DVB-T to DVB-T2 for COM multiplexes is also required as an intrinsic part of the PSB MFN COM SFN plan.

Reduced SLA Solution	Total (£M)
SINGLE HOP	310
PSB MFN COM SFN	360

*NB. All figures are presented in 2013 real prices and are subject to annual RPI indexation.*

**In the absence of detailed site by site analysis, Arqiva recommends that the costs related to the Standard SLA Solution should be used within any Cost Benefit Analysis** as they represent the upper end of likely cost outcomes for the options considered.

### Local TV Network Re-engineering

In order to ensure continuity of Local TV services during and in the absence of an agreed spectrum plan, after 700MHz Clearance, we have assumed that a complete re-engineering programme would be required.

It is recommended that the re-engineering methodology related to Local TV should be reviewed following confirmation of the Local TV frequency plan and analysis of the detailed implications arising from the Clearance programme.

### New HD Mux Impact

Based on current assumptions, no additional scope, over and above the Clearance works, has been identified in respect of the New HD multiplexes. It should be noted however that, should the provision of temporary masts at some sites not be possible, the impact on the New HD multiplexes shall have to be carefully assessed on a site-by-site basis. In the event that the impact is assessed as unacceptable the solution, scope and associated works shall be subject to review.

### Northern Ireland Multiplex

The Northern Ireland multiplex operates from three sites and will be affected by 700MHz Clearance. However, the scope of the modifications may be relatively small, based on this version of the Single Hop plan, and is covered within the scope of the HLE related to the main 700MHz Clearance programme. The re-engineering methodology related to the Northern Ireland Multiplex will need to be reviewed following confirmation of the frequency plan and the detailed implications arising from the Clearance programme.

### DVB-T2 Transition

In the event that DVB-T2 transition is required at Clearance, Arqiva has considered a potential methodology as outlined in section 10.

For the Single Hop plan, where current assumptions do not include conversion of the current five DVB-T multiplexes to DVB-T2, a separate additional 'delta cost' is provided to cover such a conversion at Clearance (in case it should be required). For the PSB MFN, COM SFN plan, the PSBs can remain as DVB-T. Despite the fact that the plan includes three additional SFNs, analysis by the DTT Frequency Planning Group (DFPG) suggests that these SFNs can

operate in the current DVB-T mode, a T2 price delta is provided in the event that DVB-T2 transition is required for the PSB Multiplexes in addition to the COM Multiplexes at Clearance.

Based on preliminary discussions with the equipment suppliers in respect of DVB-T2 conversion, the HLE may be summarised as shown in the table below.

	Total (£M)
SINGLE HOP	
T2 Delta (5 muxes)	50
PSB MFN COM SFN	
T2 Delta (2 muxes)	30

*NB. All figures are presented in 2013 real prices; costs will inflate over time*

#### 1.4 Commercial Qualifications and Assumptions

A range of commercial qualifications and assumptions apply to this HLE. If these assumptions do not hold, the costs of clearance could be substantially different to those presented here. The key assumptions and qualifications are:

- a) This is an HLE related to the implementation of Clearance based upon the Single Hop and the PSB MFN/COM SFN Plan. Any alternative frequency plan shall require a complete review of the impact on the infrastructure, the associated scope and costs of implementation.
- b) The technical and implementation feasibility of the assumptions underlying the HLE have not been fully validated, e.g. it has been assumed that it will be possible to obtain land and planning permission to build a temporary mast on all the sites that have been identified as needing a temporary mast and antenna system in order to meet SLA agreements.
- c) This HLE assumes no power supply upgrades by the Regional Electricity Companies (REC). This could have significant impact on the timescale and cost of the programme.
- d) High level implementation principles have been discussed with Multiplex Operators but approval and acceptance of potential risk to service during implementation works cannot be assumed by Arqiva until express approval has been received.
- e) This HLE is based upon the Single Hop and the PSB MFN/COM SFN plan and a provisional roll-out order. The implementation methodology and overall cost of the programme shall require review in the event of variations to the spectrum plan or roll-out order.
- f) Arqiva is unable to confirm the programme start and completion date until the spectrum plan has been finalised by Ofcom following International Co-Ordination. The dates provided herein are purely indicative based on the assumptions that the main station frequency plan is locked down by the end of 2015 with confirmed restrictions. International Co-ordination restrictions may impact the scope and cost assumptions currently made to build up the HLE.
- g) Based on the commissioned scope for the HLE, Arqiva has only been able to carry out a preliminary high level assessment of the antennas and likely replacements. Until a full assessment has been completed, Arqiva will not be able to confirm the programme start

and completion dates as antennas and any temporary mast / antenna systems are likely to form the programme critical path.

- h) Arqiva has provided costs for the scope detailed in this report. No allowance has been made for 'exceptional risks' or other matters that have a material impact upon the programme including any changes to the scope of work or timescales.
- i) The estimate is based upon activities by Arqiva only (no allowance has been made for work by Ofcom, Digital UK, Broadcasters and Consumers activities).
- j) Any changes to Law or the Regulatory Framework (e.g. Health and Safety legislation) may require changes during the period of the works and revisions to the estimate
- k) If there is any Code of Practice or Engineering Standards changes during the period of the works then the estimate would need to be revisited.

The HLE does not address variations in opex which might arise as a result of the programme. Such issues may arise in respect of power consumption (where there is a change in required transmitter power). The HLE has assumed no impact on telecom link requirements.

## 2 Frequency Plan Summary

Ofcom (DFPG) is currently in the process of considering a range of potential 700MHz Clearance plans (8 in total). Arqiva Terrestrial Broadcast has been requested to provide high level range estimates relating to two potential 700MHz Clearance Plans and this document relates to the analysis of the Single Hop and PSB MFN COM SFN plans.

### 2.1 Plan 1: The Single Hop Plan.

The Single Hop plan requires services currently above channel 48 to be transferred down the band to channel 29 – 37 (Single Hop Variant A). This is been expected to give rise to the minimum relative level of impact on the DTT Network infrastructure (subject to confirmation following the analysis of the further options).

It should be noted that the relative merits of alternative Clearance Plan options are currently being assessed within DFPG and no decision has been made on the option (if any) which is to be executed.

It is understood that the Single Hop plan could lead to an adverse impact on COM coverage depending on International Co-ordination issues which are yet to be addressed.

Arqiva Terrestrial Broadcast has produced an HLE herein based upon implementation of the nominal 'DVB-T' Single Hop plan (which would result in five DVB-T multiplexes and one DVB-T2 multiplex). An estimate is also provided herein for the additional cost relating to the implementation of a 'DVB-T2' Single Hop variant (the 'DVB-T2 Delta').

A DVB-T2 variant would result in a main UK DTT network comprised of six DVB-T2 multiplexes and the use of DVB-T2 would be expected to provide a greater range of options to the International Co-ordination process to maintain the coverage of the network.

The HLE is based upon the Single Hop frequency plan provided by Ofcom in respect of the Main Stations only. A frequency plan for the relays is yet to be produced but, to avoid potential interference between main stations and relays; it has been assumed that all multiplexes transmitted from relay stations shall be subject to modification.

### 2.2 Plan 2: The PSB MFN COM SFN Plan.

The PSB MFN COM SFN Plan involves the relocation of services currently above channel 48, with some preference to aim to keep PSB services close to their current operating frequencies in an attempt to reduce the impact on viewer receive antennas. As a result, a number of COM SFNs are created which require DVB-T2 transmission mode.

It should be noted that the relative merits of alternative Clearance Plan options are currently being assessed within DFPG and no decision has been made on the option (if any) which is to be executed.

Arqiva Terrestrial Broadcast has produced an HLE herein based upon implementation of the nominal PSB MFN COM SFN plan (which would result in two DVB-T multiplexes and four DVB-T2 multiplexes). An estimate is also provided herein for the additional cost relating to the implementation of 'DVB-T2' for two PSB multiplexes (the 'DVB-T2 Delta').

A DVB-T2 variant would result in a main UK DTT network that comprises of six DVB-T2 multiplexes and the use of DVB-T2 would be expected to provide a greater range of options to the International Co-ordination process to maintain the coverage of the network.

The HLE is based upon the PSB MFN COM SFN frequency plan provided by Ofcom in respect of the Main Stations only. A frequency plan for the relays is yet to be produced but, to avoid potential interference between main stations and relays; it has been assumed that all multiplexes transmitted from relay stations shall be subject to modification.

### 3 Main Station Impact

Any requirement to change frequency at a Main Station (ie. the top 80 highest power stations) shall lead directly to modification of the DTT infrastructure (transmitters and combiner units) and can also lead to a requirement to replace antenna system.

#### 3.1 Antenna Impact

A high level assessment has been conducted in respect of the main and reserve antenna systems at each of the 80 Main Stations. It should be noted that the assessment has been based purely on desktop study and will be subject to change following a detailed technical assessment. Such technical assessment shall include the provision of theoretical performance across the UHF band, helicopter testing, coverage assessment and discussion and agreement with multiplex operators on acceptable overall performance.

##### 3.1.1 Antenna Replacement

Any requirement to replace a main station antenna may lead, at best, to loss of antenna redundancy during re-engineering or, at worse, loss or degradation of service in the event of problem with the antenna subsystem during modification works. These issues can however be avoided through the provision of temporary mast and antenna systems which could provide additional service security throughout antenna modification works – the Dual Mast Solution.

#### The Dual Mast solution

The Dual Mast Solution requires the provision of a mast adjacent to the current structure on which temporary antenna systems would be provided in order to avoid loss of redundancy during replacement of the permanent antenna systems. This solution would, theoretically, lead to minimal SLA impact.

At the majority of sites temporary antenna systems cannot be provided on existing masts since the structures cannot accommodate additional antennas of a similar size to the current DTT antennas.

Adopting the dual mast solution will lead to minimal SLA impact since main and reserve antenna systems, capable of operation at nominal powers, would be available throughout the modification works on the temporary mast. Services would be subject to switching breaks but, when operating on the temporary antennas, it would be intended that there would be no degradation in the transmitted powers (known as Effective Radiated Power or 'ERP'). The feasibility or otherwise of providing 'no degradation on ERP' and the temporary mast shall need to be assessed on a site by site basis. It has been assumed herein that this would be possible but this shall be subject to detailed review.

The relative locations of two structures could lead to an impact on coverage. This will be assessed during the design and planning phase.

The chart below shows an indicative timeline related to works at a main station where temporary mast and antennas are required (NB. this is notional since consideration has to be given to the fact that similar work shall be required simultaneously at multiple sites).

It should be noted that our high level estimate is based upon the dual mast approach as this maintains the SLA that have been agreed with the multiplex operators. Under certain circumstances it may however not be possible or desirable to implement the dual mast solution. If the multiplex operators were prepared to accept a potential impact on SLA, then an alternative 'Single Mast Approach' could be considered. Further details on this approach are set out in Section 12.

**Dual Mast Solution – indicative timetable**

<u>Upper 50 Sites: Dual Mast Solution</u>	2013	2014 Year 1	2015 Year 2	2016 Year 3	2017 Year 4	2018 Year 5	2019 Year 6
Technical Design & Planning							
Local Authority Planning & Land Acquisition							
Temporary Mast Build							
Temporary Antenna Installation							
Main Mast - Antenna Replacement							
Clearance Event							
Dismantling of Temporary Mast & Antennas							

At Lower 32 sites (main stations where a single split antenna is provided) it is proposed that antenna replacement would take place on a single day based upon a methodology first adopted during the DSO programme. It should be noted that, since such works are weather dependent and would take place at Clearance, some flexibility has been assumed in the actual Clearance date. In the event that Clearance dates would be strictly enforced the methodology related to Lower 32 antenna replacement works would need to be reviewed.

**Implementation Methodology**

On the Upper 50 sites, where cantilever (main antenna) antenna replacement is required, a helicopter lift has been assumed. Whilst helicopter operations would take place during a single day, preparation and commissioning would take the cantilever out of service for approximately four weeks.

Any required replacement of cantilever antennas has been assumed to take place by helicopter.

It should be noted that the main antenna at Winter Hill is not a cantilever. At Winter Hill, main antenna and reserve antenna replacements would take place by conventional techniques as carried out on DSO and Clearance.

The replacement of wraparound antennas, such as are installed at Winter Hill, and including the reserve antennas at most high power sites, cannot be accomplished through the use of helicopters and masts would need to be rigged for such works. The replacement of a wraparound antenna is therefore more onerous, complicated and time consuming than the replacement of a cantilever antenna.

Power testing shall be required on all new antenna systems prior to Clearance. The method of power testing (for up to eight services at high power) has not been considered in detail at this time and shall be subject to discussion and review with the Multiplex Operators.

For the Lower 32 sites a one day crane lift replacement has been assumed as generally carried out during the DSO Programme.

## 3.2 Transmitter & Combiner System Re-Engineering

### 3.2.1 Overview

Whilst the scope and extent of air-works (antennas and structural work) will govern the overall duration of the programme, such works will not have to take place at every site where frequency changes are to take place. However, transmitter and combiner unit re-tuning will be required wherever a frequency change is required.

Due to the nature of UHF RF systems engineering, where a transmitter is to be modified to operate on an alternative frequency, the transmitter subsystem (encompassing the transmitter and all RF interconnections to the combiner unit) shall need to be adjusted and re-commissioned. On the main stations, this shall require the transmitter systems to be taken out of service to allow such modifications to take place.

For the purpose of allowing transmitter adjustment to take place, it is proposed that transportable transmitter systems are deployed to Upper 50 sites (ie. the highest power main stations) as necessary throughout the Clearance programme. This will allow stations to 'Undergo Clearance' through the transfer of service to the transportable systems. Having undergone Clearance, the current (resident) transmitters would be temporarily out of service allowing retuning, testing and re-commissioning to take place. Service would then revert to the resident transmitters following adjustment and testing allowing the transportable to move on to the next location.

At sites where frequency adjustments are required, the combiner units will require retuning. At the Upper 50 sites such combiner system modifications would be conducted either through the provision of additional CU modules or through the deployment of temporary combiner units to allow the current systems to be taken out of service allowing modification to take place. For the purpose of this HLE it has been assumed that additional CU modules would be deployed (permanently) where one or two channels need to undergo frequency changes and, where more than two channels are to be adjusted, temporary combiner systems would be deployed.

The transportable transmitters and combiners will be required to support service at those sites amongst the Upper 50 stations where frequency modifications are required. At the Lower 32 stations (ie. the 32 lower powered main stations), transportable systems shall also be required, although as powers are lower, it is anticipated that the temporary systems could be accommodated in fewer containers than for the main stations.

## 4 Relay Systems

In addition to the Main Stations, relay stations will also require modification in respect of the new frequency plan. At the time of writing a relay frequency plan does not exist but, based on some preliminary analysis and in order to provide a basis for this HLE, it has been assumed that that a frequency change (on either the input or output of a relay site) shall be required in order to allow Clearance to take place.

It has therefore been assumed that all relays shall need to be attended in the day light hours following a Clearance event at a main station or, where a main station itself is unaffected by Clearance, at a suitable point dictated by the overall Clearance programme. It should be noted that the feasibility of simultaneous Clearance of multiple main stations/relays on a single date shall be dependent upon the total number of relays which would need to be required. Following confirmation of the required rollout plan, analysis shall take place to quantify the total number of relay visits required on the separate event dates; the schedule and/or resources shall be subject to review following such a detailed assessment.

It should also be noted that, where transposers are currently used at the majority of relay sites, replacement by re-transmitters (due to RBL link impairment arising from the new frequency plan) may also be required.

It has been assumed that a number of sites would need to be provided with re-transmitters but this this figure is subject to review following confirmation of the frequency plan and detailed RBL analysis.

It has been assumed that additional lines or SHF links to relay sites shall not be required as a result of Clearance.

## 5 Provisional Rollout Plan

Following confirmation of the Frequency Plan the next step in a programme of this type would be consider potential rollout sequence of the main stations taking technical, commercial, political and major sporting or national events into account.

The rollout sequence (ie. the order of public 700MHz clearance events around the country) and the pace of Clearance events (ie. the period between such events) will have a major impact on the scope and duration of the Clearance programme.

For the purpose of this HLE, for the Single Hop Plan, a provisional rollout sequence provided by Ofcom has been assumed. It should be noted that this sequence has been used for estimating purposes only and shall be subject to change to take account of multiple issues and interests arising from various stakeholders. The scope, complexity, duration and cost of the implementation programme shall vary in accordance with changes in the rollout plan. The rollout plan will have a direct impact on the scope of Services Continuity works, Consequential works, labour requirements (instantaneous and overall) and the number of transportable systems which shall be required. For the PSB MFN, COM SFN plan a slight variant of the Single Hop plan has been assumed.

In order to prepare for Clearance in the 2019 to 2021 timeframe, antenna assessment work shall need to commence in 2014 in respect of the planning of temporary structures for those sites where temporary masts will be required. The chart in Appendix A shows the provisional overall plan relating to clearance related activities.

It should be noted that this is based upon the Dual Mast solution requirement since a number of sites will fall into this category. Final design and implementation of final antenna solutions

would be unwise prior to lockdown and finalisation of the Frequency Plan (assumed to take place by end 2015).

The key programme assumptions are:

Note: *all dates in brackets are nominal for planning purposes*

- Clearance public events unlikely to be able to commence before the end of 2018 as a result of lead-times associated with Temporary masts and likely timescales related to the refinement of the main station frequency plan to allow analysis and design to take place.
- From initial assessment these dates are achievable based on the assumptions herein. Where antenna works are required at main stations, temporary mast construction would need to commence on site in 2016. Planning and site acquisition work temporary masts would need to commence in 2015.
- In order to meet the timeframes outlined herein, the Spectrum Plan (in respect of main stations at the very least), including restriction templates, shall need to be finalised by the end of 2015.
- Arqiva cannot commit to a date until the spectrum plan, roll-out order and number of temporary masts and antenna builds are better defined.

## 6 Consequential Works

Consequential Works is the term used to describe any additional works which may be required to minimise the impact upon high power DTT multiplexes from one site as a result of Clearance at another station. The scope and complexity of such works can be identified only following the finalisation of the frequency plan and during the detailed assessment of the rollout plan (to allow interactions to be identified).

It has not been possible to conduct an assessment of potential station interactions during the preparation of this HLE and, as a result, a provisional sum has been included at the present time. On the DSO programme, consequential works were identified over a period of several years as a result of the detailed study of potential interactions between main stations and relay sites.

It is envisaged that a similar level of analysis will be required for the 700MHz Clearance programme and Consequential Works shall be the subject of on-going review and refinement.

## 7 Service Continuity

Service Continuity is the term used to describe any additional works which may be required to ensure minimal impact to third party services, which are co-located using Arqiva facilities and which might otherwise risk unacceptable service impacting events as a result of the implementation of the Clearance programme.

Service continuity can arise -

- On structures which may be impacted by structural and/or antenna works. Radio services would have been affected throughout the DSO programme had it not been for the implementation of Service Continuity works.
- In buildings where equipment has to be re-located in order to allow modifications to take place to the DTT system.

A provisional sum has been included in the HLE in respect of Service Continuity.

The actual level of Service Continuity shall depend upon the scope of antenna and building modifications and the potential impact on third party services. The methodology to be adopted will be subject to review on a site-by-site basis, and agreement with each of the relevant Multiplex Operators and other service customers.

## **8 Additional Works**

In addition to Service Continuity and Consequential works arising as a result of the modifications to the main DTT network, additional works shall be required in respect of the supplementary DTT services which are available from a number of stations.

### **Local TV**

Local TV services have been allocated spectrum across the UHF band and allocations above channel 48 have been made at a number of sites and shall be directly affected by Clearance of the 700MHz band.

Based on the assumption that all potential Local TV licences are awarded, the UK Local TV network would consist of services at approximately 58 sites (49 licence areas). The final number of sites actually involved supporting local TV services is yet to be confirmed and will be subject to the outcome of the current Ofcom process related to the licencing of the Phase 2 sites.

Work is on-going in respect of the development of frequency plans so it has been assumed, for the purposes of this estimate, that the network will need to be completely re-engineered. This includes the provision of new antenna and transmitter systems in order to allow continuity of service throughout the implementation of the 700MHz Clearance programme and thereafter, but is subject to confirmation.

The estimate relates to Phase 1 and Phase 2 sites and assumes continued operation in DVB-T. Any issues associated with the distribution network, the introduction of further SFNs has not been considered.

In the absence of any baseline technical requirements the Local TV estimate should be considered as 'Order of Magnitude' only and subject to complete review following the provision of an outline requirement specification.

### **New 600MHz HD Multiplexes**

The new 600MHz HD Multiplexes launched in 2013/2014 on channels 31-37 are assumed be fully operational until December 2018 and then terminate on a site-by-site basis thereafter in accordance with the requirements of the 700MHz Clearance programme.

During the implementation of antenna works preceding the public 700MHz Clearance events, works may be required to ensure service continuity for the New HD multiplexes. The actual scope of such works shall be subject to detailed site-by-site analysis but based on current assumptions is covered within the scope of the HLE related to the main 700MHz Clearance programme. It should be noted that changes to the frequency plan and / or the assumed method of implementing antenna modifications may result in costs to maintain

### **Northern Ireland Multiplex**

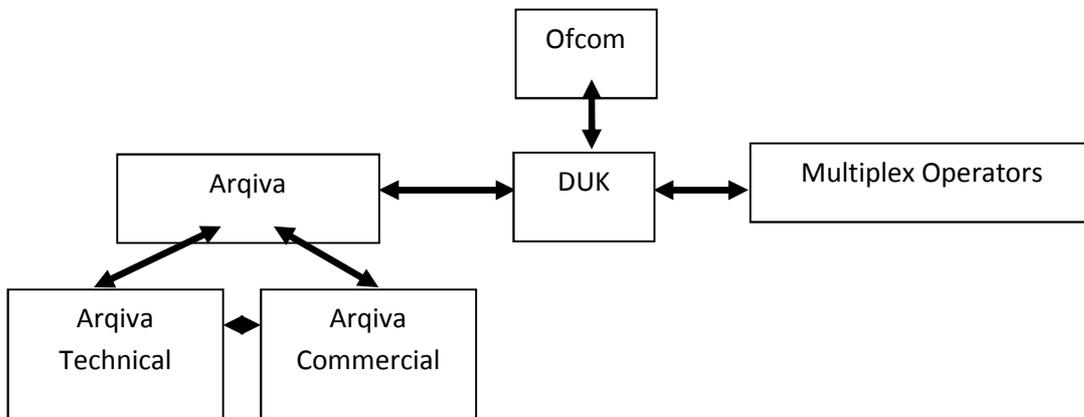
The Northern Ireland multiplex operates from three sites and will be affected by 700MHz Clearance. However, the scope of the modifications is expected to be relatively small based

on the Single Hop frequency plan, and is covered within the scope of the HLE related to the main 700 MHz Clearance programme.

## 9 Organisational / Resource Considerations

For the 700MHz Clearance, the organisational structure and relationship between stakeholders has been assumed to be the same as for 800MHz Clearance, with a tri-partite agreement in place between Arqiva, Ofcom and the Multiplex Operators. It is also assumed that Digital UK will perform the same function as for 800MHz Clearance, particularly the DUK Database and the administration of design and grant documentation between Arqiva, Multiplex Operators and Ofcom.

The operational (not contractual) structure assumed for the programme is as follows:



This assumes that the funding mechanism would be the same as for 800MHz Clearance, i.e. a grant application and reconciliation for each element of infrastructure work with separate grants for Arqiva labour. In order to process the volume of grants Arqiva will establish an appropriately sized Commercial Team based on the requirements and lessons learned on 800MHz Clearance. The Technical team will develop all antenna and station modification design documentation and carry out the implementation works in accordance with the final roll-out order.

Arqiva labour forecasts have been developed based on the scaled resource requirements from 800MHz Clearance and DSO experience for the antenna and temporary mast works.

The HLE does NOT include any costs which would be incurred by Digital UK, Ofcom or Multiplex Operator (including Arqiva MuxCo) costs which shall arise in the management of a 700MHz Clearance programme.

## 10 DVB-T2 Transition

Ofcom have requested an additional HLE related to the transition of the remaining DVB-T multiplexes to DVB-T2 as an incremental cost on the Clearance programme. Arqiva has considered the issues associated with the implementation of a DVB-T2 transition. It has been assumed that T2 transition would take place at Clearance on a main station by main station basis (together with the associated relays).

The situation related to each of the two plans is slightly different as outlined below:

Single Hop Plan	PSB MFN COM SFN Plan
<p>The Single Hop Plan is based upon the continued use of Multi-Frequency Networks (MFNs) for both the PSB and COM networks.</p> <p>The Clearance figures provided for Single Hop are based on the continued existence of five DVB-T multiplexes and a single DVB-T2 multiplex and do not consider a change of DVB mode at Clearance.</p>	<p>The PSB MFN, COM SFN plan requires the COM multiplexes to become DVB-T2 as an intrinsic requirement of the plan.</p> <p>The Clearance figures provided for PSB MFN COM SFN are based on the continued existence of two DVB-T PSB multiplexes and four DVB-T2 multiplexes and include a change of DVB mode at Clearance for the three COM muxes.</p>

An HLE has been prepared related to the modification of transmitter site equipment (main station and relays) to provide a DVB-T2 transmission.

The provision of compression systems and additional line capacity which may be required to support any additional payload which may be available and the new services which may reside therein has not been included within the DVB-T2 HLE.

It has been assumed that the frequency plan (ie. the use of offsets and T2 extended carriers) does not lead to issues which would require modification of the main station combiner systems. This is specifically excluded and shall be subject to review.

## 11 High Level Estimate

### 11.1 Clearance Estimate

#### 11.1.1 Scope and Implementation Methodology

The table below summarises the cost elements, implementation methodology assumptions and impact on the Standard SLA Solution.:

Scope Element	Standard SLA Solution
Main Station (U50) Antennas	At the Upper 50 sites, temporary masts and antenna systems would be required to implement minimal SLA impact when antenna replacements are required.
Main Station (L32) Antennas	At the Lower 32 sites; single day replacement with the provision of a 'fall back antenna' to allow service to be maintained in the event of unforeseen circumstances impacting the replacement. It was agreed that some flexibility should be assumed in respect of the Clearance Date to allow implementation to be planned for a 'Clear Weather Window'.  It should be noted that one L32 site has been assumed to require a Temporary Mast.
Main Station (U50) Combiners (when 2 or less channels impacted)	Additional Combiner modules will be added to Combiner Chains (as Channel 61/62 Clearance)
Main Station (U50) Combiners (when 3 or more channels impacted)	Temporary Combiner chains will be provided and the existing combiner modules re-tuned.
Main Station Transmitters (U50)	Main Station Transmitter systems will be 'retuned in situ'. Temporary Transmitter Systems (Transportables) shall be required to allow existing transmitter systems to be taken offline. Temporary transmitters to be grouped and containerised.
Main Stations (L32)	Transportable transmitter and combiner systems in order to maintain service.
COM DVB-T2 Conversion	Installation of DVB-T / T2 modulators into permanent transmitter systems at 80 sites for 3 COM multiplexes ahead of the Clearance Event.
COM SFN	Installation of GPS receivers, T2 Gateways and Transport Stream Analysers.
PSB SFN	Installation of the GPS receivers, line feeds to replace RBL back up, installation of T2 Gateways.
Service Continuity	Allowance only at this stage until the full scope of antenna works is defined and individual site assessment can be carried out.

Scope Element	Standard SLA Solution
Transition and Consequential Works	Allowance only at this stage until the spectrum plan and roll-out order is further defined.
Relays	All sites will need to be visited on day of any main station channel changes. Relays which are associated with Main Stations which are not changing frequency are also factored into the plan.

The 700MHz Clearance Programme 'High Level Estimate' is made up of the following elements:

- Main station antenna works, including temporary masts and antennas.
- Main station groundworks (civils, power, system integration and RF feeders)
- Main station temporary transmitters (transportables)
- Main station temporary combiners
- Relays – transmit antennas; RBL antennas and site modification works
- Service continuity provision
- Transition issues and consequential works
- Other scope (Legal fees; IT development; Test equipment logistics; On-site security)
- Design assessment costs (Antenna assessments – helicopter tests, modelling and works tests)
- Arqiva Commercial & Finance and Technical Labour

The key estimate assumptions are:

- All figures are presented in 2013 prices and will be subject to annual indexation but has been excluded due to uncertainty over timing.
- The Ofcom grant application, reconciliation and reporting requirements are the same as 800MHz Clearance
- No DUK/Broadcaster/Ofcom or Consumer costs are included.
- The cost estimate is based on comparison of the likely 700MHz scope to the actual costs incurred for similar work on DSO and 800MHz Clearance.

Standard SLA Solution	Total (£M)
SINGLE HOP	410
PSB MFN COM SFN	470

*NB. All figures are presented in 2013 real prices; costs will inflate over time*

In the absence of detailed site by site analysis and the consent of Multiplex Operators, Arqiva recommends that the costs related to the Standard SLA solution (which minimises impact

service on and levels of redundancy) should be used within any Cost Benefit Analysis, as they represent the upper end of likely cost outcomes for the options considered.

## 11.2 Additional Works

### 11.2.1 Local TV Re-Engineering

In order to ensure continuity of Local TV services during and after 700MHz Clearance, a re-engineering programme would be required.

### 11.2.2 New 600MHz HD Multiplex Continuity

Based on current assumptions, no additional cost, over and above the Clearance works, has been identified in respect of the New 600MHz HD multiplexes. This will be subject to detailed design and review to validate these assumptions.

### 11.2.3 Northern Ireland Multiplex

The Northern Ireland multiplex operates from three sites and will be affected by 700MHz Clearance. However, the scope of the modifications shall be very small and is covered within the scope of the High Level Estimate related to the main 700MHz Clearance programme.

## 11.3 DVB-T2 Transition

The estimate for DVB-T2 transition is based on concurrent implementation of the works with the 700MHz Clearance programme. It is assumed the works will be carried out approximately one year ahead of the Clearance Event dates which provide synergy saving on Arqiva labour with the core team effort (Finance, PMO and SHE). T2 specific labour for Project Management, Design, Logistics, Coordination and Procurement is included in this estimate.

	Total (£M)
SINGLE HOP	
T2 Delta (5 muxes)	50
PSB MFN COM SFN	
T2 Delta (2 muxes)	30

*NB. All figures are presented in 2013 real prices and are subject to annual RPI indexation.*

For Single Hop, the estimate for DVB-T2 transition (2 x PSB Multiplexes & 3 x COM Muxes) is based on concurrent implementation of the works with the 700MHz Clearance programme.

For PSB MFN, COM SFN, the estimate for DVB-T2 transition (2 x PSB Multiplexes) is based on concurrent implementation of the works with the 700MHz Clearance programme.

## 12 Alternative Solution – Reduced SLA

In respect of the installation of antennas, the provision of a temporary mast (the Dual Mast Approach) will minimise impact of service and allow the 'Standard SLA Solution' to be provided.

However, in the event that this approach is not feasible at a site where antenna works are required alternatives will need to be considered. One such alternative would be the 'Single Mast Approach' which would need to be considered on a site by site basis. This approach, whilst removing the need for a temporary mast, could lead to service and/or coverage degradation – and should hence be considered as a 'Reduced SLA solution' – which, depending on the specific details, is likely to be unacceptable Multiplex Operators and their viewers.

To summarise the two approaches:

### Option A: The Dual Mast Approach

- Temporary antennas would be provided on a temporary mast
- No impact on antenna redundancy throughout works
- Minimal SLA impact due to switching breaks

### Option B: The Single Mast Approach

- Temporary mast would not be provided
- Risk of reduced ERP transmissions in event of antenna anomaly
- SLA impact during such periods

The Dual Mast Approach has been described in detail and provides the means by which there would be minimal impact to the SLA.

### The Single Mast Approach

The Single Mast approach avoids the requirement to provide a temporary structure through the reconfiguration of existing antennas. This would allow services to be supported at reduced power in the event of an antenna problem during antenna modification works. This solution would result in potential impact on the SLA which would need to be acceptable to multiplex operators.

The Single Mast approach would only be feasible if, in the event of a problem during reserve antenna replacement work, service would not be degraded by more than 3dB. Furthermore under such a reduced power condition, coverage would need to be maintained above acceptable limits.

The feasibility and acceptability of reduced ERP transmission from the reserve antenna will need to be reviewed in detail on a site-by-site basis with the multiplex operators.

This approach would impact the SLA since, in the event of a requirement to operate from a 'half aperture reserve antenna', the ERP and coverage would be reduced, potentially, for a relatively long period. This would lead directly to an impact on the SLA.

The chart below shows an indicative timeline related to works at a main station where temporary mast and antennas can be avoided.

**Single Mast Approach - indicative timetable**

Upper 50 Sites: Single Mast Solution	2013	2014	2015	2016 Year 1	2017 Year 2	2018 Year 3	2019 Year 4
Design & Planning				█			
Split Reserve Antenna					█		
Replace Cantilever					█		
Replace Reserve: Half A						█	
Clearance						★	
Replace Reserve: Half B							█

The requirement, feasibility and/or suitability of either the Dual Mast or Single Mast approach at a given site shall depend upon the particular circumstances of that site i.e. feasibility of providing temporary mast (Dual Mast approach), the population served, potential service impact in the event of a power reduction (Single Mast approach), potential duration of 'risk period' (where service might suffer degradation, Single Mast approach).

The Single Mast approach relies on the installation/availability of cantilever antennas which can operate across the UHF band (channel 21 to 60). In the event that an antenna cannot be designed to meet the specific requirements of a given site, then it may not be possible to implement the Single Mast approach at such a site and temporary mast and antenna systems (the Dual Mast Solution) would be unavoidable.

Analysis shall have to take place on a site-by-site basis and issues, implementation options and potential impact on services shall need to be reviewed and agreed with multiplex operators.

**The Reduced SLA Solution**

The 'Standard SLA Solution' relies on the provision the 'Dual Mast Approach' at all sites where antenna replacements are required. In the event that provision of a temporary mast is not feasible, the 'Single Mast Approach' will be considered as a compromise on a site-by-site basis.

If a 'Single Mast Approach', with the requirements for a broadband antenna systems and compromised reserve antenna capability, is considered acceptable then its deployment might be considered on a wider basis. In the event that the Multiplex Operators were prepared to accept a 'Single Mast Approach' in order to avoid Dual Masts wherever possible, then this would result in a 'Reduced SLA Solution'. It should be noted that this is a purely hypothetical situation at present and subject to further rigorous analysis and debate.

For indicative purposes only, Arqiva has considered the costs of such a 'Reduced SLA Solution' where the Single Mast approach would take place on as many sites as possible. Where the risk/impact to service is considered too great at a particular site, then the Dual Mast solution would be required.

Whilst the Reduced SLA solution would avoid the deployment of temporary masts, there would be a degree of compromise in the SLA at such sites. Until such time that issues have been analysed and assessed on a site-by-site basis, the feasibility or otherwise of the

Reduced SLA solution cannot be confirmed. The protection of service is of paramount importance to Multiplex Operators. As a result it is recommended that the Standard SLA solution should be used as the basis of any CBA.

Scope Element	Standard SLA Solution	Reduced SLA Solution
Main Station (U50) Antennas	At the Upper 50 sites, temporary masts and antenna systems would be required to implement minimal SLA impact when antenna replacements are required.	Alternative options include the provision of 'Broadband Cantilevers' and 'Half Aperture Reserves' to remove the need for temporary masts and antennas as far as possible (-3dB impact)
Main Station (L32) Antennas	At the Lower 32 sites; single day replacement with the provision of a 'fall back antenna' to allow service to be maintained in the event of unforeseen circumstances impacting the replacement. It was agreed that some flexibility should be assumed in respect of the Clearance Date to allow implementation to be planned for a 'Clear Weather Window'. It should be noted that one site has been assumed to require a Temporary Mast. It is the only Lower 32 site with a temporary mast.	No change from Standard SLA Solution. It should be noted that, in the Reduced Scope solution, one site has been assumed to require a Temporary Mast.
Main Station (U50) Combiners (when 2 or less channels impacted)	Additional Combiner modules will be added to Combiner Chains (as Channel 61/62 Clearance)	No change from Standard SLA Solution
Main Station (U50) Combiners (when 3 or more channels impacted)	Temporary Combiner chains will be provided and the existing combiner modules re-tuned.	No change from Standard SLA Solution
Main Station Transmitters (U50)	Main Station Transmitter systems shall be 'retuned in situ'. Temporary Transmitter Systems (Transportables) shall be required to allow existing transmitter systems to be taken offline. Temporary Transmitters to be grouped and containerised.	No change from Standard SLA Solution

Scope Element	Standard SLA Solution	Reduced SLA Solution
Main Stations (L32)	Transportable transmitter and combiner systems in order to maintain service.	No change from Standard SLA Solution
COM DVB-T2 Conversion	Installation of DVB-T / T2 modulators into permanent transmitter systems at 80 sites for 3 COM multiplexes ahead of the Clearance Event.	No change from Standard SLA Solution
COM SFN	Installation of GPS receivers, T2 Gateways and Transport Stream Analysers.	No change from Standard SLA Solution
PSB SFN	Installation of the GPS receivers, line feeds to replace RBL back up, installation of T2 Gateways.	No change from Standard SLA Solution
Service Continuity	Allowance only at this stage until the full scope of antenna works is defined and individual site assessment can be carried out.	No change from Standard SLA Solution
Transition and Consequential Works	Allowance only at this stage until the spectrum plan and roll-out order is further defined.	No change from Standard SLA Solution
Relays	All sites will need to be visited on day of any main station channel changes. Relays which are associated with Main Stations which are not changing frequency are also factored into the plan.	No change from Standard SLA Solution

The 700MHz Clearance Programme 'High Level Estimate' is made up of the following elements:

- Main station antenna works, including temporary masts and antennas.
- Main station groundworks (civils, power, system integration and RF feeders)
- Main station temporary transmitters (transportables)
- Main station temporary combiners
- Relays – transmit antennas; RBL antennas and site modification works
- Service continuity provision
- Transition issues and consequential works
- Other scope (Legal fees; IT development; Test equipment logistics; On-site security)
- Design assessment costs (Antenna assessments – helitests, modelling and works tests)

- Arqiva Commercial & Finance and Technical Labour

The key estimate assumptions are:

- All figures are presented in 2013 prices and are subject to annual RPI indexation.
- The Ofcom grant application, reconciliation and reporting requirements are the same as 800MHz Clearance
- No DUK/Broadcaster/Ofcom or Consumer costs are included.
- The cost estimate is based on comparison of the likely 700MHz scope to the actual costs incurred for similar work on DSO and 800MHz Clearance.

Reduced SLA Solution	Total (£M)
SINGLE HOP	310
PSB MFN COM SFN	360

*NB. All figures are presented in 2013 real prices and are subject to annual RPI indexation.*

Other costs would arise in respect of Local TV and the T2 delta as for the 'Standard SLA Solution'.

### 13 Recommendation for Preparation Works

#### 13.1 Technical and Programme

In order to increase the likelihood of achieving the delivery timetable contemplated herein, Arqiva makes the following recommendations for further work::

- **Development of a 700MHz Clearance Engineering Principles document(s)**

A key lesson learned from the 800MHz Clearance programme was that the agreement of Engineering Principles at the start of the programme with Multiplex Operators facilitated a smoother approval process for the site designs. The high level engineering principles underpinned the site specific modification documents that followed through the design phase and minimised variations in terms of methodology. If there were deviations from the principles then these were highlighted at the design document presentation with the Multiplex Operators.

Engineering Principles document(s) are envisaged which would cover the following areas as a minimum: antenna design and implementation; combiner module installation and retunes; transmitter retuning; telemetry and service reporting considerations. These considerations would include the impact on SLA and redundancy at each step of the implementation process and would need signing-off by the Multiplex Operators prior to proceeding with site-by-site design.

Engineering Principles document(s) would be required in respect of Main Stations and Relays station modifications.

#### - **Antenna Assessment**

Antenna Analysis will need to be carried out involving the original supplier. Discussion of those results with Multiplex Operators will need to take place as soon as possible to scope the minimum requirements of any 700 MHz Clearance antenna modification process.

The following steps are proposed:

- **Existing antennas**

- i) Consult with antenna suppliers to obtain information relating to existing antennas. Such work to include; antenna gains and return loss issues at new channels and the half antenna capability of antennas.
- ii) Collate all of the data (including existing works test/ Helicopter tests) and publish a draft Initial Pattern Assessment (IPA).

The IPA would include proposals related to the potential replacement or modification of existing antennas.

Post-Clearance coverage assessments shall also be required at some point to be agreed based upon then existing frequency assumptions.

- **New Replacement Antennas**

- i) It is recommended that more detailed discussions commence with suppliers and installers as soon as possible to scope the scale and potential duration of a 700MHz antenna replacement programme. This would be based on the antenna assessments herein and would be refined over time as the plan matures and more detailed analysis takes place.
- ii) More detailed feasibility studies in respect of the provision of 'Broadband Antenna Systems' are also recommended to commence as soon as possible to better understand available options.

#### - **Service Continuity**

As part of the site specific antenna assessments, the potential impact on other services needs to be reviewed to give a better indication of service continuity requirements and highlight any particular planned works issues. This will help to start early discussions with radio and other customers to determine the likelihood of obtaining planned works approval. If there are difficulties then alternate solutions can be developed.

During the 2014 feasibility study, it may be possible to identify work which could commence in 2015 to facilitate a 700 MHz Clearance Programme. This work can proceed in advance of a frequency plan being available by focussing efforts on stations currently operating in the 700 MHz band.

#### - **Planning and Land Acquisition Assessment**

Activities need to commence at any sites which could require a temporary mast to allow the possibility of Clearance Events taking place in 2019. This work would focus on the design requirements of the temporary mast and antennas, which would be designed to the current frequencies, in order to allow the site acquisition and Local Authority Planning process to start in 2015.

In parallel to the antenna assessment it is proposed to carry out desktop assessments of the likely planning and land acquisition issues that will be encountered with proposed temporary mast and antenna systems. This information will assist in making informed decisions about the likely antenna solution at sites.

The following priority would be followed:

Priority 1: The sites where antenna replacement is expected to be required leading to the provision of a temporary mast.

Priority 2: Remaining Main Stations where frequency changes will take place but an antenna replacement requirement has not been identified at this time. Such sites may require antenna replacement in the event of detailed antenna analysis and, as a result, the possibility of a Dual Mast solution exists.

Priority 3: Remaining Main Stations where there is NO frequency change under the current frequency plans and, as a result, the possibility of antenna replacement requirement has not been considered. Since no frequency plan has been ratified or agreed and is subject to International Co-Ordination the possibility of frequency modification at all main stations remains. Such sites may require antenna replacement in the event of detailed antenna analysis and, as a result, the possibility of a Dual Mast solution exists.

#### - **Structural Assessment**

In parallel to the antenna assessment it is proposed to carry out desktop assessments of the structural impact of the proposed antenna solutions. This includes the replacement or modification works of the existing permanent antenna and potential temporary antennas on existing masts.

#### - **Site Modification Works**

Based on the recent experience on DSO and 800 MHz Clearance it is proposed to carry out desktop site modification design work. The main focus of this work would be to check whether there is sufficient space available on sites to house the containers required for the transportables and temporary combiners.

#### - **Site High Voltage (HV) Power Supply**

In the HLE it has been assumed that the HV power supply to site has sufficient capacity to support the 700MHz Clearance Programme. This is a reasonable assumption and major upgrade works by the Regional Electricity Companies (REC) are not expected to be required. However, an assessment should be carried out as the time and costs associated with REC works could be significant.

#### - **Transportable Specification**

The proposal for transportables on 700MHz Clearance is not the same as implemented on 800MHz Clearance, i.e. not like-for-like architecture. This proposal needs further investigation with suppliers to validate the assumptions and develop a reliable transmission system that gives the Multiplex Operators confidence in the proposal; this can then form part of the Engineering Principles document.

### - **Local TV and New HD Multiplexes**

It is not possible to predict with certainty the impact on Local TV until the spectrum plan is more mature., The impact on the New HD Multiplexes can be further assessed to determine if there are any additional costs required to maintain the New HD Multiplex services as a result of any proposed antenna modification or replacement proposals.

### - **DVB T2 Transition**

An early decision on adoption of DVB-T2 would allow Arqiva to engage with suppliers. This would also allow efficient scoping and design of a combined Clearance and DVB-T2 conversion programme by defining requirements at an early stage.

In the event that the PSBs are required to adopt DVB-T2, there are a number of issues which need further consideration relating to the use of SFNs for the relays. Arqiva would recommend that work takes place as soon as possible to investigate issues and potential solutions related to the provision of SFN T2 networks.

## **13.2 Resource and Programme Considerations**

Based on the antenna and temporary mast assessment, the contractor resource capacity can be reviewed with key suppliers to better detail the implementation works and overall programme duration. The additional information will give a better view of the programme critical path and key focus sites which are complex in nature.

The recommendations for early works are on the basis that antenna installation programmes can take 4 years to complete where a temporary mast is required, and therefore would need to be progressed in 2015 to allow Clearance Events in 2019. If this work is delayed until a formal decision to proceed with 700 MHz Clearance is provided, there will be a subsequent delay to the actual Clearance of spectrum if temporary masts are required.

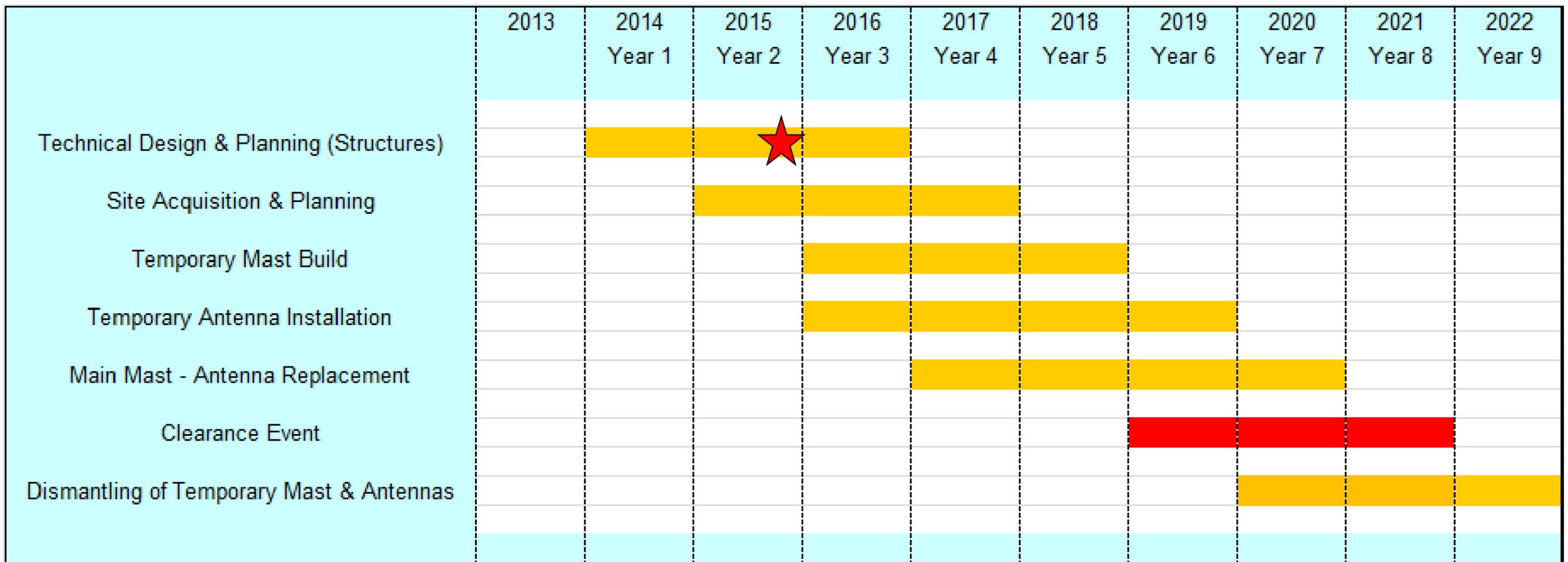
## **13.3 Commercial**

Arqiva has assumed the commercial arrangements are similar to those deployed for the 800MHz Clearance programme. In particular, it has been assumed that there will be a similar Grant Approval process, with similar reporting and reconciliation requirements. We recommend that the detailed scope for these activities is agreed in order that we may better estimate the Commercial and Finance labour element of this HLE.

## **14 Caveats and Assumptions**

Technical caveats and assumptions can be found in Appendix B and will be used as an action list through the development of the 700MHz Clearance Programme. Any changes in these underlying assumptions will have an impact on the scope, duration and cost of the programme.

Appendix A – Indicative Overall Programme Plan



 Indicates expected date of availability of Frequency Plan (Main Stations).

**Appendix B – Technical Caveats and Assumptions**

Title	Issue	Potential Consequences
<b>700MHz Clearance</b>		
International Co-Ordination	International Co-Ordination is yet to be agreed / finalised. The co-ordination requirement may lead to an impact and/or revision of the frequency plan or the adoption of an alternative plan.	Alterations to the Frequency Plan could lead to a direct impact on the antennas and a change in the required scope of antenna works. This would lead to a change in the scope, duration and cost of works.
Frequency Plan	Assessment of the frequency plans under consideration herein may lead to issues which could result in the adoption of an alternative Frequency Plan.  It has been assumed that Frequency Plan lockdown would occur (to the extent required) in 2015 to allow antenna designs to be finalised from January 2016.	Alterations to the Frequency Plan could lead to a direct impact on the antennas and a change in the required scope of antenna works. This would lead to a change in the scope, duration and cost of works.
Rollout Order	A notional sequence and station order has been assumed.	Alteration/refinement of the rollout order will vary the potential levels of interference between sites and lead to consequential works. Changes in the sequence/dates will lead to a change in the transportable transmitter requirements and the labour resource profile.
Clearance Dates	Flexibility has been assumed in respect of Clearance dates to allow some scope for movement in the event of any implementation issues. This shall also be required in respect of the replacement Lower 32 antenna systems (where a single day antenna replacement at Clearance shall be required). Clearance events may have to be delayed in the event of inclement weather to allow such antenna replacements to take place.	In the event that Clearance date flexibility is not available then additional provisions shall need to be made to maximise the likelihood of achieving Clearance at a given (fixed) date.
Pace of Clearance Events	A Clearance event has been assumed every two weeks with suspension around major sporting events and the winter months.	Any variation in the pace of Clearance works shall have a direct impact on the number of transportables required and the labour resource profile.
Clearance Switch-Over Assumption	It has been assumed that main stations and their associated relays would undergo Clearance (and T2 Transition if applicable) on the same date. The Clearance programme would be a series of 'main station and associated relays' events.	Any requirement for an alternative method of implementation would require a review of the proposed methodology and associated costs.
Antenna Impact	Antenna modification requirements are based upon a desktop assessment of antenna performance against the Single Hop & PSB MFB COM SFN Frequency Plans.	Detailed antenna assessment may identify additional antenna modification requirements. The scope of antenna works (number of antennas requiring modification) shall have a direct impact on the scope and scale of 700MHz Clearance Programme.
Dual Mast Solution	Implementation of the Dual Mast solution at a site shall require the provision of a Temporary Mast and, therefore, shall rely on acquisition of land and planning permission.	It may not be possible to secure additional land and/or planning permission at certain site and, as a result, it may not be possible to implement a Dual Mast solution at such sites. Under such circumstances a revised solution (impacting the costs and duration of the programme) would be required.
Sites where Temporary Masts may be required.	Under the Standard SLA solution all sites (where antenna works are required) would be provided with a temporary mast. As stated above the feasibility of providing such a temporary structure at any site is to be confirmed.	The current provisional frequency plans have allowed sites to be identified where frequency changes would occur. This has been used as the basis of the analysis to identify antennas which might need replacing. Changes to the plans (or adoption of an alternative plan) would change the fundamental base of the antenna analysis and, as a result, the feasibility or otherwise of providing a temporary structure is recommended to take place at all main station sites.  The following priority would be followed:  Priority 1: The sites where the requirement to replace an antenna has been

Title	Issue	Potential Consequences
		<p>identified (leading to the provision of a temporary structure).</p> <p>Priority 2: Remaining Main Stations where frequency changes will take place but an antenna replacement requirement has not been identified at this time. Such sites may require antenna replacement in the event of detailed antenna analysis and, as a result, the possibility of a Dual Mast solution exists.</p> <p>Priority 3: Remaining Main Stations where there is NO frequency change under the current frequency plans and, as a result, the possibility of antenna replacement requirement has not been considered. Since no frequency plan has been ratified or agreed and is subject to International Co-Ordination the possibility of frequency modification at all main stations remains. Such sites may require antenna replacement in the event of detailed antenna analysis and, as a result, the possibility of a Dual Mast solution exists.</p>
Broadband Cantilever Transmit Antennas	These may be required to simplify antenna replacement. The feasibility or otherwise of the implementation of a Broadband Transmit antenna shall depend upon specific requirements of the frequency plan and restrictions at a given site.	In the event that a Broadband (Cantilever) Antenna is not feasible then alternative implementation solutions may need to be identified (to be confirmed).
Antenna Power Testing	Power testing shall be required for new antenna systems prior to use. It has been assumed that existing in service transmitter systems would be used to power test such systems. Under certain circumstances this could lead to a loss of service which would need to be authorised by Multiplex Operators (such testing would take place overnight). No additional transportable transmitter systems have been included herein in respect of power testing.	Any requirement for an alternative method of implementation would require a review of the proposed methodology and associated costs.
Transmitter Size	Changes in the Frequency Plan and antenna subsystems may result in alterations in the required transmitter power. It has been assumed that such changes shall be minor and fall within the operating range of installed transmitters.	Should modifications be required to the size of transmitters, this shall have a knock on impact on accommodation and power systems. This shall be addressed in the detailed design phase.
Temporary Transmitters (Quantity)	The number of Temporary Transmitters is based on the requirements of the Rollout Plan which is subject to review.	Any change in the Rollout Plan may lead to a change in the number of Transportables required with an associated impact on cost.
Combiner Modifications	Where three or more RF channels are to be Cleared at a certain site, transportable combiners would be deployed and the primary systems would be re-tuned.	The number of transportable combiner units shall be subject to review.
Relay Modifications	In the absence of a frequency plan for the relays, it has been assumed that frequency modifications shall be required at all relay stations.	The scale and scope of such modifications shall be subject to review.
RBL Analysis	RBL Analysis shall be required to consider the performance of RBL paths from main stations to relays.	RBL Analysis shall be required to assess the quality of RBL performance. The impact on relay sites (and any requirement for re-transmitters) shall be subject to review.
Telecom Links	This HLE has assumed no change in telecom or SHF link requirements.	The scale and scope of such modifications shall be subject to review.
Local TV	The Local TV costs provided herein should be treated as order of magnitude only and shall be subject to review. Impact on the network configuration and distribution network has not been considered.	The scale and scope of the Local TV re-engineering project shall be subject to the details of the new frequency plan, and confirmation of the transmission mode (DVB-T or DVB-T2).