

700 MHz REPURPOSING COST COMPENSATION

Non-confidential report for ComReg

15 December 2016



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EXECUTIVE SUMMARY

The Commission for Communications Regulation (“ComReg”) has engaged Frontier Economics (“Frontier”) to conduct a fully reasoned analysis and assessment of the efficiently incurred capital and operational costs which 2rn, and ultimately RTÉ¹, would incur as a result of migrating DTT from the 700 MHz band. This will form the basis of an estimate of the compensation that RTÉ could recover as a result of incurring costs in the 700 MHz migration.

Frontier’s proposed methodology for estimating costs is designed to identify the net costs that are incurred as a result of migration, taking into account that in the coming years some investment in RTÉ’s network would be made regardless of the migration. Therefore the appropriate method should provide sufficient compensation such that RTÉ is indifferent between migrating from the 700 MHz band (with compensation) and staying in the band (without compensation). In addition, ComReg also wishes to ensure that current tariffs in the Broadcasting Markets A² and B³, are not altered by the impact of additional costs imposed as a result of migration.

In making our assessment of the costs of 700 MHz migration, we have examined in detail the strategy chosen by 2rn to migrate its services from the 700 MHz band, to assess whether that strategy is reasonable and proportionate. Our assessment has then examined the estimated costs of implementing the strategy. As there is an inevitable degree of uncertainty over the precise level of costs that would be incurred, we understand that ComReg proposes that the actual compensation paid should reflect reasonable costs actually incurred. As such, the estimates presented in this report do not reflect the final agreed amount of compensation that could be paid.

2rn has proposed a migration strategy based on simulcast of the old and the new frequencies for a time period, indicatively four to six months, to allow the gradual migration of households who might face some reception issues with aerials when retuning the TV channels. Such a period of simulcast will allow these viewers (who generally may have poorly installed grouped aerials, or grouped aerials at the margins of the reception area) sufficient time to test whether their aerials are sufficient to continue to receive a signal, post migration, and make any necessary adjustments. If there is no simulcast, and if migration occurs overnight, many of these households may find that they are unable to receive their TV service until they have made the necessary changes to their TV antennas. Ultimately there is a risk that some may even churn from the DTT platform as a result.

¹ RTÉ is Ireland’s national public service broadcaster for television and radio. 2RN is a wholly-owned subsidiary company of RTÉ though it operates independently of RTÉ and fully at commercial arms’ length. 2RN built and operates a communication network in Ireland and has a substantial portfolio of developed sites and in house engineering, planning, construction resources and capabilities. The costs at issue would initially be incurred by 2RN but would ultimately be borne by RTÉ.

² Market A is describes as wholesale access to national terrestrial broadcast transmission services in which 2rn is designated as having SMP.

³ Market B is described as wholesale access to DTT (Digital Terrestrial Television) Multiplexing Services in which RTÉ is designated as having SMP.

There is a degree of uncertainty over the precise number of households affected by grouped aeriels. 2rn estimates that around 50,000 households in total could be affected, whereas Frontier estimates that the number is around 2,500 – 9,500 DTT only households, and a further 6,600 – 25,100 households with DTT as a secondary reception technology. However, we note that these households are disproportionately likely to include the more vulnerable groups such as single occupancy households with elderly people.

We estimate that the incremental costs incurred by 2rn as a result of 700 MHz migration could amount to between:

- €8.6 million assuming simulcast; and
- €4.6 million assuming no simulcast.

However, there is a degree of uncertainty in the estimates of costs of no simulcast (or a more limited simulcast). In particular, other costs (in addition to those set out in this report) may be incurred in a “no simulcast” migration which could include: more costly engineering resources (to accommodate night time migration); greater support for households who have to change antenna equipment; and greater information costs to inform and assist viewers (which 2rn could amount to up to around €1.8m). Inevitably, even with these mitigation measures, some viewers who have to change their equipment may lose signal and choose to churn from the DTT platform (which in turn would impose costs on broadcasters).

Our estimate of €8.6 million (assuming simulcast) contrasts to the total cost of 700 MHz migration, forecasted by 2rn to be €[~~8.6~~] (assuming simulcast). The difference between the two estimates relates to the fact that where 700 MHz migration would cause some investments to be brought forward, we assume that only those costs that would not be recovered from the tariff model would be compensated. In addition, the mark ups for Non-Recoverable VAT and Contingency are different. Finally, we considered it more appropriate to compensate for stranded assets through tariffs whereas 2rn had assumed that recovery of stranded assets would be through the compensation mechanism.

1 INTRODUCTION

The Commission for Communications Regulation (“ComReg”) has engaged Frontier Economics (“Frontier”) to conduct a fully reasoned analysis and assessment of the efficiently incurred capital and operational costs which 2rn, and ultimately RTÉ⁴, would incur as a result of migrating DTT from the 700 MHz band. This will form the basis of an estimate of the compensation that RTÉ could recover as a result of incurring costs in the 700 MHz migration.

The cost compensation methodology summarised in section 2 is designed to provide compensation to RTÉ for migrating from the 700 MHz band such that it is indifferent between remaining in the band (with no compensation), and migrating from the band (with compensation). This will mean that 2rn’s customers will not face higher costs as a result of the migration.

In assessing the appropriate methodology for estimating compensation Frontier is mindful of the need to develop an approach which is consistent with compensation offered under State Aid laws.

This is the non-confidential version of the report where information that is confidential to 2rn is redacted and marked with “[X]”.

1.1 The market and policy context to the report

Frontier Economics previously prepared for ComReg a report setting out an analysis of the costs and benefits of 700 MHz spectrum being repurposed for the provision of wireless mobile broadband services. ComReg published this report by Frontier in June 2015⁵ and it then formed an input into ComReg’s radio spectrum management strategy, published in June 2016.

That spectrum management strategy noted that Ireland’s migration activities in relation to the 700 MHz band are indicatively planned for 2019/20. However, ComReg stated that it intended to engage actively with relevant stakeholders before this point to progress the repurposing of the 700 MHz band, in order to obtain clarity on its timing and availability.

The migration from the 700 MHz band by existing DTT users will mean that they will incur costs that they would not otherwise incur, if the band was not repurposed.

In line with international practice, the Irish Government may compensate existing users for their migration costs. For example, the Radio Spectrum Policy Programme (RSPP) Decision of 2012 (in relation to the repurposing of 800 MHz spectrum) sets out that Member States:

⁴ RTÉ is Ireland’s national public service broadcaster for television and radio. 2RN is a wholly-owned subsidiary company of RTÉ though it operates independently of RTÉ and fully at commercial arms’ length. 2RN built and operates a communication network in Ireland and has a substantial portfolio of developed sites and in house engineering, planning, construction resources and capabilities. The costs at issue would initially be incurred by 2RN but would ultimately be borne by RTÉ.

⁵ See: The 700 MHz radio frequency band Results of the Cost Benefit Analysis (CBA) of a change in use of the 700 MHz radio frequency band in Ireland 30 June 2015, ComReg 15/62, ComReg 15/62a and ComReg 15/62b

- *should be allowed, where appropriate, to introduce compensatory measures relating to migration costs (recital 18);*
- *[...] where appropriate and in conformity with Union law, ensure that the direct cost of migration or repurposing of spectrum usage is adequately compensated in accordance with national law (article 6 (5)).*⁶

Although the digital dividend (resulting from the repurposing of the 800 MHz band) forms the context of these statements, the principles as laid out in the RSPP decision would equally appear applicable to any repurposing of the 700 MHz band.

ComReg committed to engaging with all relevant stakeholders, including the Department of Communications, Energy and Natural Resources (now the Department of Communications, Climate Action and the Environment (“DCCAÉ”)) the incumbent DTT service provider (RTÉ) and the DTT transmission network operator (2rn) on the appropriate compensation.

As a consequence of this, ComReg has received a request for assistance from the DCCAÉ to assist the DCCAÉ in its work in respect of a cost recovery mechanism to be applied to expenditure on the DTT transmission network relating to 700 MHz migration.

In a recent statement on the 2017 budget, the Minister for Communications, Climate Action and Environment, Denis Naughten, noted that €8m of budget was allocated to facilitate the reallocation of the 700 MHz spectrum away from TV broadcasting to support broadband and mobile telephony plans in rural areas⁷.

In assessing the costs of 700 MHz migration, we examined in detail the strategy chosen by 2rn to migrate its services from the 700 MHz band, to assess whether that strategy is reasonable and proportionate. We also examined the estimated costs of implementing the strategy. As there is an inevitable degree of uncertainty over estimating the precise level of costs that would be incurred, we understand that ComReg proposes that the actual compensation, that will eventually be paid, should reflect the reasonable costs that will actually be incurred. As such, the estimates presented in this report do not reflect the final agreed amount of compensation that could be paid.

1.2 Report structure

The remainder of this report is set out as follows.

- Section 2 describes the cost compensation methodology
- Section 3 assesses the migration strategy chosen by 2rn to determine whether it is reasonable and proportionate
- Section 4 assesses whether the estimated costs of implementing 2rn’s migration strategy are reasonable and proportionate

⁶ See: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012D0243>

⁷ See: <http://www.dccae.gov.ie/news-and-media/en-ie/Pages/PressRelease/Budget-2017-Statement-by-Minister-for-Communications,-Climate-Action-and-Environment-Denis-Naughten.aspx>

- Section 5 provides the results of our analysis and sets a range for the likely reasonable and proportionate compensation to be provided to RTÉ / 2m to ensure that incremental costs as a result of migration are met.

There are two annexes. Annex A provides more information on the likely impact of the use of grouped aerals on migration. ANNEX B provides a detailed breakdown of estimated costs of migration under different scenarios.

2 COST COMPENSATION METHODOLOGY

In this section, we set out our method for determining the appropriate level of compensation to cover the efficiently incurred capital and operational costs which 2rn, and ultimately RTÉ, would incur as a result of migrating Digital Terrestrial Television (DTT) from the 700 MHz band. This method is designed to identify the net costs that would be incurred as a result of 700 MHz migration, taking into account that in the coming years some investment in the DTT network would be made regardless of the migration. Therefore, the appropriate method should provide sufficient compensation such that RTÉ is indifferent between migrating from the 700 MHz band (with compensation) and staying in the band (without compensation).

2.1 Description of methodology

Repurposing the 700 MHz band will require that current DTT users migrate from the band. As a result of this required migration, these users are likely to incur costs that they would not otherwise incur. The current users include 2rn, a DTT service provider. ComReg intends to compensate RTÉ for the costs that 2rn would incur, as those costs would flow through to RTÉ.

In developing our method for determining the appropriate level of compensation, we sought to ensure that the amount payable would leave 2rn indifferent between migration and the counterfactual of no migration. In addition, ComReg also wishes to ensure that current tariffs in the Broadcasting Markets A⁸ and B⁹ would not be not altered by the impact of the additional costs of 700 MHz migration.

We have therefore designed an approach which would compensate RTÉ for the reasonable costs which it would ultimately incur as a result of 700 MHz migration, depending on whether:

- the cost is exclusively a direct result of migration (i.e. it would never have been incurred absent migration), in which case costs are fully compensated; or
- 2rn has to bring forward investments it otherwise would have made at a later time (i.e. once its existing assets became fully depreciated), in which case the compensation covers the costs incurred by 2rn in making this investment earlier than would otherwise be necessary.
- The value related to the existing assets which become stranded will continue to be recovered from the tariff model (as if the migration had not taken place), until the existing assets would have been fully depreciated. This is to ensure that existing tariffs in Market A and B are not affected by the migration.

This method is applied to the following cost categories:

⁸ Market A is describes as wholesale access to national terrestrial broadcast transmission services in which 2rn is designated as having SMP.

⁹ Market B is described as wholesale access to DTT (Digital Terrestrial Television) Multiplexing Services in which RTÉ is designated as having SMP.

- Transmission equipment
- Antennas and structures
- Network and distribution
- Project and resourcing

A contingency rate of 15% is applied to the sum of these migration costs to cover uncertainties and unforeseeable elements. To derive the total recommended compensation, non-recoverable VAT (NRV) is included at a rate of 13.34% and in the event that 2rn should engage in simulcast¹⁰, associated costs are eligible to be compensated.

While the methodology in this section describes the approach to forecasting the economic costs that 2rn would incur as a result of the migration, we note that, inevitably, the *actual* costs that are eventually incurred may be different. Amongst other things, the actual costs figure will be dependent on the outcome of a competitive tender process to be conducted by 2rn, for the provision of the required equipment and related services. Therefore, ComReg proposes to phase the compensation payments to reflect the phased incurrences of the costs. This means that a final balancing payment should ensure that RTÉ is not over-compensated. This is explained in section 5.4.

Frontier notes that the costs at issue would initially be incurred by 2rn, the DTT network operator, but that those costs would flow through to and would ultimately be incurred by RTÉ, the DTT service provider. The compensation at issue would therefore be paid to RTÉ, and not to 2rn. This report was prepared on this understanding and all sections herein should be interpreted as such, even where the entity referred to is 2rn.

2.1.1 Costs which are exclusively a direct result of migration

Following the methodology set out above, our estimate of the compensation payable assumes that full compensation is applied for incremental operating expenditures (opex) and capital expenditures (capex) that would result from 700 MHz migration, where these costs would never have been incurred absent such migration (i.e. the costs are a direct result of the migration).

For those costs, the compensation level is set equal to the forecast cost. The capex is compensated for the period of asset life for each piece of equipment. Following this point (when assets installed which are exclusively a direct result of migration reach the end of their asset life - i.e. from around 2030) we assume that asset costs will be recovered via tariffs.

The list of costs eligible for full compensation is provided in Figure 1.

¹⁰ Simulcast describes the simultaneous broadcasting of services on channels in both the 700 MHz band and in remainder of the UHF band below the 700 MHz band to which the services will migrate to. 2rn's rationale for the use of a simulcast is explained in section 3.2.

Figure 1 Fully compensated costs

Category	Compensation rationale	Items
Transmission Equipment	Costs eligible for full compensation where costs relate to new sites.	Transposers for new site, Transposer combiners for new site Combiner re-tuning
Antennas & Structures	Costs fully recompensed, as aerials are specific to the 700 band	Aerial replacement, Surveys (Structures and Cabins), Structural Strengthening, New site development (2 Sites), Antenna Modification & Retunes
Network & Distribution	Costs fully recompensed as costs relate to the migration (and would not have been incurred absent migration)	Fibre links to distribution network for resilience, SFN Configuration, RBR Backup Network, Off-air Feeds/Antennas/Filters/Re-Transmitters
Project & Resourcing	Costs fully recompensed as costs relate to the migration (and would not have been incurred absent migration)	Information for local switchovers, Consultant Project Management, Site Rigging and Engineering, Project Engineers, Frequency Planning and Reception Investigation, Environmental, Health and Safety

Source: Frontier

2.1.2 Costs relating to the early replacement of assets

If we assume that 700 MHz migration would take place using simulcast, then this would require the *early* replacement of some of 2rn's assets, primarily transmitters or transposers. We assume that it would be reasonable to compensate for the economic cost of having to bring forward investment in these assets. However, because 2rn would, in any event, have incurred costs in having to replace these assets (once they had reached the end of their economic life) it would not be appropriate to compensate for the full value of these assets. To do so would result in over-compensation. Instead, we calculate the appropriate level of compensation as the shortfall between (a) the investment costs, and (b) the allowed revenues recovered in relation to the asset (from the tariff model). Given that we have imposed the constraint that current tariffs should not be affected by the 700 MHz migration, we assume that those tariffs will continue to be based on existing assets until those assets have reached the end of their asset life (in 2025). From that point in time, 2rn would begin recovering its investment costs incurred from 700 MHz migration, from the tariff.

Therefore, the compensation payable for early replacement of assets is the cost of those assets at installation (we assume 2018) minus the expected revenues associated with those assets (from 2025 until the end of the assets' lives).

In summary:

- costs are to be compensated over a proportion of the asset life only (i.e. the proportion of value which reflects the period after installation (2018) up to when assets would have been replaced (2025)); and
- the tariff model is constructed such that allowed revenues are based on the weighted average cost of capital (WACC, 8.11%) applied to the NBV of the capital employed. Plus the depreciation charge in each year. The NBV declines at a constant rate of depreciation over the asset life (13.33 years for DTT equipment).

Following 2025 (the years in which 2rn would replace its existing assets if there had been no 700 MHz migration) 2rn will recover the remainder of the value of its assets from the tariff model, in the normal way and until the assets reach the end of their useful life.

Compensation for costs related to the early replacement of assets is equal to the net present value of the sum of:

- accumulated depreciation between when the assets were installed and when existing assets would have fully depreciated; and,
- allowed return on capital employed between when the assets were installed and when existing assets would have fully depreciated.

More specifically, the compensation level is calculated using the following equation:

$$\text{net present value of compensation} = \sum_{i=1}^N \frac{P_i}{(1 + wacc)^{t_i}} \quad (1)$$

where:

- P_i is payment i in the schedule of annual depreciation in year i plus return on capital employed in year i
- $wacc$ is the weighted average cost of capital
- i is equal to the payment number
- N is equal to the total number of payments
- t_i is the year of payment (i.e. the number of years after asset installation up to when the existing assets would have been fully depreciated)

Migration is assumed to take place in 2018 and 2rn is assumed to incur all investment costs in at the start of that year.

3 ANALYSIS OF 2rn's MIGRATION STRATEGY

2rn has proposed a 700 MHz migration strategy based on simulcast of the old and the new frequencies for a time period, indicatively four to six months. This would allow the gradual migration of households that might face some reception issues with aerials when retuning TV channels. Such a period of simulcast would allow these households (who generally may have poorly installed grouped aerials, or grouped aerials at the margins of the reception area) sufficient time to test whether their aerials are sufficient to continue to receive a signal, post migration, and to make any necessary adjustments.

In this section:

- we first consider the impact of poorly installed grouped aerials on reception in Ireland, and the implications on 700 MHz migration; and
- we then consider the rationale for the key investment decisions relating to 700 MHz migration.

For each we have assessed 2rn's view and then considered this in developing the appropriate compensation estimate.

3.1 The impact of poorly installed grouped aerials on reception in Ireland, and the implications on migration

UHF TV reception aerials can be classified as "grouped aerials" or "wideband aerials". Grouped aerials are optimised to receive signals from a specific narrow frequency range, whereas wideband aerials receive all UHF TV channels¹¹.

The different antenna groups are provided below.

Figure 2 Different antenna groups

Aerial Group	UHF Channel	UHF Frequency
Group A	21 – 37	470 – 606 MHz
Group B	35 – 53	582 – 734 MHz
Group C/D	48 – 68	694 – 854 MHz
Group E	35 - 68	582 – 854 MHz
Group K	21 - 48	470 – 694 MHz
Group W (wideband)	21 - 68	470 – 854 MHz
Group T (wideband)	21 - 60	470 – 790 MHz

Source: Ofcom, "Consumer aerial survey. Implementing Ofcom's UHF Strategy", 2014

So, for example, a household using a band C/D antenna, optimised for reception of the 700/800 MHz band, will receive a weaker signal for a similar TV broadcast station transmitting on, for example, a group A frequency.

¹¹ The UHF band is divided into number of "channels" each of 8 MHz bandwidth.

This means that households using group C/D antennas, and which have marginal DTT reception at present, could lose their DTT reception altogether following a retune from the 700 MHz band to a lower frequency. This could happen because, unlike all other aerial groups, a C/D Group aerial is not optimised for frequencies below the 700 MHz band. The reduction in the signal received¹² would depend on the type of antenna used to receive DTT and how low the frequency of the new DTT signal is.

If all households have properly installed antennas, the marginal reception cases would only happen in the fringe coverage areas. However, in practice, there might also be some poorly installed antennas in coverage areas which otherwise receive a good signal (e.g. the antenna isn't properly aligned towards the broadcast station, cables are damaged, there are poor connectors, etc). As of today, these households would still be able to receive DTT, but after a frequency retune they would have a slightly weaker signal which could result in them no longer being able to receive DTT.

3.1.1 2rn's view

According to 2rn, 700 MHz migration will have the greatest impact on households with aerial group C/D aerials but will also impact some households with other aerial groups such as Group B aerials (described below)¹³. As group C/D aerials are optimised to receive a DTT signal which is transmitted in the 700 MHz band, after 700 MHz migration, group C/D aerials will therefore receive a weaker signal. Group B aerials will be out of band for some households.

The figure on the next page is a graphical and tabular representation, provided by 2rn, of the locations of households impacted, the number of households impacted, and the likely severity of the impact on the 98% of households covered by DTT/Saorview.

¹² Signal strength is measured in decibels (dB)

¹³ Aerial groups are aerials optimised for a specific sub-band of the UHF TV band. The C/D aerial group is optimised for the 700 MHz band but these aerials don't receive as well as for example the 500 MHz part of the band. So a change of frequency outside the sub-band for which the aerial group has been optimised results in reduced reception levels which potentially can impact the service.

need to upgrade their aerial installations (due to additional interference/ more concentrated use of spectrum).

- **Orange areas (slightly out of band):** All 180,000 households receiving DTT/ Saorview will require a re-scan. Of those, 2rn estimates that approximately 9,000 households will need to upgrade their Group B aerial installations (3 dB reduction in signal strength available at receiver(s)).
- **Red areas (further out of band):** All 230,000 households receiving DTT/ Saorview will require a re-scan. Of these, 2rn estimates that approximately 23,000 households will need to upgrade their Group C/D, Group B or Group E aerial installations (approximately 6–10 dB reduction in signal strength available at receiver(s)).
- **Blue areas (new transmission sites):** All 7,000 households in these areas should upgrade and/or redirect their aerial installation to receive DTT/Saorview from the new ‘best server’ transmission site. 2rn estimates that approximately 50% of this group, or approximately 3,500 households, will receive fringe coverage from overlapping sites and will choose not to change to the new transmission sites, or will only do so over a prolonged period of time.
- **White areas (no change):** Of the 450,000 households in this group receiving DTT/Saorview, 2rn estimates that approximately 9,000 households will need to upgrade their aerial installations and re-scan due to additional interference/ more concentrated use of spectrum. However, the majority of households in this group will not be affected and will not have to re-scan.

Figure 4 Summary of television households impacts 2rn estimate

Reception category	% (98% of households covered by DTT / Saorview)	Based on current growth rates, assumes two million households in the state by 2019	Based on current growth rates and assumes 50% of households will have DTT / Saorview	% of households requiring new antenna and or installation work	Number of households requiring new antenna / and or installation work
Yellow	11%	220,000	110,000	5%	5,500
Orange (Aerial group B)	18%	360,000	180,000	5%	9,000
Red (Aerial Group C/D)	23%	460,000	230,000	10%	23,000
Blue	0.7%	14,000	7,000	50%	3,500
White	45%	900,000	450,000	2%	9,000
Total	98%	1,954,000	977,000		50,000

Source: 2rn

Note: It is not possible to know the condition or orientation of each households’ antenna installation, therefore these are based on 2rn assumptions

3.1.2 Frontier comments

We have reviewed the information provided by 2rn to ensure it provides a sound basis for the estimate of reasonable compensation requirements.

The number of DTT households

The most recent ComReg statistics show that 187,000 households in Ireland (11.9% of total TV households (1,574,000)) depend on DTT for their primary TV service (see Figure 5 and Figure 6).

Figure 5 TV Households by Reception Method

Reception	July 2006 (000s)	May 2015 (000s)	July 2016 as % of Total TV Households	% Change May 2015 – July 2016
Irish Terrestrial	187	170	11.9%	+10.0%
Multi Total	1,387	1,413	88.1%	-1.8%
Analogue Cable/Sat	19	19	1.2%	0%
Digital Cable/Sat	1,368	1,394	86.9%	-1.9%
Total Cable/Sat	1,387	1,413	88.1%	-1.8%
Total TV Households	1,574	1,583	N/A	-0.6%

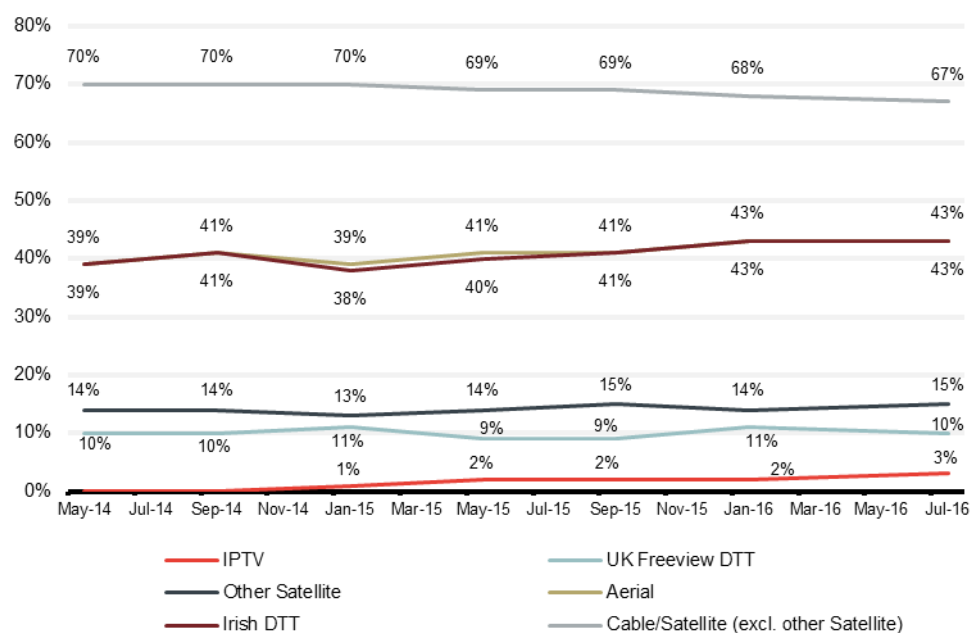
Reception: Reception type categories are hierarchically defined and mutually exclusive. A home is classified once within reception type and this is based upon the highest form of reception available within the home.

Multi-total: Made up of UK DTT/FTA Satellite, Cable, and SKY households.

Irish Terrestrial refers to households which only receive any or all of the following: RTÉ One, RTÉ Two, UTV Ireland, TV3, TG4, 3e, RTÉ One+1, RTÉ News Now, RTÉ jr via an aerial and a set-top box or an aerial and an integrated digital TV or via Saorsat.

Cable/Satellite: Includes UK DTT/FTA Satellite, Cable, IPTV and SKY households. SKY households based on the possession of SKY boxes, not on being SKY subscribers.

Source: ComReg, Irish Communications Market, Quarterly Key Data Report (R), Data as of Q2 2016

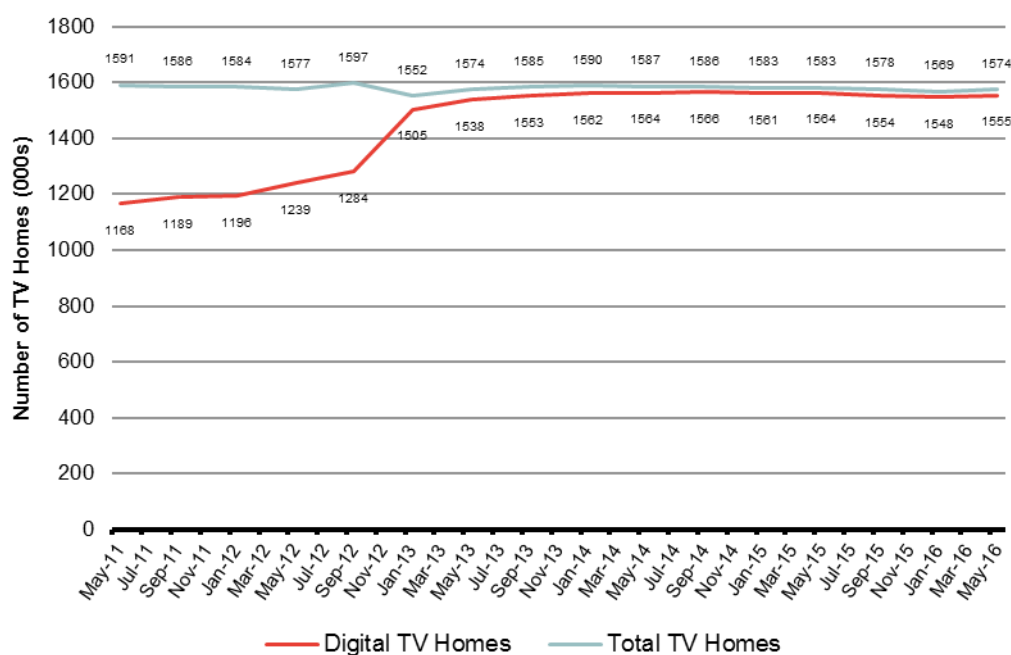
Figure 6 TV Households by Reception Method 2014 -2016 (chart)

Source: ComReg, Irish Communications Market, QuaRTÉrly Key Data Report (R), Data as of Q2 2016

In contrast, RTÉ has made assumptions on the number of DTT households in 2019. RTÉ assumes that the total number of households/TV households in Ireland will have increased by 2019. RTÉ further assumes that the percentage of those households/TV households that receive DTT in 2019 will be higher than the percentage of total households/TV households that currently receive DTT.

However, given the available statistics and general market trends, we conclude that it is unlikely that the number of households depending on DTT will continue to grow strongly.

Most notably, the total number of TV households has been relatively flat in last two years and there is no reason to anticipate a very strong growth in the number of TV households (see Figure 7), though we recognise that there is a degree of uncertainty in projections of the number of households (for example increasing economic output could increase the number of households built).

Figure 7 TV Households 2011 –2016

Source: *Irish Communications Market: Key Data Report – Q2 2016, figure 5.1.3*

In addition, broadband networks, and especially FTTH, are expected to be deployed at a much larger scale across Ireland in the coming years. This should result in increased competition for DTT services, from IPTV services and over the top services providing paid and free TV content, not only in urban areas but also in rural areas where roll-out of broadband networks is expected to increase significantly. While IPTV currently represents 3% of the total primary TV market in Ireland, in some other EU Member States IPTV has already grown to 20 or to 30+% of the market, suggesting there is considerable room for IPTV growth in Ireland.

Furthermore, whilst the number of DTT households could increase as a result of the construction of new houses, it is likely that such households would have wideband aerials and hence would not face problems following 700 MHz migration and the re-scan. Today, installers would recommend a wideband antenna as the default option. Comparable data from the UK also shows that, in more recent years, wideband antennas have become the norm.

Therefore, we conclude that it would be reasonable to make the following assumptions in deriving a reasonable estimate of compensation requirements.

We assume that the following proportions shall remain relatively constant:

- (i) the total number of DTT households in the State relative to the total number of TV households in the State; and
- (ii) the total number of DTT-only households in the State relative to the total number of TV households in the State.

We expect that the above proportions shall remain relatively constant because it is difficult to know whether the difference in the number of DTT households between May 2014 and July 2016 (see Figure 6) represents an upward trend or is simply fluctuating data without representing a trend;

While we recognise that there is a degree of uncertainty as to the total number of households, we further consider that the majority or new DTT households will use the more popular wideband aerials which will be unaffected by the migration.

This means that we assume throughout our analysis that there will be 187,000 DTT-only households (12% of total TV households) and 676,820 DTT households in total (43% of total TV households) (i.e. the same as at Q2 2016). This is less than the number of DTT households 2rn is using in their calculation, (977,000 households in 2019). However, we also test our results using the assumptions used by 2rn.

Further, we note that the impact on a household of a retune, or of losing signal, is far more severe when DTT is used as that household's *only* TV service or where the household takes Irish DTT alongside either (UK based) Freeview¹⁴ or Freesat¹⁵.

This is because if a household with only Irish DTT loses service it completely loses its TV. Where Irish DTT is used alongside Freeview or Freesat, an interruption of the Irish DTT service could significantly adversely affect viewers. This is because Freesat does not include any key Irish channels (such as RTÉ1, RTÉ2 TV3, TG4, UTV Ireland) and Freeview only includes RTÉ1 and RTÉ2 but not others such as TV3, TG4, UTV Ireland).

Where the household takes Irish DTT alongside either Sky's satellite service or cable then a loss of Irish DTT service will enable consumers to continue to watch Irish TV on the other technology.

Disproportionate number of vulnerable groups use DTT

When assessing the costs and benefits of different 700 MHz migration strategies, it is appropriate to consider whether a given strategy could disproportionately affect some persons who fall within potentially vulnerable demographic groups, including the elderly or persons with disabilities.

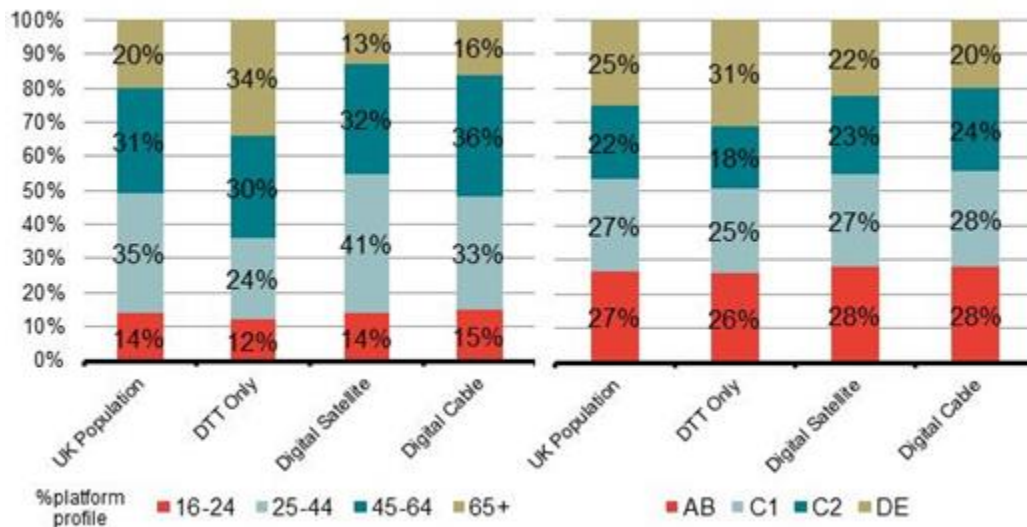
We have not seen data on the proportion of DTT users who fall within such potentially vulnerable groups. However, since DTT technology provides free-to-air access to digital multi-channel TV services containing the Irish TV channels, it would not be surprising if a disproportionately high number of persons from such potentially vulnerable groups do use DTT as their principal means of watching TV, relative to the total population.

In particular, following Digital Switch Over (DSO), it is considered likely that a disproportionately high number of elderly households use DTT, rather than having switched to alternative platforms. In the UK, the over 65s are disproportionately more likely to be DTT users; they comprise 20% of the UK population but 34% of the UK's total DTT users.

¹⁴ <https://www.freeview.co.uk/why-freeview/channels>

¹⁵ <http://www.freesat.co.uk/channels>

Figure 8 UK Platform demographics by age and socio-economic group (2016)



Source: Ofcom CMR

Estimate of DTT households affected by migration

We concur with 2rn that a household using a group C/D aerial which is optimised for 700/800 MHz would have a reduced signal level if the transmitter was returned to a much lower and out of band frequency.

However, with properly installed equipment¹⁶, 700 MHz migration should only affect households in fringe coverage areas (as referred to in Figure 3 above):

- Red areas (new frequencies are significantly out of band) (up 6 - 10 dB reduction in signal)
- Orange areas (new frequencies are slightly out of band) (up to 3 dB reduction in signal)

Only households in fringe coverage areas should be affected because properly installed grouped aerials should continue to receive sufficient signal, provided that the transmission is close to the grouped aerial's optimised range (this is explained in more detail in ANNEX A.

In practice, it is difficult to know how many households would be affected by 700 MHz migration because they have grouped aerials (i.e., aerials optimised to receive a DTT signal within a specific frequency range). There are no large-scale UHF TV aerial survey results available for Ireland, by which to determine the type and number of aerials that are used by Irish households and the quality of the DTT reception which those aerials offer. However, benchmark data is available from the UK, where some studies have been performed under somewhat similar grouped aerial conditions.

Ofcom found that about half of UK aerials¹⁷ in the group C/D coverage areas had already become wideband aerials. This implies that those households with those

¹⁶ See section 8 of the Saorview/2rn reception installation guidelines. Source: <http://www.2rn.ie/wp-content/uploads/2013/05/RT%C3%89NL-SAORVIEW-FAQs-May-2012-Rev-7.1.pdf>

aerials would not be impacted significantly or suffer from weaker signal levels, after a frequency retune. If similar trends apply in Ireland – i.e. if about half of Irish aerials in the group C/D coverage areas have already become wideband aerials – then this should reduce the impact of a frequency retune by the same relative extent.

Ofcom's study on Rooftop TV Aerial Performance in Manchester¹⁸ found that, in the UK, approximately 75-90% of aerials will be of the wideband type by the time of the frequency retune. Following actual measurements of aerials (which included effects like poorly installed aerials, damaged aerials, etc.) the number of households that would be affected was estimated to be 100,000 – 160,000, out of total DTT TV households of about 20 million (or less than 1% of total DTT TV households).

We recognise that the UK is not an ideal benchmark by which to assess the use and deployment of terrestrial TV aerials in Ireland. This is because, as compared with Ireland, DTT has been available in the UK since the late 1990s, offers more multiplexes, and has been more popular. However, despite these differences, the UK does provide a useful benchmark by which to cross check the assumptions made by 2rn.

In this context, we estimate that the percentage of Irish DTT households that would be impacted by 700 MHz migration would be likely to fall below the levels indicated by 2rn's analysis. Nonetheless, we sensitivity test the results, including 2rn's estimate.

3.1.3 Conclusion and recommendation

We consider that 700 MHz migration could affect a small group of households who use grouped aerials and have poor installations. Without a new wideband aerial or maintenance on their existing grouped C/D aerial, such households could lose their primary or secondary TV service, following the migration.

2rn estimates that approximately 50,000 households (or 5% of the 977,000 DTT households projected to exist by 2019) could be affected by 700 MHz migration. This estimate is based on 2rn's assumptions as to (i) the proportion of Irish households with grouped aerials, and (ii) future growth in the total number of DTT households.

As a cross-check to the above, we also estimated the potential number of Irish DTT households which could be adversely affected by 700 MHz migration. We began by taking the current total number of DTT households according to ComReg statistics. We then estimated the number of households that could be affected by 700 MHz migration, using 2rn's assumptions as the proportion of households that would be affected, but assuming that there would be no increase in the total number of DTT households. Based on these assumptions, we estimate (i) that approximately 9,500 households which use DTT as a primary TV source could be affected, and (ii) that approximately 25,000 households which

¹⁷ Ofcom recommend that UK viewers install wideband aerials (rather than grouped aerials) to receive DTT. In Ireland, according to 2rn Saorview and 2rn recommend that viewers install grouped aerials, i.e., aerials optimised for the frequency of their nearest DTT transmitter.

¹⁸ See: https://www.ofcom.org.uk/data/assets/pdf_file/0027/74277/manchester_research_report.pdf

use DTT as a secondary TV source could be affected. So, by these estimates approximately 34,500 of all DTT households could be affected by 700 MHz migration (or approximately 5% of the 677,000 DTT households projected to exist by 2019).

Figure 9 Estimate of the households adversely affected by migration

Reception category	% (98% of households covered by DTT/Saorview)	July 2016 ComReg TV households	DTT households based on Nielsen 43%	DTT as primary TV service	DTT as secondary TV service	2rn impact estimate	Impacted DTT as primary service households (2rn impact %)	Impacted DTT as secondary service households (2rn impact %)
Yellow	11%	173,140	76,203	21,054	55,149	5%	1,053	2,757
Orange (Aerial Group B)	18%	283,320	124,696	34,452	90,243	5%	1,723	4,512
Red (Aerial Group C/D)	23%	362,020	159,333	44,023	115,311	10%	4,402	11,531
Blue	0.7%	11,018	4,849	1,340	3,509	50%	670	1,755
White	45%	708,300	311,739	86,131	225,608	2%	1,723	4,512
Non DTT area		36,202						
Total	98%	1,574,000	676,820	187,000	489,820	5.12%	9,570	25,068

Source: Frontier

For the reasons noted above, 2rn's assumptions, as to the proportion of DTT households that would be affected by 700 MHz migration, might be unduly high. Experience in the UK would suggest that a much lower proportion of Irish households would be affected.

If we assume that the estimated impact of 700 MHz migration would be proportionally the same in Ireland as in the UK, then even if we take the *high-end* of the estimated impact in the UK (1.35% of households), this would mean that only approximately 9,100 Irish households in total would be affected (i.e. 1.35% of 677,000 households). Of these, approximately 2,500 would use DTT as their primary source of TV.

Figure 10 Estimates of the total number of households adversely affected by migration

	2rn approach	2rn assumptions on grouped aerial and no change in total DTT	Ofcom "high" assumption on grouped aerial and no change in total DTT
DTT only		9,570	2,525
DTT on 2 nd sets		25,068	6,613
Total	50,000 (5% of 977k households)	34,638 (5% of 677k households)	9,137 (1.35% of 677k households)

Source: 2rn, Frontier

Furthermore, we note that of the estimated total number of Irish households that would be affected by the 700 MHz band migration, most use DTT as their

secondary TV source. This would reduce the impact of 700 MHz migration, since these households would have an alternative transmission option on their primary set to watch TV. Nonetheless we note that just because a house uses DTT as a secondary TV source does not mean that losing DTT would not be a major inconvenience as some households (with UK based Freeview or Freesat) would be unable to receive key Irish channels.

Nevertheless, of the total Irish households which use DTT as their primary TV source, these are likely to include a high proportion of more vulnerable persons, such as elderly people living in more rural areas. Specific support measures and information campaigns are therefore likely to be beneficial in these cases, to support such DTT users through the retune.

3.2 Simulcast vs other approaches

3.2.1 2rn's view

As noted above, 2rn favours a simulcast approach which is described below. A simulcast period means that DTT services would be broadcast in both frequency bands for a period of time (say 3-6 months). This would allow viewers enough time in which to take the necessary measures so that they could still access the DTT platform, post 700 MHz migration. Such measures may include retuning frequencies and adjusting aerials, if applicable. A simulcast period would thus reduce the risk that, as a result of 700 MHz migration, some viewers could not receive their DTT services (which in turn could result in churn from the platform).

However, simulcast would also require the deployment of additional equipment, which means that there would be additional costs:

- It would require additional active transmitters at each of the main broadcast locations for the simulcast period; and
- It would require additional transmitter equipment at transposer and repeater sites for the simulcast period.

2rn has provided us with detailed information as to how it would undertake the 700 MHz migration. This information shows that:

- The main broadcast locations where both multiplexes change would require three new transmitters (five sites in the 11 sites above 1 kW transmit power category);
- The main broadcast locations where only one multiplex changes would require one new transmitter (two sites in the 11 sites above 1 kW transmit power category);
- 16 transposer/retransmission sites at below 1 kW transit power would follow a similar approach (i.e. where both multiplexes change, three new transposers would be required, and where only one multiplex is changed only one new transposer would be required);
- 13 low power sites are considered “one-nighters”, implying a one-night frequency retune and hence no simulcast; and
- 32 broadcast locations would not be affected.

3.2.2 Frontier comments

Simulcast would result in a substantial increase in the cost of 700 MHz migration in Ireland. It would require additional transmitters to be on-air at the same time, with all the consequential additional costs thereof. There is, therefore, a trade-off between the cost of 700 MHz migration and the level of protection to be given to DTT viewers (including, in particular, more vulnerable viewers). The more that DTT viewers are protected from the potential detrimental impact of 700 MHz migration, the more 700 MHz migration will cost.

In previous analogue-to-digital TV switch-overs, as carried out around the world, periods of simulcasting have been commonly used. These periods allow TV-users time to adjust to the new technology. This may include having to purchase

new set-top boxes or receivers, and/or having to adjust aerials. Furthermore, changes to the actual broadcast infrastructure, in many cases, meant that the transmission operators had to deploy new digital capable transmitters (hence such simulcasts did not impose incremental costs, compared to no simulcast).

A digital frequency retune, such as would be required for a 700 MHz migration in Ireland, requires no change in technology. This means that a “single night” frequency retune would technically be possible. However, a digital frequency retune does still require preparation of back-up antenna systems and work on the main antennas, in order to obtain the correct antenna pattern for the new frequencies. Furthermore, combiners would have to be retuned over a period of time, as this task is typically not suited to a single night. However, most transmitters can be retuned relatively easily and so the need for additional transmitters could be avoided.

We have, therefore, considered whether lessons from completed 700 MHz migrations in other jurisdictions are useful in assessing whether a simulcast period is appropriate or necessary, in an Irish context.

- In the US, 700 MHz migration involved an analogue-to-digital migration and so the facts are not comparable;
- In several jurisdictions, 700 MHz migration involved a change in network technology (from DVB-T to DVB-T2). This in turn increased the need to replace or adjust some viewer reception equipment, and so those cases are also not comparable.

However, two relevant cases do have some level of similarity:

Australia has completed its Digital Restacking of the 700 MHz DVB-T and has made the band available for LTE services. The ACMA, the regulatory authority, considered several scenarios for migration but an all-out simulcast was not applied. Due to particular issues with retuning in MDUs (Multi Dwelling Units), the ACMA urged the application of some simulcast in urban areas but not a full national simulcast.¹⁹ The ACMA also concluded that combiner retuning would be too complicated for on-site single night migrations, and therefore combiners had to be replaced or moved around. “(Hybrid) Temporary Retune Units” were used to replace combiners and to retune transmitters.

- In the **UK**, 700 MHz clearance plans are still in progress. Test transmissions are mentioned as a tool to verify coverage of the new frequencies. An Ofcom document titled “*Managing the effects of 700 MHz clearance on PMSE and DTT viewers. Summary of progress and call for input*” (published in March 2016) considered “test transmissions” which are similar to simulcasts. The study focused on the incremental cost of such test transmissions, as against how effective they would be in resolving viewers’ problems.

Most countries, including the UK and Ireland, adopted simulcasts for **800 MHz clearance and analogue switch off** (i.e. for a period of time there were

¹⁹ Source: ACMA (2011) “IFC 07/2011 - Clearing the digital dividend: Planning objectives and principles”. Note it also expected negative impact on ordinary households due to the multiple retuning and potentially duplicate services on the channel list. We note that 2m is aware of such issues and expect this problem can be avoided in the Irish case due to the set top box software.

simultaneous transmissions on the analogue and digital technologies). However, the 800 MHz clearance and analogue switch-off required a simulcast period because some viewers' equipment had to be changed. However in the case of 700 MHz migration, the vast majority of DTT viewers would not have to change their equipment. As noted in section 3.1, it is estimated that a small proportion of DTT viewers (1.35-5%) would have to change or update their aerial equipment.

Further, a 2015 study prepared for the European Commission - titled "*Economic and Social Impact of Repurposing the 700 MHz band for Wireless Broadband Services in the European Union*" – considered the simultaneous introduction of DVB-T2, a new technology. Introducing a new technology as part of a 700 MHz migration would impact on viewers reception equipment. However, despite this, the 2015 study concludes that the traditional simulcast approach would not be not feasible even if a new technology such as DVB-T2 was being introduced, for the following reasons:

- *Insufficient frequencies for restacking.* This is unlikely to be an issue in the case of a 700 MHz migration in Ireland, as there are just two multiplexes in Ireland while some other countries have many more multiplexes;
- The cost of an additional transmitter at each site could be relatively high. This could apply a 700 MHz migration in Ireland;
- *The benefits of such a simulcast, compared to the one brought about by the transitional simulcast (where only a small number of channels are simulcast and others are gradually migrated) is relatively small.* Transitional simulcast implies that no new frequencies are used but, within the available frequencies, that multiplexes are migrated from DVB-T to DVB-T2. As a consequence, some channels will only be available in one technology at a time. That is somewhat comparable to a one night change/frequency retune, though the transitional simulcast would allow simulcast for some of the most important channels, while the one night change would not. A transitional approach could be taken if 2rn was to use the stand-by transmitter. However, this would mean that if there was a transmitter failure then there could be a risk of an outage of DTT services.

Conclusion and recommendation

Simulcast was considered best practice for migration from analogue to digital TV. However, it may not be best practice, or necessary, in the case of a digital retune/restacking of the 700 MHz band. This is because the benefits of a simulcast for 700 MHz migration are likely to be lower than was the case for DSO, whilst the costs could be higher. Additional combiners and combiner retuning would be required regardless of whether there is a simulcast, but additional transmitters, transposers and retransmitters would be required only if there is a simulcast.

We consider the case for simulcast at different types of sites below.

For 2rn, the largest cost components of a 700 MHz migration (around € [X] investment, based on 2rn's data) would relate to transmitters at the following locations:

- **Clermont Carn and Truskmore.** Although these sites are, according to the 2rn map, in the group B category (orange area) from a viewer's aerial perspective, these sites are key for coverage, not only in Ireland but also in Northern Ireland. Any loss of coverage would therefore be a sensitive issue;
- **Kippure.** This is a group C/D category (red area). It covers a large population including rural areas and is in an area affected by UK interference. Therefore, this is a site where 700 MHz migration could have a significant impact and where loss of coverage would be a sensitive issue.

Simulcast at the above sites could be used to minimise any impact on viewers and to avoid risk that at migration viewers lose service, in combination with the sensitivity around North Ireland coverage.

Another group of four sites would also contribute to the additional transmitter costs to 2rn associated with simulcast (around € [X] investment), but these costs are significantly less than the three most costly sites (Clermont Carn, Truskmore and Kippure). These are:

- **Hollywell hill.** According to Figure 3, this site is in group A category (yellow area) from a viewer's aerial perspective. This means that the risk of service degradation due to the type or quality of viewers' aerials, post 700 MHz migration, would be much smaller. That could be grounds for considering that a single night migration would be justified, instead of a simulcast. However, this site is also used for coverage into Northern Ireland and hence it has additional policy significance²⁰. Hence there is an increased risk in viewers who receive their DTT signal from this site (including viewers in Northern Ireland) not being fully informed about the possible need to retune;
- **Kilduff.** According to the Figure 3, this site is in group C/D category (red area) from a viewers' aerial perspective. The risk of service degradation due to the type or quality of viewers' aerials, post 700 MHz migration, is relatively high and the coverage area is relatively large. Hence a simulcast period is well justified.
- **Maghera and Spur Hill.** In Maghera only one of the two frequencies would change and the change would have a limited effect since the difference in frequency as a result of migration is not large²¹. Alternative migration options (such as an overnight switch) would exist and any risks would be reduced, since at least one of the multiplexes would still be received. Due to the low risk of any loss of service, a single night migration could be considered as justified, instead of a simulcast. In addition, Maghera has a stand-by transmitter which could be utilised to provide simulcast, if desired. However doing so would mean that no spare transmitter would be available during the simulcast period.

²⁰ Given the Good Friday Agreement's mutual recognition of the validity of the unionist and nationalist traditions and the role that cross border transmission played in achieving this.

²¹ The original channels at Maghera were 48 and 55 and the new channels are 48 and 46. So the new channel 46 is only 2 channels away from channel 48 which had to be within the receive band of a group C/D aerial (channel 48 to 68). So since it is just beside the band for which the aerial has been optimised the loss of received signal is fairly minimal so few affected households.

However, an additional transmitter might not be strictly necessary for this site. The situation is similar in Spur Hill, where again only one of the two frequencies would change, there is an available spare transmitter, and an additional transmitter might not be strictly necessary for this site.

In addition to the above, there are:

- 16 lower transmit power transposer/retransmission sites (which require simulcast related investments of around €[X]) for which 2rn proposes a simulcast; and
- 18 lowest transmit power sites for which 2rn proposes a single night migration.

The costs per site of the 16 lower transmit power transposer/retransmission sites which require simulcast are lower but also the number of affected households is smaller. The 16 lower transmit power sites could be reconsidered for single night migrations, especially those sites for which there would be a smaller change in frequency and therefore less loss of coverage for grouped aerials (these include Castletownbere, Crosshaven, Fanad, Gorey, Letterkenny, and Monaghan).

Ultimately the decision as to whether to adopt a simulcast approach, and for which sites, is a political one. It is a choice between the additional cost of a simulcast against minimising the risks of a 700 MHz migration including, in particular, any loss of service or degradation of service for DTT viewers (including persons within possibly vulnerable groups located mostly in rural areas).

Avoiding those risks by simulcast is reasonable but cost reductions²² could be achieved accepting a somewhat higher impact on a fairly small number of households and/or the use of test transmissions to verify reception issues before the single night migration.

One approach would be to decide whether to conduct a simulcast on a site-by-site basis. This would involve weighing (a) the additional cost of a simulcast at each site against (b) the risk of a loss or degradation in the DTT service emanating from that site and the number of household likely to be affected by same.

Furthermore, even if the 700 MHz migration was completed without any simulcast(s), it would still be possible to use the spare transmitters, at those sites which have same, to be on-air on one of the new frequencies. This would enable 2rn to verify if the DTT signal was being received at the lowest new frequency, for a certain period of time. This “test transmission” approach is an option that falls between having a full –simulcast and having no simulcast, in that it would enable to 2rn, for a period of time, to verify if there any DTT reception issues but while avoiding the costs of having to purchase and install new transmitters.

In section 4, we set out the various estimated costs of a 700 MHz migration, assuming: (a) no simulcast, (b) a general simulcast, and (c) a limited simulcast at those sites where the problem of grouped aerials is likely to be greatest (such as the Clermont Carn, Kippure and Truskmore sites).

²² For example, up to €810k in investments costs could be saved with an overnight migration approach at Hollywell Hill, Maghera, Spur Hill and the 16 lower transit power transposer/retransmission sites. However other cost considerations may increase with such a migration approach.

3.3 Analysis of 2rn's estimate of the assets required to perform the migration

We set out below 2rn's assessment of the different categories of assets that it would have to acquire to perform 700 MHz migration under its chosen strategy. We then comment on whether each of 2rn's assessments is reasonable and proportionate. We consider, under the headings below:

- Transmitters
- Transposers
- A new antenna at Kippure
- Two new sites
- New fibre distribution links
- New feeds, antennas and filters

3.3.1 Transmitters

2rn's view

2rn assumes that it will adopt a simulcast migration strategy for those sites set out in section 3.2.

In respect of its main transmitter sites, 2rn proposes the following approach:

- Where 700 MHz migration would require a change in frequency of both multiplexes, 2rn proposes that it would replace the three existing transmitters with three new transmitters (two active and one stand-by).
- Where 700 MHz migration would require a change in frequency at just one multiplex, 2rn proposes that it would replace the existing transmitter with one new transmitter.

At sites where two changes in frequency would be required, 2rn proposes to replace all three transmitters – i.e. the two transmitters which are in use (i.e. the additional transmitters for simulcast) plus the active stand-by transmitter. 2rn proposes this measure because it considers that the benefits of operating three similar transmitters (including, for example, op ex savings) would exceed the additional cost of having an active stand-by transmitter of a different type (since in this case 2rn could have kept the active stand-by transmitter and only changed the two transmitters in use - i.e. the additional transmitters for simulcast).

Where only one change in frequency would be required, 2rn proposes the cheaper option of adding just one transmitter (required for simulcast) and continuing its operation with a mix of old and new transmitters (i.e. 2rn does not propose to replace the three existing transmitters because of a change in frequency at a site where there is just one multiplex).

Frontier comments

Where the 700 MHz migration would require a change in frequency of multiplexes at a given site, there would certainly be operational benefits to using

three similar transmitters (of which two would be active and one would be stand-by). This would require fully replacing the three existing transmitters with three new transmitters. This in turn should save on spares, result in operational simplification, and should reduce certain opex costs such as having to train technicians. 2rn's proposed approach therefore seems reasonable.

Where the 700 MHz migration would require a change in frequency of just one multiplexes at a given site, 2rn does not consider that the benefits of having only one type of equipment would be sufficient to justify replacing all transmitters at that site. Instead, 2rn proposed that it would replace just one transmitter.

We consider that, in the case of such single multiplexes, 2rn could have considered implementing a simulcast using the stand-by transmitter. Such an approach would eliminate the cost of an additional transmitter and sustain an operational condition of having just one type of transmitter on a site. However, it would also mean that, there would be no stand-by transmitter on site for the period of the simulcast and such an albeit temporary lack of network redundancy would carry the risk of viewers not being able to access DTT services, if the main transmitter should fail for any reason.

Conclusion and recommendation

Where 700 MHz migration would require a change in frequency of both multiplexes, we note and agree with 2rn's proposal that there would be clear operational benefits, in terms of improved efficiencies, in replacing the three existing transmitters with three new transmitters (two active and one stand-by).

Where 700 MHz migration would require a change in frequency at just one multiplex, we consider that 2rn's proposal to add just one new transmitter is reasonable. This approach would sacrifice a degree of operational efficiency for a period of time, but would result in significant cost savings.

3.3.2 Transposers

2rn's view

Assuming that it would follow a simulcast approach, 2rn has proposed the following for each site:

- Where 700 MHz migration would require a change in frequency at just one multiplex, 2rn would replace just one transmitter at the site (transposer/retransmission);
- Where 700 MHz migration would require a change in frequency of both multiplexes, 2rn would replace all three transmitters at the site²³

Frontier comments and conclusion

2rn proposed approach for transposers is very similar to its proposed approach for transmitters.

²³ i.e. a new transmitter system (two transmitters for sites with N+0 configuration (i.e. no stand-by), three new transmitters for N+1 configuration (with stand-by)).

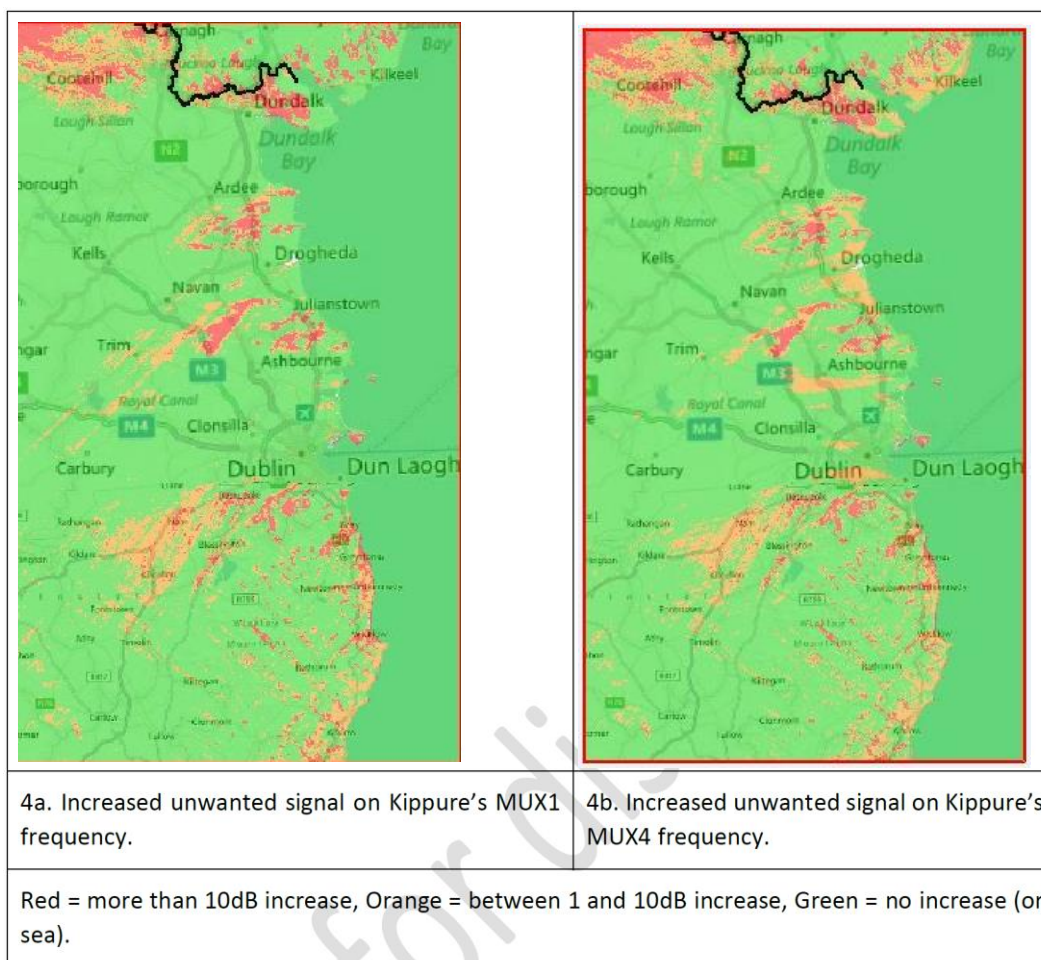
Given the rationale is similar as for the main transmitters, 2rn’s approach has a logical rationale.

3.3.3 New antenna at Kippure

2rn’s view

2rns site at Kippure covers a large geographic area and many households. This same area will also be the worst affected by increased interference from the UK, post 700 MHz migration. The maps below show the increase in interference levels as predicted by a RF planning tool.

Figure 11 Impact of interference



Source: 2rn

2rn states:

“Kippure is a key main station serving the east coast which is the area worst affected by increased interference as a direct result of the 700 MHz migration. In order to repair coverage greater height is needed from Kippure (in line with the original analogue TV transmissions). A new antenna is required approximately 18m higher than the current main UHF antenna at Kippure. The new antenna which is expected to consist of 10

tiers of panels will be installed on a spine at the top of the mast and will be designed for the new frequencies with their associated coordinated radiation patterns. The cost estimate is based on broadly similar installations carried out during the DTT project, but it is expected that the final cost may vary significantly following detailed design and tender. Once this new antenna is in place the existing DTT antenna will be deployed as a back-up. This will allow us to cover a significant part of the coverage area at reduced power during outages arising from faults or maintenance in the main antenna. The existing antenna cannot be operated at full power without breaching coverage restrictions. The coverage given is therefore a useful emergency back-up but no more. This will make working on the new antennas more efficient.

This is the only antenna of this scale being replaced as a direct result of the 700 MHz clearance and is therefore significantly more costly than the other new antennas required.”

Frontier comments

We consider that 2rn appears to be justified in its expectation that there will be increased interference from the UK in the geographic area covered by the Kippure site, as a direct result of 700 MHz migration. We consider that it will be necessary for 2rn to maintain a sufficiently strong level of transmission from the Kippure site, in order to avoid any degradation to the DTT service in the area covered by that site as could result from increased interference emanating from the UK. However, 2rn is also aware that the site must operate within the restrictions of the coordinated international frequency plan between Ireland and the UK, which places restrictions on the radiation pattern of antennas (or expressed differently, on the maximum ERP power in a particular direction).

Conclusion and recommendation

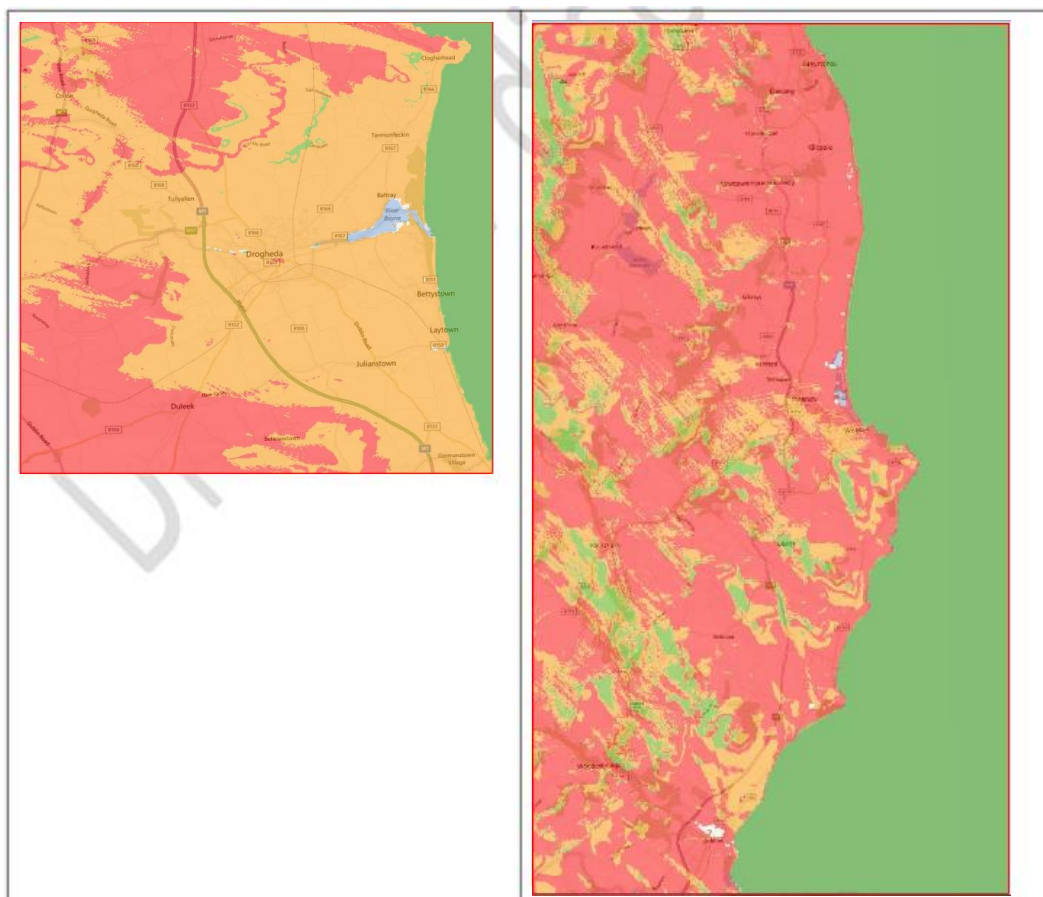
We concur with 2rn that installing a new main broadcast antenna at the Kippure site, and using the current main antenna at that site as a back-up antenna, would appear to be an appropriate and proportionate measure by which to address any degradation to the DTT service (as would be likely to occur in the area covered by that site if such a measure was not taken).

3.3.4 Two new sites

2rn's view

In its correspondence, 2rn expressed its concern about the increased levels of interference in Ireland that are expected to occur following 700 MHz migration, with such interference emanating from the UK. The graphs below show the predicted increase in interference on Ireland's east coast, as predicted by a radio frequency (RF) planning tool. The areas shaded red show the increased interference that is expected to occur.

Figure 12 Interference as a result of the planned migrations



Source: 2rn

<p>1a. Increased signal strength from interferers in the Drogheda area on MUX1 from Clermont Carn</p>	<p>1b. Increased signal strength from interferers in Wicklow area on MUX1 from Greystones</p>
<p>Red = more than 10dB increase, Orange = between 1 and 10dB increase, Green = no increase (or sea).</p>	

2rn states:

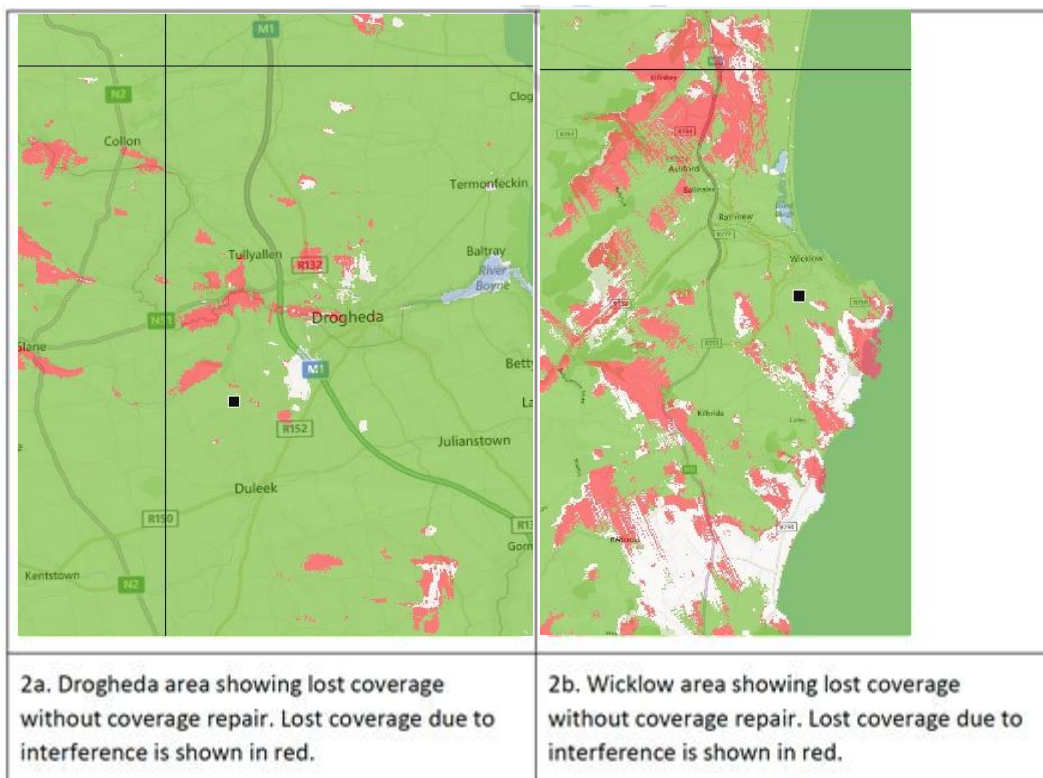
“Increased frequency usage below 700 MHz following the 700 MHz clearance both in Ireland and the UK will create increased unwanted

signal levels with the potential to cause additional interference. This problem will be most severe in broader areas and along the east coast resulting in an overall reduction in total population coverage in the sub-700 MHz network. While potential interference is generally spread over large geographical areas and difficult to protect against or repair, two areas of relatively dense potential impact have been identified: Drogheda and Wicklow. The addition of a new relay transmission site in each of these areas will recover some of the additional interference and reduce the decrease in population coverage.”

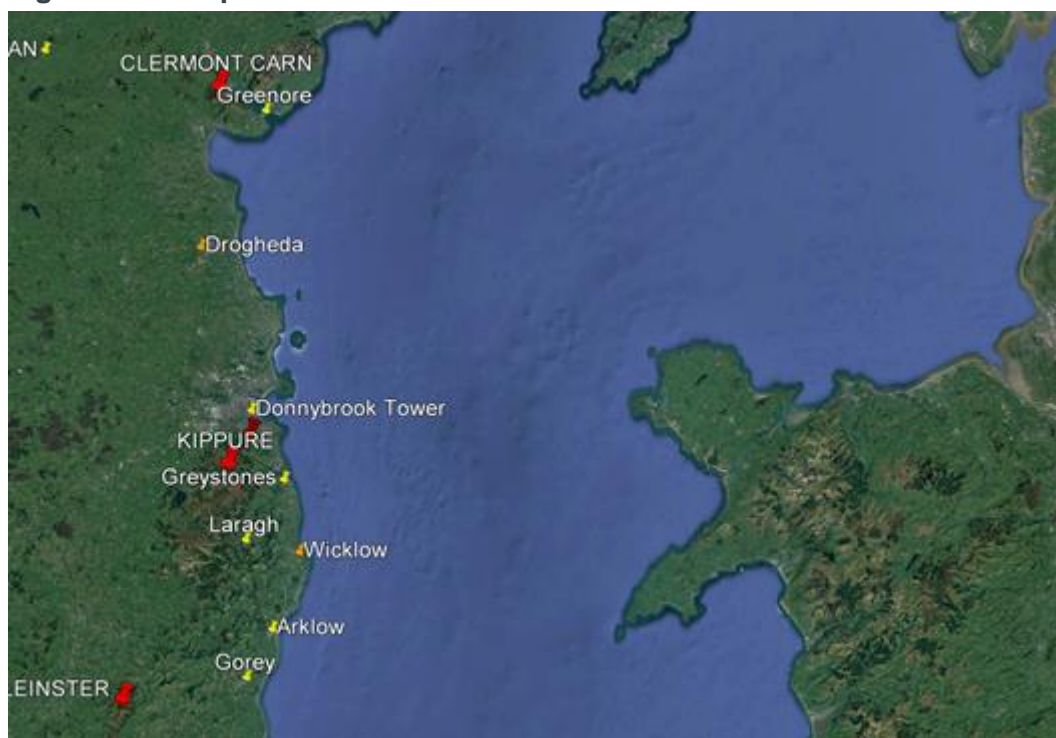
The maps below (2a and 2b) show the relevant areas of lost coverage due to interference around Drogheda and Wicklow in the sub-700 MHz plan, with respect to current predicted levels of on-air coverage. In practice we expect coverage loss to be worse – including more in the urban areas than is shown in the predictions below - following some measurements made of the potential interfering UK sites currently on-air and assuming viewers’ antennas are not optimally installed.

Maps 3a and 3b show the same areas, but with the two additional sites at Drogheda and Wicklow implemented. Implementing these relays is a cost effective way to reduce the net loss in Saorview coverage as a result of the 700 MHz migration as the loss is typically distributed over a wide area making it difficult to repair. The addition of sites at Drogheda and Wicklow is expected to recover almost 4k households from the overall coverage loss.

Figure 13 Lost coverage in Drogheda and Wicklow area without repair



Source: Source:2m

Figure 15 Map of transmission sites on the East Coast of Ireland

Source: 2m

In considering the need for two additional sites, at Drogheda and Wicklow, we note that the areas surrounding the Kippure, Greystones, Laragh and Wicklow sites are hilly and that some such areas are not in line of sight of the main Kippure site. That is, even though the Kippure site is at an elevated location relative to the surrounding areas, other nearby hills block line of sight between Kippure and certain areas while some of those same areas are fully exposed to UK interference (i.e. they are in line of sight of transmissions originating in the UK). Similarly, the two existing fill-in sites, at Laragh and Greystones, also do not have line of sight to all of the affected areas, again due to the hilly nature of the area. Adding an additional site at Wicklow should therefore reduce the number of areas without direct line of sight to a 2m site, thereby reducing any loss of DTT service in those areas as may result from 700 MHz migration.

Separately, the Drogheda area is covered by broadcast stations which are relatively distant. Not all areas in and around Drogheda have good line of sight to those broadcast stations, again because of the local terrain (river valley, rolling hills) and again the problem is exacerbated by the fact that there is, in some cases, line of sight to transmissions originating in the UK. A strong local signal from a new site at Drogheda, should therefore reduce the impact of increased UK interference as is likely to result from 700 MHz migration.

Assessing the impact which these two additional sites would have is challenging because the number of households and users which would benefit from such sites, in a post 700 MHz migration context, depends on various factors such as local topography and the location and power of near-by transmitters. However,

we note that the proposed locations for the two sites would cover population centres with at least several thousand households.

Conclusion and recommendation

We conclude that it would be proportionate and reasonable for 2rn to add two fill-in sites at Drogheda and Wicklow, in order to ensure that there is sufficient DTT coverage in the surrounding areas in which the DTT signal would otherwise be likely to be too weak or subject to UK interference, post-700 MHz migration. We also consider that the proposed locations of both new sites are logical as they would cover affected populous centres.

The final locations of both sites and their configuration (antenna pattern, transmit power) can be decided once all the frequency plans and consequent anticipated UK interference are known.

3.3.5 Antennas and structures (remaining components)

2rn's view

The remaining issues relating to 700 MHz migration, besides the main issues of antenna replacement at Kippure and establishing two new sites at Drogheda and Wicklow, as discussed above, concern antennas and structures category. These remaining issues are:

- the need, for reasons based on various local factors, to replace 9 smaller antennas;
- the need to retune or modify some existing antennas; and
- the need to conduct various surveys and minor works.

Frontier comments

The smaller adjustments to existing antenna systems are necessary to achieve the necessary antenna diagram at the new frequency. For example the feeder line²⁴ length or the position of the antenna may need to be adjusted, in order to ensure that the phase difference between different panels is such that the desired radiation pattern can be achieved.

Conclusion and recommendation

2rn's two main proposals are to replace the antennas at Kippure and to establish two new sites at Drogheda and Wicklow. The various other measures which 2rn proposes – to replace or retune some antennas or to conduct various surveys or minor works – appear relatively small and, though we have not seen details of these proposed measures, they appear proportionate and reasonable in the context of completing the 700 MHz migration.

²⁴ The feed line is the cable connecting the transmitter to the aerial.

3.3.6 Fibre links

2rn's view

2rn expects that 700 MHz migration would result in increased interference, with such added interference emanating from within Ireland and from the UK. The feed for 2rn's main broadcast sites consists of a combination of a microwave ring and off-air feeds. The off-air feeds would become less reliable, or could even be no longer functional, as a result of such increased interference.

2rn states:

“Currently, DTT distribution uses a microwave radio network connecting all of the main transmission sites. Relay stations are then fed off-air from their parent main stations. We also deploy a back-up network to the main stations where each main station is fed off-air from another main station. This back-up network is necessary to maintain operation during significant anomalous propagation, major faults (including disaster recovery) or while resilience is reduced during maintenance on the microwave radio network. Reliance on the back-up off-air network

The 700 MHz clearance, and associated denser usage of the remaining UHF spectrum, is expected to reduce the reliability of the back-up off-air network, after it has been reconfigured sub-700 MHz. The expected impact of the 700 MHz clearance on the back-up off-air network has not been assessed yet; and some contributing factors such as all UK interference patterns are still unknown.

To restore overall network reliability to pre 700 MHz clearance levels, we will need to bring direct fibre connections to up to two main stations. This will increase the resilience of the main distribution network to compensate for the reduced utility of the main station off-air network, and maintain the off-air back up network - in the presence of increased interference - by directly feeding key source stations.”

Upon further questioning, as to more detailed substantiation of the specific locations affected, 2rn responded:

“It is known so far that the West (including North West) and South will become entirely reliant on a single site for off-air feeds – Cairn Hill (i.e. a single point of failure). Currently a diverse path is utilised through Clermont Carn and Truskmore which will no longer be viable due to increased frequency re-use. Approximately 825k (~50%) of Irish households are within the coverage area at increased risk. This would initially indicate a requirement for at least one fibre link in the West/South, with possibly another one following further analysis.”

The total impact of any increased interference in Ireland, as is likely to result from 700 MHz migration, has not yet been fully analysed and cannot be determined at this point in time. This is because this analysis is dependent on the final frequency plans, both in Ireland and the UK. The extent of any UK interference on the availability of off-air feeds in Ireland cannot be fully known until 700 MHz migration in the UK has been completed. However, at this stage and based on

the information currently available, 2rn expects that two fibre feeds, at a total cost of approximately €[X], would be likely to be sufficient to resolve its concerns as to the likely impact of increased interference on its off-air feeds, post 700 MHz migration.

Frontier comments

We agree with 2rn that it is reasonable for it to anticipate that 700 MHz migration would result in increased interference, given the increased re-use of the UHF frequencies in Ireland and in the UK, and that would be likely to affect the reliability of its off-air feeds (using the received UHF signal of one broadcast station as feed for another broadcast station). We further note that exceptional propagation conditions can occur (such as tropospheric ducting which extends the reach of signals far beyond their usual range and is a common phenomenon across sea paths such as between the UK and Ireland) and that such conditions could also negatively impact on the reliability of 2rn's off-air feeds. These same propagation conditions can also affect the main microwave feed at broadcast sites, which means that the main and alternative feed could both be affected simultaneously.

Conclusion and recommendation

Although there is currently no explicit justification from 2rn for the two fibre links, the proposed locations or the length of the routes, we believe that 2rn is correct to identify the issue. The reliability of the off-air back-up feeds will be affected negatively and fibre links to one or more broadcast locations is an appropriate and proportional solution to resolve such issues. The actual costs will depend upon which broadcast locations will be provided with a fibre based feed.

3.3.7 Feeds / antennas/filters/re-transmitters

2rn's view

2rn has also estimated that it would incur the following incremental costs from 700 MHz migration relating to feeds/antennas/filters/re-transmitters:

- €[X] for purchasing and installing ten highly-directional receive antennas for relay sites (to help reject increased incoming interference).
- €[X] (5 x € [X]) for purchasing and installing five re-transmitters to replace existing transposers where no frequency change is expected to occur. 2rn considers that these five re-transmitters are required as it will be more challenging to operate relay stations using off-air feeds in the sub-700 MHz spectrum, due to increased interference following 700 MHz migration. Re-transmitters use the error correction capabilities of the DVB-T system to correct for some co-channel interference received on off-air feeds in some instances. It is therefore expected that re-transmitters would be needed to ensure the continued use of some off-air parent site relationships, following 700 MHz migration. However, 2rn will only be able to complete a detailed analysis of these requirements when more details of UK transmission are finalised in the frequency plan.

- Purchasing and installing 26 receivers (24 existing sites and 2 new sites) to enable the reception of the new frequency of the donor site.

Frontier comments

2rn expects to incur costs in making necessary upgrades to its DTT network, in order to address the increased levels interference which are expected to occur, post 700 MHz migration. This includes resolving issues with the off-air feeds (even after two new fibre links have been installed). The different measures proposed by 2rn all appear reasonable and proportionate, having regard to the objective and the costs of measures. However, as the actual increased interference levels are still uncertain, 2rn is not yet in a position to specify which measure would be required for which site. As such, this cost should be considered as a “provision”, with actual requirements determined once actual interference conditions are known. 2rn will implement solutions in most circumstances before migration. However, there may be some limited provision for additional costs following migration.

Conclusion and recommendation

2rn expects to witness increased interference as a result of the migration, with this requiring further network upgrades to resolve. 2rn has provided its best estimate of a mix of different solutions to address the issues that could arise. In general, we consider that these are reasonable, although note the final requirements are not known at this time. Most notably, we consider it is reasonable to expect a number of problems with the off-air feeds which require better antennas and an upgrade of existing transposers without signal processing capabilities to re-transmitters with signal processing capabilities. The actual scale of investment will then partly depend on the real interference situation experienced during and after the 700 MHz migration in Ireland and the UK. Though inevitably, some investment will have to be made based on simulation models and expert judgement to ensure that a significant service outage is avoided.

4 COSTS INCURRED BY 2RN

2rn's estimate of the costs of 700 MHz migration are based on it adopting a simulcast migration strategy (as described in section 3).

2rn has provided estimates of the costs of the investments it would make to enable the migration, based on either initial budgetary quotes provided by prospective vendors, or 2rn's own estimates. These estimates are subject to a number of uncertainties, including the following:

- At this stage, we understand that a detailed engineering plan has not yet been completed. As such, some issues are still works in progress such as the final 700 MHz migration frequency plans, both for Ireland and the UK. And whilst the associated new international frequency coordination agreement between Ireland and the UK has been finalised, the actual implementation of that agreement will impact on the final interference conditions. Therefore, detailed assessments of the scale of the increased interference conditions, as are likely to result from 700 MHz migration in Ireland and in the UK, have not yet been made. Further, establishing the required counter measures to such increased interference conditions is still subject to the final, actual interference conditions which will be encountered, post 700 MHz migration.
- The pricing of cost components will be refined through the competitive tender process, to be conducted by 2rn. Prior to completion of this tender, there is a significant level of uncertainty as to the pricing of transmitter equipment, antenna work, and related services. For example, prices may vary depending on how competitive the tender process is and, possibly to a limited extent, on the timetables of 700 MHz migrations in other countries which are competing for the same resources (i.e. high demand for a limited amount of equipment or expertise could increase the market value of that equipment or expertise). Overall, the demand from Ireland from UHF DVB-T transmitters is small compared to the global market for such transmitters. However, the availability of skilled and qualified regional human resources to implement the 700 MHz migration in Ireland could be affected by the timing of 700 MHz migration in the UK, for example.²⁵

Given the above uncertainties, the eventual compensation payable to RTÉ will be reconciled to the costs which are actually incurred by 2rn, as a result of its competitive tender. However, our analysis has produced our best estimate of the costs that 2rn would incur in 2017 and 2018, as a result of 700 MHz migration (though we note, as set out in section 2, that some of those costs would be recovered via tariffs, meaning that the cash costs which 2rn would incur would not necessarily equate to the eventual quantum of compensation payable to RTÉ).

²⁵ In particular the antenna work on the main broadcast sites is on the critical path since work has to be done mostly in the summer period and good weather conditions are a prerequisite.

4.1 Frontier assessment

The main driver for the overall cost to 2rn of 700 MHz migration will be its chosen migration strategy. In this regard, we note that 2rn has opted for a full simulcast strategy on all of its main broadcast sites and on most of its transposer/retransmission sites.

Acting on the assumption that 2rn will adopt a simulcast approach to the extent which it has indicated, we examined whether 2rn's cost estimates are reasonable and consistent with those of an efficient DVB-T provider. In this context, we note that an efficient commercial DVB-T provider could decide to make different trade-offs, in terms of weighing the additional costs of simulcast against mitigating the potential disruption to the DTT service and any other associated risks arising from 700 MHz migration. We also note, in this regard, that a public broadcast DVB-T provider such as 2rn must take public policy objectives into consideration, as well as having to consider such matters from a pure financial perspective, and that 2rn is required to pay particular attention to safeguarding viewers' interests and to protecting more vulnerable viewers, such as some elderly persons living in rural areas.

Having taken into consideration the above differences between different types of DVB-T providers, depending on the extent of their public service remit, if any, we reviewed 2rn's cost estimates taking into account its obligations as a public broadcast provider.

Below we have set out whether, based on our review, 2rn's estimated costs of installing new assets appear reasonable. As part of this we have, where possible, benchmarked 2rn's cost estimates against alternative benchmarks (notably the experience in Australia in 2011).

We consider in turn, below, the costs associated with:

- Transmitters, transposers and retransmission equipment
- Antenna costs
- Combiners and combiner retuning
- Fibre links
- SFN configuration, RBR back up
- Off air feeds / antennas and retransmitters
- Information campaign
- Project management
- Site rigging and project engineering
- Contingency
- Simulcast costs
- Write off costs or revenues

4.1.1 Transmitter/transposer/retransmission equipment (including installation)

2rn has estimated the costs of purchasing (excluding installation) new transmitters and, following a request by Frontier, 2rn refined the categories to show the cost of each of the new transmitters, at different power levels above 1 kW.

For one of its main broadcast sites, a single 5 kW transmitter is budgeted by 2rn as costing €[X]. Hence the total cost of purchasing and installing three 5 kW transmitters, at one of 2rn's three transmitter sites, is estimated as €[X].

We then compared this estimate to the costs quoted for transmitters in the Australian 700 MHz migration, as set out in Fig 16 below.²⁶

Figure 16 Cost in AUS \$ for different number of multiplexes (cost of three multiplexes highlighted)

	1	2	3	4	5
5kW					
Scoping visit	9,450	9,450	9,450	9,450	9,450
Pre install prep	7,760	11,640	15,520	19,400	23,280
Mobilisation/demobilisation	3,480	3,480	3,480	3,480	3,480
Install transmitter & commissioning	16,740	33,480	50,220	66,960	83,700
Electrical/plumbing	4,500	9,000	13,500	18,000	22,500
Test equipment	150	300	450	600	750
Misc materials	600	1,200	1,800	2,400	3,000
Equipment freight - to site	2,000	4,000	6,000	8,000	10,000
Equipment freight - disposal off site	50	100	150	200	250
EME Report Update	500	500	500	500	500
SubTotals	45,230	73,150	101,070	128,990	156,910
UHF Equipment Costs	257,026	514,053	771,079	1,028,106	1,285,132
UHF Totals	302,256	587,203	872,149	1,157,096	1,442,042

Source: "Digital TV Restack, Modular Costs, ACMA, February 2011"

From the above benchmark figures (using 2011 costs) it can be seen that the cost of three multiplexes in Australia (which is comparable to 2rn's set-up of two active transmitters and one stand-by transmitter) would be AUS \$771,079, which is equivalent to about €570,600. Further, the cost of installing such transmitters and other overheads would add about AUS \$101,070, which is equivalent to about €74,792 (for a three transmitter site). In addition, 2rn estimates an average installation cost of €[X] per transmitter (on average across all sites).

²⁶ Source: *Digital TV Restack, Modular Costs, ACMA, February 2011*". A typical 2011 Euro to Australian \$ exchange of Aus \$ 1 = € 0.74.

Figure 17 Benchmarking of 2rn cost estimates

		2rn estimate	Australia benchmark
3 x 5 kW	Transmitter cost	€ [X]	€ 570,598
	Installation/site	€ [X]	€ 74,792
	Total	€ [X]	€ 645,390
3 x 1.5 kW	Transmitter cost	€ [X]	€ 282,244
	Installation/site	€ [X]	€ 44,089
	Total	€ [X]	€ 326,333
3 x 800 W	Transmitter cost	€ [X]	€ 159,292
	Installation/site	€ [X]	€ 28,490
	Total	€ [X]	€ 187,782
3 x 200 W	Transmitter cost	€ [X]	€ 107,447
	Installation/site	€ [X]	€ 22,022
	Total	€ [X]	€ 129,469
3 x 50 W	Transmitter cost	€ [X]	€ 47,868
	Installation/site	€ [X]	€ 20,646
	Total	€ [X]	€ 68,514

Source: "Digital TV Restack, Modular Costs, ACMA, February 2011". A typical 2011 Euro to Australian \$ exchange of Aus \$ 1 = € 0.74.

As set out in Figure 17, 2rn's estimate for the above 1 kW category of transmitters is somewhat higher than the 2011 Australian estimate, while 2rn's estimates for the below 1 kW sites are lower than the 2011 Australian estimate. Such differences are not unusual and, overall, 2rn's estimates as to the costs of purchasing and installing transmitters and transposers/retransmission equipment appear to be within a reasonable range, taking into consideration a number of factors which could be expected to cause costs to vary between projects²⁷. In particular, and as noted above, the final actual cost of purchasing and installing the required equipment will depend on the outcome of 2rn's competitive tender.

Therefore we conclude that the costs described by 2rn provide a reasonable basis for this initial estimate of compensation requirements (and we note that actual compensation paid will reflect actual costs incurred the way set out at section 5.4).

4.1.2 Antenna costs (including survey, new site, retune)

The largest cost component in 2rn's estimate would be the new antenna at its Kippure site. According to 2rn's response to our questions on this proposed investment, the new antenna at Kippure would be a 10-tier antenna at an estimated cost of €550,000. We understand this cost has been estimated by reference to the cost of comparable projects which were implemented during the analogue to digital migration.

²⁷ For example the tender costs including the available capacity of equipment suppliers and the demand for equipment from other transmission providers.

Figure 18 Benchmarking antenna costs

	2rn	2011 Australian estimate
6 tier antenna		€ 223,965
12 tier antenna		€ 375,284
10 tier antenna	€ [X]	

: Source: "Digital TV Restack, Modular Costs, ACMA, February 2011". A typical 2011 Euro to Australian \$ exchange of Aus \$ 1 = € 0.74.

Again, we have compared 2rn's cost estimate to a publicly available Australian estimate. However, the Australian estimate assumes that the towers in question do not require any structural work whereas, in the case of the Kippure site, 2rn proposes that the new antenna would be installed about 18 meters higher than the current antenna tower. This would be done in order to improve clearance and create line of sight transmission to some areas which are currently shielded by nearby hills. This added structural work, in raising the height of the tower at Kippure, would increase project costs over and above the cost of merely installing the new antenna on the existing tower.

We consider that 2rn's estimated cost of € [X], for the purchase and installation of a new antenna at its Kippure site and for related structural work to the Kippure tower, appears reasonable, having regard to costs incurred by 2rn in previous comparable projects and the costs of a comparable project in Australia. We also note that the purpose of the added structural work is to increase the coverage area of the Kippure site.

The other antenna costs are mostly for replacing smaller antennas and 2rn's estimates of those costs are again based on its past experience in comparable projects.

The cost of modifying/retuning existing antennas at 6 sites is estimated by 2rn at € [X]. Most of this cost relates to a modification of a single antenna at the Truskmore site, which is estimated to cost € [X]. Truskmore is the only large/main antenna system which would require significant modification. 2rn's estimate of the cost of modifying the antenna at Truskmore is taken from the manufacturer of that antenna. The estimated cost includes the design, factory testing and installation (noting that this is high up on a tall mast) of the modification. The antennas at other sites which would require modification or tuning are either much smaller (and/or lower) or would require a lesser degree of modification or tuning.

Therefore, we conclude that 2rn's estimate, as to the cost of modifying and/or retuning existing antennas at six of its sites, appears reasonable and is consistent with international benchmarks.

4.1.3 Combiners and combiner retuning

2rn estimates these costs in two categories:

- Transposer combiners: € [X]
- Combiner retuning: € [X] (6 @ € [X])

The above cost estimates are quite low compared to the 2011 Australian benchmark. However, in Australia the much longer distances and resultant increased travel time are likely to have added to the costs and, in this respect, the Australian costs are less directly comparable to the costs in Ireland.

For example, a single 5 kW site with two multiplexes (from a combiner and frequency perspective) is estimated at € 16,450 in the Australian benchmark²⁸ while 2rn estimates this cost to be at € [X].

Therefore, we conclude that 2rn's estimate as to above costs are reasonable and consistent with international benchmarks.

4.1.4 Fibre links

At this stage in the migration plan 2rn were unable to supply detailed description of the fibre links to be installed. Ultimately this will depend on where additional fibre links will best provide additional resilience and redundancy for off air feeds, given the use of spectrum (and any potential consequent interference) following migration. Given the lack of details this cost component cannot be benchmarked. However, we consider that it is not unrealistic for 2rn to budget € [X] for getting a fibre optic connection to a hilltop broadcast site. However, 2rn could seek to share this costs with any or all of the three Irish mobile network operators who co-locate their equipment at the same site, or with any other parties who co-locate their equipment at the same site. Given the traffic growth in 3G and 4G/LTE, the mobile network operators might be interested in having a fibre optic connection from such a main hub site. If such cost could be shared then the total cost for 2rn would decrease accordingly.

4.1.5 SFN configuration, RBR backup

SFN configuration (€ [X]) is related to expert labour work and the RBR backup (€ [X]) is related to work on the microwave feeds. We conclude that 2rn's estimated costs appear reasonable.

4.1.6 Off-air feeds/antennas/re-transmitters

The estimated costs of additional receivers and of the very directional (higher-gain) antennas to receive the off-air feed has two main components:

- € [X] (receivers costing € [X] each, with 24 new receivers installed at existing sites and 2 new receivers installed at 2 new sites); and
- € [X] (10 highly directional receive antenna, costing € [X] each, installed at 10 sites).

By comparison the 2011 Australian benchmark shows €8,554/site.

²⁸ Source: "Digital TV Restack, Modular Costs, ACMA, February 2011". A typical 2011 Euro to Australian \$ exchange of Aus \$ 1 = € 0.74.

Figure 19 Antennas benchmark data

Receive Antenna Installation			
Type	Receive Antenna	Receive Antenna	
Number of Antennas	1	2	
Mobilisation/demobilisation	5,160	5,160	
Installation	2,150	2,150	
Test equipment	150	150	
New antenna	500	1,000	
Misc materials	100	200	
Input filter	1,200	2,400	
Equipment freight	500	500	
Totals	9,760	11,560	

Source: Source: "Digital TV Restack, Modular Costs, ACMA, February 2011". A typical 2011 Euro to Australian \$ exchange of Aus \$ 1 = € 0.74.

2rn proposes to use antennas which are more directional than typical, in order to reduce any interference which would otherwise occur. This will increase the cost. On the other hand, mobilisation costs in Ireland are likely to be lower than in Australia. Overall, we consider that 2rn's estimate of the costs of purchasing and installing the new antennas, at each of the identified sites, is within range and appears reasonable. Further, a budget of € [X] for a professional receiver is also within the typical range. The average cost of the re-transmitters, at € [X]/site, is within range of the cost of such equipment.

Therefore we conclude that these costs are reasonable and consistent with benchmarks.

4.1.7 Information campaign

2rn has only budgeted a small amount for its information campaign relating to 700 MHz migration, namely €14,000 to cover the 18 local areas in which 700 MHz migration would occur without simulcast. 2rn has not budgeted for a large scale, nationwide information campaign, to inform all consumers about the change. This is because 2rn considers that such a campaign should be the responsibility of the broadcasters, or of the Government and that the process to establish a mechanism for funding of this element of disruption costs will be dealt with in due course.

Therefore we conclude that these costs are reasonable.

4.1.8 Project management

2rn's estimated project management cost is based on 2rn hiring a professional project manager for the duration of the project, plus some 2rn internal project management cost. We consider that 2rn's estimated cost of hiring a professional project manager for the duration of the project appears reasonable.

4.1.9 Site rigging and project engineering

2rn could use its own staff as rigging engineers and project engineers or it could hire externally. This depending on the work load and the time schedule for completing the 700 MHz migration. 2rn's estimates are based on the project taking 24 months complete, at a cost of € [X] per month for site rigging and € [X] per month for project management. Of course, the amount of site rigging and engineering work, and the cost of same, is ultimately dependent upon the final migration strategy per site.

Based on our experience, we consider that 2rn's estimates of its total site rigging and project engineering costs seem reasonable. While there is a degree of uncertainty as to such costs, we note that the staged payments of compensation will ensure that 2rn will not over recover in respect of such costs.

4.1.10 Contingency

In its cost estimate, 2rn included a contingency component of € [X] (23% of costs).

For the following reasons, we propose that a more reasonable contingency budget would be set at 15% of all opex and capex costs. However, we note that while there is a difference in the calculation of the contingency, ultimately this is only a reference point and that any compensation that is eventually paid will only be for actual costs incurred. These may be higher than the contingency.

A contingency budget set at 15% of all opex and capex costs would be significant but not unreasonable, given the level of uncertainties and risks involved. First of all, the final level of interference as may emanate from within Ireland and from the UK, post 700 MHz migration, remains uncertain at this time. The level of interference as may occur depends not only on the new International frequency coordination agreement but also on the actual implementation of this agreement, in the UK and in Ireland. There could be situations where the actual level of interference will be more, or less, than had been anticipated. This can result in a broad range of issues to be resolved. 2rn has budgeted some specific categories upfront (such as two additional sites, fibre links to two sites, highly directional off-air reception antennas for ten sites and five re-transmitter instead of transposers) for this, but it is possible that these will not be sufficient.

There is also uncertainty as to how many viewers will actually be affected by 700 MHz migration, and as to their locations, and as to the degree to which they may be affected.

Finally, the antenna work is highly dependent upon weather conditions, especially at the main hill-top sites. Bad weather could result in many additional days for antenna rigging and other delays in antenna work, resulting in additional costs.

4.1.11 Simulcast costs

The simulcast costs in the budget are covering additional power/cooling capacity required during the simulcast period. This is an additional opex for 2rn which would not be incurred without the 700 MHz migration.

As set out in the below example, this additional electricity cost is significant:

- Assuming a modern transmitter is able to achieve a power efficiency of 35-40% (43% is mentioned by some vendors under ideal cases).
- An additional 10 kW transmit power would require about 27 kW in additional power at the given efficiency. (10 kW will be transmitted, the rest is dissipated as heat in the equipment room.)
- Cooling the 17 kW of additional heat would also require additional energy, (around 50%, about 8 kW).
- This would result in 35 kW of additional power consumption for 24 hours/day and about 180 days of simulcast, so generating 151,200 kWh additional power consumption for a main broadcast site.
- At an electricity tariff of €0.15/kWh this would equate to an additional cost of €22,680/main high power broadcast site for 180 days of simulcast.

In total, 2rn has included a budgeted amount of € 210,000 for this element. Given the assumptions set out above, this seems reasonable. However, the actual power consumed will be highly dependent upon the period of simulcast, the actual power efficiency of the new transmitters and the cooling efficiency of the equipment rooms.

Despite these uncertainties, we conclude that these costs are reasonable and consistent with benchmarks.

4.1.12 Write off costs or revenues

2rn assumes that following migration the transmitters that are replaced are stranded. 2rn assumes that there is no cost incurred in decommissioning and scrapping the equipment at the end of their asset lives, nor that there is any resale value in the decommissioned assets.

This is a reasonable assumption.

5 RESULTS

5.1 Introduction

To derive an appropriate estimate of the compensation that could be due to 2rn, we have applied the compensation methodology set out in Section 2 to the migration costs forecasted by 2rn, as described (and where appropriate, amended) in the preceding section of this report. Section 5.2 presents the results of this analysis.

This results in the following range of compensation:

- €8.6 million assuming simulcast; and
- €4.6 million assuming no simulcast.

This contrasts to the total cost of migration forecasted by 2rn to be €[X] million with simulcast (including stranded asset write-off costs).

As noted in section 3.2 of this document, there are other simulcast options aside from the 2rn simulcast approach modelled in this section. One approach could be to assume “no simulcast” (i.e. all sites use overnight migrations). Alternatively 2rn could adopt a (“limited simulcast”) approach, making explicit site-by-site decisions on the trade-off between the additional costs for simulcast against the benefits in reducing the risk of service degradation for the number of DTT households affected. These options are described in section 5.2. Section 5.3 then presents the results. Finally section 5.4 makes recommendations on the phasing of compensation payments.

5.2 Description of “limited simulcast” and “no simulcast” options

2rn did not provide a fully worked up estimate of the costs assuming limited and no simulcast. We set out below the assumptions made by Frontier to assess costs in each of these scenarios.

5.2.1 “No simulcast” scenario

In assessing the costs for the “no simulcast scenario”, we have removed the costs of transmitters and transposers that are used to provide simulcast and include an additional € [X] in health and safety costs forecasted by 2rn. However we note that the “no simulcast” solution may require greater project management costs since migration will occur over a period of night time changes. For this reason, there is a degree of uncertainty over the estimate of the costs assuming no simulcast, and that costs may be higher than stated in the results.

5.2.2 “Limited simulcast” scenario

A further approach to migration (in addition to simulcast and no simulcast options), could be to use a limited simulcast approach to migration. This would involve providing simulcast to select areas with particular sensitivities (such as on the border region) and areas where simulcast is relatively more cost effective than elsewhere (as more households are likely to be affected).

This scenario is based on the following strategy:

- Simulcast is offered at Clermont Carn, Kippure, Kilduff and Truskmore sites
- Overnight transmission takes place at Holywell Hill, Maghera, Spur Hill and 16 lower transmit power transposer/retransmission sites which would otherwise use simulcast.

Compared to the full simulcast strategy, limited simulcast offers reduced costs in the following ways:

- Avoided capex and opex associated with the replacement and installation of DTT equipment at Holywell Hill, Maghera, Spur Hill and 16 lower transmit power transposer/retransmission sites
- Lower opex associated with the powering/cooling capacity as there are fewer simulcast sites

We note that as with the “no simulcast” scenario, additional costs may result as a “limited simulcast” strategy will require more *overnight* migrations (requiring expensive night hour engineer time), while fewer installations will lower the number of project engineer hours required.

We therefore assume no change in engineer costs compared to 2rn’s full simulcast, but we note that the estimate includes a degree of uncertainty.

5.3 Compensation costs estimate

The reasonable costs to be compensated assuming simulcast (as proposed by 2rn and described in section 3.2), limited simulcast, and no simulcast are in Figure 20.

Figure 20 compares the total compensation recommended using Frontier’s methodology and 2rn’s total forecasted costs under simulcast, limited simulcast and no simulcast scenarios.

Figure 20 Comparison of recommended compensation

	2rn Approach (€)	Frontier Approach (€)
Simulcast	€ [X]	8,600,000
Limited simulcast	€ [X]*	7,000,000
No simulcast	€ [X]*	4,600,000

Source: 2rn forecasted costs, version 12.b.

Note: *Frontier estimate based on 2rn assumptions

For the full simulcast approach, 2rn estimates it will incur costs of €[X]m, whereas Frontier estimates that costs are €8.6m.

Figure 21 below summarises the key differences between 2rn’s proposed approach and Frontier’s approach.

Figure 21 Key differences between 2rn and Frontier’s approach

Cost category	2rn Approach (€)	Frontier Approach (€)	Difference
Transmitter costs and installation	€ [X]	€ [X]	€ [X]
NRV	€ [X]	€ [X]	€ [X]
Contingency	€ [X]	€ [X]	€ [X]
NBV of stranded transmission assets	2,400,000	0	2,400,000
		Total:	4,600,000

Source: Frontier

The differences are driven by the following elements of our approach:

- only partial compensation (in accordance to the methodology set out in section 2) is given for transmitter equipment where migration requires 2rn to bring forward investments that would have been made anyway (since we assume that at the point when 2rn would have replaced its assets the costs will be recovered from the tariff model). This amounts to a € [X] difference between Frontier and 2rn.
- Non-Recoverable VAT²⁹ is a fixed percentage of the costs incurred since 2rn will not be able to recover the full value of VAT on the costs it incurs. This amounts to a € [X] difference between 2rn and Frontier.
- the contingency level is set at 15%, above 23% forecasted by 2rn³⁰; and this amounts to a € [X] difference between 2rn and Frontier.
- the stranded assets are not directly compensated for (since the value of existing transmitters will continue to be recovered from the tariff model). This amounts to a difference of €2.37m difference between 2rn and Frontier.

In the “no simulcast” scenario, the costs fall to €4.6m. Thus “simulcast” has a cost of approximately €4.1m in order to protect between 2,500 – 9,500 DTT-only households, and a further 6,600 – 25,100 households with DTT as a secondary transmission technology (using Frontier estimates) or 50,000 households in total (using 2rn estimates).

As noted in section 3.1, vulnerable groups such as elderly households are likely to be disproportionately among DTT users affected.

Costs to be compensated under a limited simulcast approach are forecasted to be €7 million. Overall, the limited simulcast scenario involves a reduction in recommended compensation by €1.9 million compared to the full simulcast scenario.

²⁹ Due to the legal nature of The RTE Group and 2rn’s position within that Group 2rn is entitled to reclaim only part of the VAT charged to it by suppliers. The actual cost of goods and services to 2rn therefore includes the element of VAT which cannot be reclaimed/recovered, i.e. Un-Recoverable VAT.

³⁰ For a full explanation please see section 4.1.10

5.4 Note on phasing of compensation to avoid over compensation

We propose that the compensation is paid in a number of phases. This is to partly reflect the phasing of the costs incurred by 2rn. In particular, 2rn will phase the tendering of equipment in two discreet phases in early 2017 and late 2017.

A phasing of compensation will also ensure that where actual costs incurred diverge from forecast costs, then the final compensation payment can reflect the reconciliation between actual and forecast costs such that 2rn is not over or under compensated (the process to achieve this is described in more detail below).

We have examined the projected cashflow of 2rn to implement the migration. Our proposed profile of compensation payments broadly reflects 2rn's projected cashflow. This avoids 2rn incurring additional costs to finance investments pending receipt of compensation payments.

Therefore, we consider that the following staged compensation payments should be made:

- Phase 1 early 2017: 60% to reflect tendering and installation of equipment that will be installed in the summer 2017
- Phase 2 late 2017: 30% to reflect tendering and installation of equipment that will be installed in the summer 2018;
- Phase 3 2020: 10% to reflect the final reconciliation between forecast and costs incurred.

In phase 2, the compensation paid will be reviewed to reflect any underspend up to this point.

In order to ensure that the correct level of compensation is paid at phases 2 and 3, ComReg, prior to commencement of phases 2 and 3, will oversee an assessment of the costs which were incurred in the previous phases (i.e., in phase 1 and/or in phase 2). This will include:

- A report from 2rn (potentially provided by its auditors) which identifies all costs incurred in relation to the 700 MHz migration during the previous phase(s). The report will identify whether costs incurred relate to opex or capex, and will enable ComReg to identify whether costs incurred relate to assets which are fully or partially compensated for;
- A report from Frontier³¹ which reviews the costs incurred by 2rn to assure ComReg that those costs are as a direct result of the 700 MHz migration and are in line with the migration strategy set out by 2rn (as described in this report). Frontier's reports will determine the amount of 2rn's "Allowable Costs" and will describe the compensation methodology³².

³¹ Or other suitable party.

³² "Allowable Costs" equal the sum of costs which are fully compensated for incurred as a result of migration, and the portion of costs which are partially compensated for using the methodology described in this report.

At phase 2, if Frontier should determine that the Allowable Costs up to that point are *less* than the amount of compensation that has been paid, this difference will be netted off the compensation payment in that phase³³. Conversely, if at phase 2 Frontier should determine that the Allowable Costs, up to that point, are *more* than the compensation paid in phase 1, RTÉ will not receive a larger compensation payment in phase 2 than the 30% allocated to that phase³⁴.

The payment to RTÉ at phase 3 is to act as a balancing payment such that the total compensation paid will equal the total Allowable Costs incurred, subject to the maximum compensation payable of €8.6m (unless otherwise determined by the DCCAE). If, at phase 3, the Allowable Costs incurred in phases 1, 2 and 3 are *less* than the compensation in phases 1 and 2 (i.e. if there has been an overpayment of compensation) then RTÉ should repay the difference such that the total compensation paid to RTÉ will equal the Allowable Costs.

If, at phase 3, Frontier should determine that the total Allowable Costs are more than the estimate set out in out in this report (€8.6m) RTÉ will not receive more than this amount (unless the DCCAE considers otherwise). Given that the Allowable Costs include a contingency, the DCCAE expects RTÉ to take on the risk that Allowable Costs may exceed the maximum compensation payable (€8.6m).

If, at phases 2 or 3, Frontier should determine that the 700 MHz migration strategy differs materially from the planned strategy (as described in this report) then Frontier may recommend changing the total level of compensation paid accordingly.

³³ For example, if Allowable Costs in phase 1 were €4.6m and €5.6m compensation was paid, then the difference of €1m, will be netted off the phase 2 payment (reducing it from €2.6m to €1.6m).

³⁴ For example, if Allowable Costs in phase 1 were €6.6m and €5.6m compensation was paid, in phase 2, 2m will not as a result receive higher compensation than planned (i.e. it will receive €2.6m).

ANNEX A FURTHER DISCUSSION OF THE LIKELY IMPACT OF THE USE OF GROUPED AERIALS ON MIGRATION

This annex provides more detail and context to the discussion in section 3.1 on the percentage of customers who are likely to be affected by the migration as a result of having grouped aerial installed.

It considers:

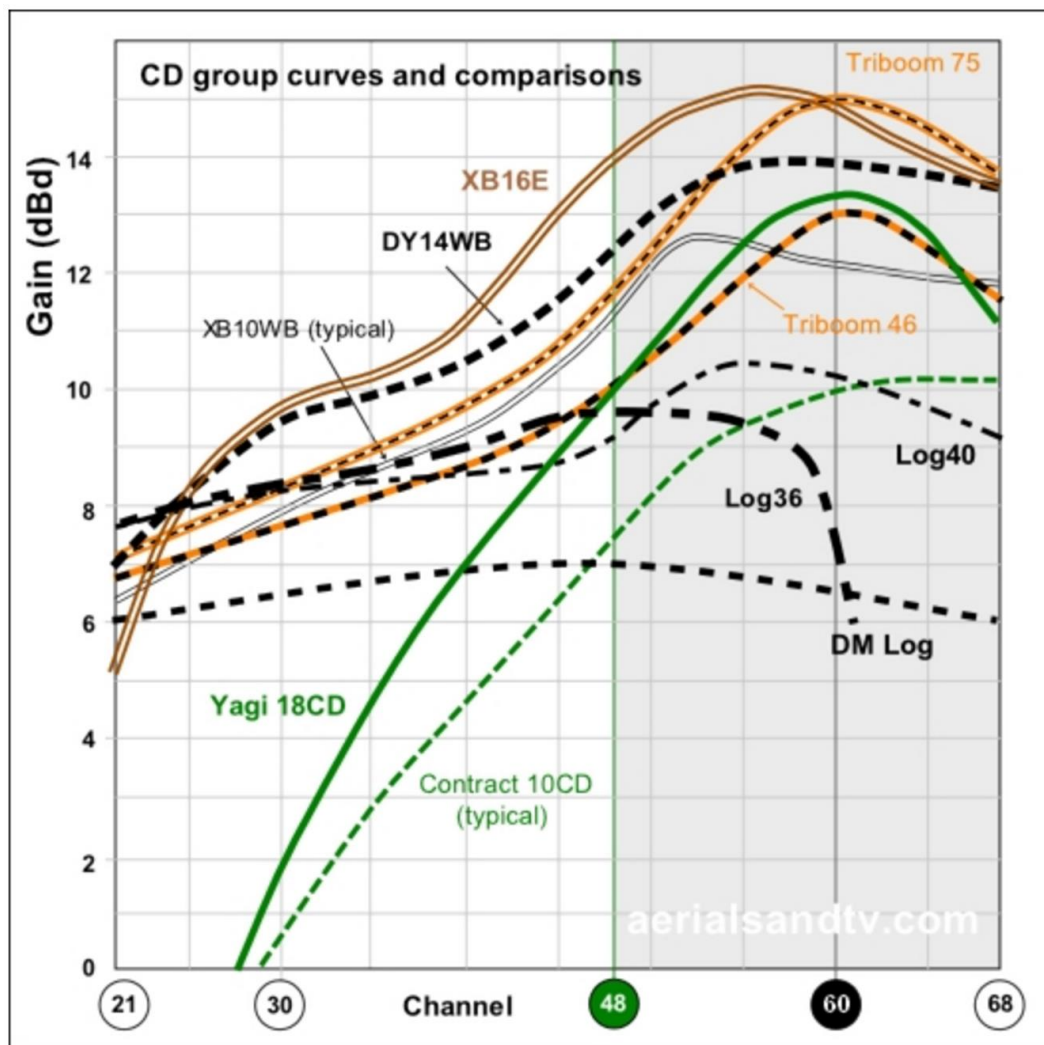
- the impact of migration on households with grouped aerials
- the percentage of households who have grouped aerials.

A.1.1 The impact of migration on households with grouped aerials

To illustrate the impact from using a grouped antenna to receive UHF channels for which is not designed on antenna gain³⁵ is set out in Figure 22. The graph shows the available gain across a number of UHF frequencies/channels for a number of different grouped C/D aerials (optimised for channels 46-68 i.e. the shaded part of the chart) is shown in Figure 22. All antenna show decline in gain from frequencies outside the optimised channels (channels 46-68). Therefore when services migrate to the lower part of the UHF band (below channel 48) C/D grouped antennas can expect to experience a decline in gain. The rate of decline depends on the specific antenna. However, most (properly antennas still receive the signal but at a lower gain. Therefore the precise fall in gain for users with Group C/D antennas will depend on frequencies which the muxes broadcast following migration. Where households' antennas are aimed at masts which transmit on channels close to the upper part of the UHF band used for DTT, they will show a minimal effect on gain.

³⁵ Antenna gain is a measure of the effectiveness of a reception antenna.

Figure 22 Group C/D aerial gain between channel 21 and 68



: Source: www.aerialsandtv.com/gaincurves.html#CDallcurves

In practice, poor aerial installation means that some households could have fringe-like coverage even though they are located in a good coverage area. The percentage of households who could fall into this category is, however, difficult to estimate.

In addition, there are two other factors that could affect reception:

- Increased interference/congestion of the spectrum due to a tighter frequency reuse and more interference from the UK is possible. This is because both Ireland and the UK will have to reuse the frequencies more often after migration out of the 700 MHz band. So this could impact users even in areas without a local change of frequency.
- Changes in aerial installations due to two new proposed fill-in sites in an area with anticipated increased interference from the UK (blue areas).

A.1.2 The percentage of households who have grouped aerials

We consider below the likely number of households affected by grouped antennas which may be affected by the migration.

There are no known large-scale UHF TV aerial survey results available for Ireland to determine which type of aerial is used by how many households and what quality that aerial offers. However there are some benchmarks available from the UK where some studies have been performed under somewhat similar grouped aerial conditions.

Benchmark data based on UK data is available. We recognise that the UK is not an ideal benchmark for the use and deployment of terrestrial TV aerials. This is because DTT has been available since the late 1990s in the UK, it offers more multiplexes and has become more popular in the UK. Furthermore we note the comments made by 2rn in response to ComReg's consultation on its Draft Radio Spectrum Management Strategy 2016 to 2018³⁶ where 2rn noted that the UK context was not directly applicable to the Irish context. In particular,

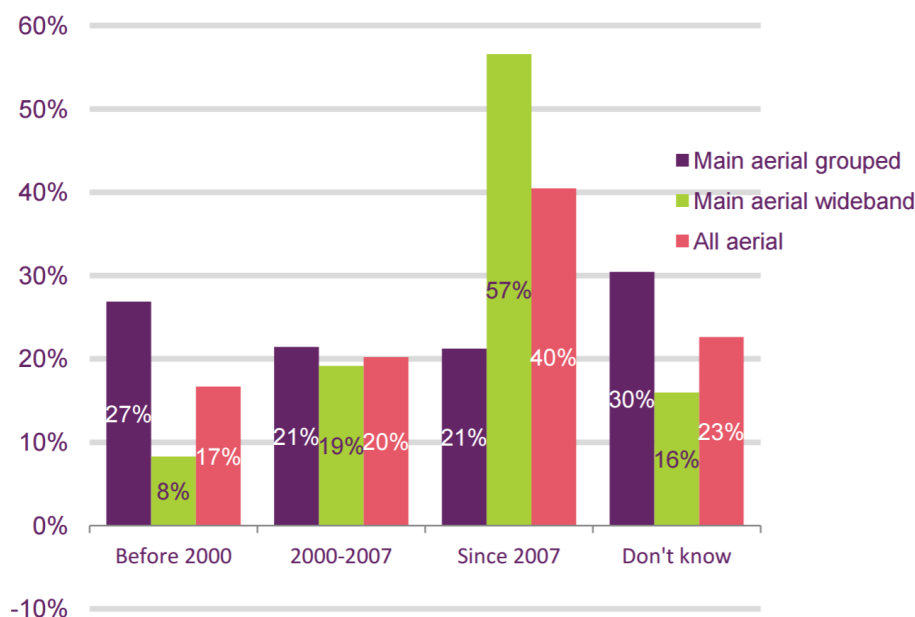
“UK estimates of the number of households requiring a retune [as a result of the 700 MHz migration] should not be applied in Ireland, where typical reception conditions can be very different given the development of terrestrial reception predominantly based on longer range reception, often including multiple sources (e.g. Irish and UK TV).”

However, despite the differences it does provide a useful benchmark to cross check against the assumptions made by 2rn. We therefore considered three sources of benchmark information.

- Ofcom, “Rooftop TV Aerial Performance in Manchester”, Report on Q4 2015 Household Visits and Measurements
- Ofcom, “Consumer aerial survey, Implementing Ofcom’s UHF Strategy”, 2014
- Ofcom, “Managing the effects of 700 MHz clearance on PMSE and DTT viewers. Summary of progress and call for input”. March 2016

The UK consumer aerial survey has shown that the use of wideband aerials, instead of grouped aerials, has increased over time (see Figure 23 below). Before 2000, wideband aerials represented only 8% of the total and grouped aerials were dominant. However, since 2007, wideband aerials are now used (as a main household aerial) in 57% of DTT households, and have overtaken grouped aerials.

³⁶ RTÉ & 2RN RESPONSE TO COMREG CONSULTATION Draft Radio Spectrum Management Strategy 2016 to 2018 ComReg 15/131, 1st February 2016

Figure 23 Grouped and wideband aerial replacement trend

Source: Ofcom, Consumer aerial survey, Implementing Ofcom's UHF Strategy, 2014

Base: All households talked to with an outdoor aerial in use, excluding those households where we are unsure about the aerial type (2,292), with grouped main aerial (1,031) and wideband main aerial (1,253)

Indicatively, about half of the aerials, also in the group C/D coverage areas already had become wideband aerials in the UK. This implies that those viewers will not be impacted significantly or suffer from weaker signal levels after a frequency retune. If similar trends are applicable to Ireland as well, this would reduce the impact of a frequency retune.

Ofcom's study on Rooftop TV Aerial Performance in Manchester³⁷ assumes that in the UK about 75-90% of the aerials will be of the wideband type by the time of the frequency retune. Following actual measurements of aerials (which included effects like poorly installed aerials, damaged aerials, etc.) the number of affected households was estimated to be 100,000 – 160,000 out of total DTT TV households of about 20 million, or less than 1%.

In the UK Ofcom estimated that the 700 MHz retune would affect between 140,000 up to 270,000 out of 20 million DTT households³⁸, **0.7% up to 1.35%**. This is significantly lower than the 50,000 out of 977,000, **5.1%**, estimated by 2rn for Ireland.

As noted above, we recognise that the UK is not a direct comparator. In particular, unlike the UK, there are significant areas in Ireland which have dual reception (from Ireland and the UK) and some households will have two aerials coupled to one cable. However, we consider that the UK remains a relevant benchmark. For example there is similarity in the UK and Ireland in terms of: the

³⁷ See: https://www.ofcom.org.uk/_data/assets/pdf_file/0027/74277/manchester_research_report.pdf

³⁸ Of which 100,000-160,000 households may need to replace their aerials and 40,000-110,000 households may need to repoint their aerials.

See: https://www.ofcom.org.uk/_data/assets/pdf_file/0027/71928/700_mhz_implementation.pdf

use of grouped aerials, the construction of houses and attaching aerials to these households, it has similar sources for aerials,

ANNEX B COMPENSATION COST BREAKDOWN

The full breakdown of estimated compensation costs is set out below in Figure 24.

Figure 24 Full cost breakdown

Category	Item	Frontier recommended compensation assuming simulcast (€)	Frontier recommended compensation assuming limited simulcast (€)	Frontier recommended compensation assuming no simulcast (€)	2rn forecasted costs (€)
Transmission Equipment	Transmitters, Transposers, Installation	€ [X]	€ [X]	€ [X]	€ [X]
	Transposer combiners, combiner disconnect prep	€ [X]	€ [X]	€ [X]	€ [X]
	Transposers for new site	€ [X]	€ [X]	€ [X]	€ [X]
	Transposer combiners for new site	€ [X]	€ [X]	€ [X]	€ [X]
	Combiner re-tuning	€ [X]	€ [X]	€ [X]	€ [X]
Antennas & Structures	Replacement	€ [X]	€ [X]	€ [X]	€ [X]
	Surveys (Structures and Cabins)	€ [X]	€ [X]	€ [X]	€ [X]
	Structural Strengthening	€ [X]	€ [X]	€ [X]	€ [X]
	New site development (2 Sites)	€ [X]	€ [X]	€ [X]	€ [X]
	Antenna Modification & Retunes	€ [X]	€ [X]	€ [X]	€ [X]
Network & Distribution	Fibre links to distribution network for resilience	€ [X]	€ [X]	€ [X]	€ [X]
	SFN Configuration	€ [X]	€ [X]	€ [X]	€ [X]
	RBR Backup Network	€ [X]	€ [X]	€ [X]	€ [X]
	Off-air Feeds/Antennas/Filters/Re-Transmitters	€ [X]	€ [X]	€ [X]	€ [X]
Project & Resourcing	Information for local switchovers	€ [X]	€ [X]	€ [X]	€ [X]
	Consultant Project Management	€ [X]	€ [X]	€ [X]	€ [X]
	Site Rigging and Engineering	€ [X]	€ [X]	€ [X]	€ [X]
	Project Engineers	€ [X]	€ [X]	€ [X]	€ [X]
	Frequency Planning and Reception Investigation	€ [X]	€ [X]	€ [X]	€ [X]
	Environmental, Health and Safety	€ [X]	€ [X]	€ [X]	€ [X]
	Contingency	€ [X]	€ [X]	€ [X]	€ [X]
Sub-total		€ [X]	€ [X]	€ [X]	€ [X]
Sub-total incl. NRV		€ [X]	€ [X]	€ [X]	€ [X]
Write-offs		-	-	-	€ [X]
Simulcast Costs		210,000	119,720	-	210,000
Total		8,643,477	6,974,639	4,577,576	€ [X]

Source: Frontier

