Commission for
Communications Regulation

Response to Survey and Decision
Fixed Links Survey

Response to Survey

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Additional Information

Approval

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1 Introduction

1 In February 2012, ComReg published a Fixed Links Survey[1] to gauge the experiences of licensees with a view to informing a future revision of the engineering guidelines[2]. The publication of the survey is part of ComReg's Strategy for Managing the Radio Spectrum: 2011 – 2013[3] .

2 This Response to Survey only addresses issues raised in responses received to Survey 12/10[1] and does not restate ComReg's proposed approach, policy or position where there has been general agreement expressed with ComReg's proposal and where, as a result, this approach, policy or position is unchanged from that set out in Document 11/89[3].

3 This document summarises the responses received from interested parties and outlines ComReg's position and the actions that ComReg intends to take in response to the points raised by interested parties.

4 The amendments set out in this document will come into effect upon the publication of the revised engineering guidelines[2], which will be published in due course.

1.1 List of Respondents

5 Seven interested parties provided a response to Fixed Links Survey 12/10 and ComReg is grateful to all respondents for their input:

- Aviat Networks (Aviat)
- BT Communications Ireland Ltd (BT)
- eircom Group (eircom)
- European Satellite Operators Association (ESOA)
- Inmarsat
- UPC Ireland (UPC)
- Vodafone Ltd (Vodafone)

[1] ComReg Document 12/10 - Fixed Links Survey - published 15 February 2012.
[2] ComReg Document 09/89 - Guidelines to Applicants for Radio Links Licences - published 27 November 2009.
[3] ComReg Document 11/89 - Spectrum Management Strategy Statement - published 22 November 2011.

6 ComReg has published non-confidential versions of all responses received in Document 12/104s[4] and information marked as confidential is in accordance with ComReg Document 05/24[5].

[4]ComReg Document 12/104s - Submissions to Fixed Links Survey – published September 2012.
[5] ComReg Document 05/24 - Guidelines on the treatment of confidential information– published 22 March 2005.

2 Background

7 The purpose of the Fixed Links Survey[6] was to seek information on the experiences of licensees with a view to informing a future revision of the current engineering guidelines[7]. In particular, ComReg asked respondents to comment on the following proposed areas of reform raised in ComReg's Response to Consultation Document 11/88[8] :

- current high/low interference search radii used for the 23 GHz and 26 GHz Fixed Links bands;
- making 56 MHz and higher bandwidth channels available in current and new fixed links bands;
- opening of further fixed links bands in the next strategy review period covering 2014-2016 and
- the possibility of making spectrum in three new frequency bands scheduled for release in the period 2011-2013 available for Point-to-Point (PP) and/or Point-to-Multipoint (PMP) use.

8 ComReg requested operators to provide technical data and documents in support of the views expressed in their responses to this survey.

[6] ComReg Document 12/10 - Fixed Links Survey - published 15 February 2012.
[7] ComReg Document 09/89 - Guidelines to Applicants for Radio Links Licences - published 27 November 2009.
[8] ComReg Document 11/88 - Response to consultation 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013 - published 22 November 2011.

3 Responses to Survey

3.1 High/low Interference Search Radii

9 In response to ComReg's consultation document 11/28[9], a number of respondents requested ComReg to reduce the High-Low search radius of 200 metres to 100 metres for the 23 GHz and 26 GHz frequency bands. In particular, one respondent stated that the High-Low radius of 200 metres was causing a "*significant limitation" to their ability to utilise fixed links in the 26 GHz band efficiently, particularly in dense urban areas*." [10]

10 In the Fixed Links Survey[11] document 12/10, ComReg stated the following:

- that far-field approximation is currently employed to calculate the high/low interference radius, as shown in equation 1.

Equation 1:

$R \geq \frac{2D^2}{\lambda}$ or, since $\lambda = \frac{v}{f}$

=> $R \geq 6.7.D^2.f$

where D = diameter of antenna (metres), λ = wavelength, v = velocity $(3 * 10^8 m/s)$, & f = frequency (GHz);

- that if the High-Low search radius is causing significant limitation to deploy fixed links then a possible solution for reducing the search radii in the 23 GHz and 26 GHz bands would be to limit the antenna size to 0.6 metres on links in urban areas. As this would allow for the reduction of search radius to 100 metres, ComReg proposed that an antenna with a diameter greater than 0.6 metres would only be licensed in rural areas and would be subject to a search radius of 200 metres.

- that ComReg is willing to reduce the co-ordination distance, subject to sufficient technical proof that interference would not increase and subject to the agreement of current licensees in the 26 GHz band. And asked the following question:

[9] ComReg Document 11/88 - Response to consultation 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013 - published 22 November 2011.
[10] ComReg Document 11/28s - Submissions to Consultation 11/28 - published 9 September 2011.
[11] ComReg Document 12/10 - Fixed Links Survey - published 15 February 2012.

Q. 1 Please state your views regarding the current and proposed search parameters for the 23 GHz and 26 GHz bands as well as for existing and new frequency bands, providing technical proof in support of your views as appropriate.

3.1.1 Views of Respondents

11 Four respondents, BT, eircom, UPC and Vodafone, provided comments to Question 1.

12 BT, eircom and Vodafone supported ComReg's proposed reduction in radius with BT and eircom of the view that it would assist in planning links in urban areas.

13 BT stated that antenna beamwidths in the higher frequency ranges would be quite narrow so interference would be minimal. It considered that having separate urban and rural search radii may complicate the licensing process. While Vodafone requested that ComReg clearly delineate the urban areas within which the reduced interference radius will be permitted.

14 eircom, UPC and Vodafone were supportive of the proposal to limit the antenna size to a maximum of 0.6 metres in urban areas. UPC suggested careful consideration would need to be given to the technical specifications of the antenna used as smaller antennas are likely to have lower rejection specifications.

15 UPC stated that it had not encountered any issues when planning radio links in either the urban or rural areas but recognised that limitations are likely to exist when planning within the main urban areas.

3.1.2 ComReg's Position

16 ComReg notes that none of the four respondents that supported a reduction of the search radius from 200 metres to 100 metres submitted supporting technical reasoning.

17 There was, however, strong consensus amongst the respondents that a search radius of 100 metres would aid frequency planning and encourage spectrum reuse in both the 23 GHz and 26 GHz bands.

18 As set out in the Fixed Link Survey a reduced High-Low search radius of 100 metres is greater than the calculated minimum separation distance of 56 metres and 63 metres for a 0.6 metre antenna employed in the 23 GHz and 26 GHz bands respectively. ComReg agrees with respondents that a reduced search radius of 100 metres would assist with fixed link planning and promote more efficient frequency reuse in urban areas where demand for 23 GHz and 26 GHz links is greatest.

19 ComReg agrees that the narrow beamwidths in the higher frequency bands will minimise interference between sites with a separation distance of 100 metres.

20 ComReg's database indicates that antennas with a diameter greater than 0.6 metres are not widely used in either the 23 GHz or 26 GHz bands. For example, the maximum antenna size used in the 26 GHz band is 0.6 metres and the total number of links in the 23 GHz band employing antennas greater than 0.6 metres is 61 accounting for 3% of the total number of licensed links in the 23 GHz band. These links are predominantly situated in rural locations and will not need to be swapped out for a smaller diameter antenna. The majority of 23 GHz and 26 GHz fixed links are located in urban areas and employ antenna less than or equal to 0.6 metres.

21 Therefore, ComReg will implement the new reduced High-Low search radius of 100 metres and limit the antenna size to 0.6 metres in both the 23 GHz and 26 GHz bands. The new High-Low search radii will come into effect upon the publication of the revised engineering guidelines, which will be published in due course[12].

22 Given the low number of fixed links employing antennas greater than 0.6 metres and the associated difficulty defining urban and rural boundaries ComReg considers that it is not appropriate to introduce separate search radii for urban and rural areas.

23 ComReg will monitor the effect the reduced High-Low search radius has on fixed links interference. If the reduced High-Low search radius leads to an increase in interference in the 23 GHz and 26 GHz bands, ComReg reserves the right to revert the High-Low search radius to 200 metres in these bands.

[12] To ensure that the potential for interference is kept to a minimum, all equipment licensed in the fixed link bands must adhere to the technical specifications as set out in relevant guidelines document.

3.2 Further Release of 26 GHz Spectrum

24 One respondent to ComReg's consultation 11/28[13] stated that there were technical issues relating to the 26 GHz band that needed to be resolved before the issuing of any further National Block licences. Arising from this ComReg asked the following question in its survey:

Q. 2 Is the High/low interference radius the only issue that needs resolution before ComReg can consider releasing further National Block licences in the 26 GHz band at some future date?

3.2.1 Views of Respondents

25 Five respondents, Aviat, BT, eircom, UPC and Vodafone, provided comments to Question 2. Three respondents, eircom, UPC and Vodafone said that there were no other issues to be addressed regarding the release of further National Block licences. Two respondents, Aviat and BT, raised issues regarding block licensing.

26 Aviat questioned whether block licensing is the most spectrum efficient method of allocating spectrum to users because:

- once a user is allocated a block of spectrum, no other user has access to that spectrum which could either cause congestion in other bands or lack of competition in service provision and
- the owner of this block of spectrum may not have sufficient traffic to fully utilise the amount of spectrum owned and as a result the spectrum is underutilised.

27 BT stated that ComReg should consider allowing the use of 56 MHz channels where operators have consecutive blocks of spectrum.

[13] ComReg Document 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013. - published 12 April 2011.

3.2.2 ComReg's Position

28 Regarding the potential for under utilisation of National Block licences, ComReg would note that to date a total of 1,550 fixed links have been deployed by four operators with 26 GHz National Block licences since the licences were awarded five years ago. This represents 12% of the total number (12,480) of fixed links deployed within Ireland. Contrary to Aviat's assertion, ComReg considers this to be an indication of high utilisation of the 26 GHz National Block allocations when compared with the other fixed link bands which are currently open. The high utilisation of the 26 GHz National Block assignments demonstrates the effectiveness of auction mechanisms in enabling spectrum efficiency.

29 While congestion has been an issue in the 23 GHz band, the introduction of National Block licensing in 2007, has enabled operators with National Block licences to migrate fixed links from the 23 GHz band to the 26 GHz band. In addition the introduction of congestion charges for the 18 GHz and 23 GHz frequency bands[14] in 2009 has also contributed to the utilisation of 26 GHz National Block allocations. The issuing of National Block licences within the 26 GHz band has not led to congestion in other bands and there is no evidence to suggest a lack of competition in service provision.

30 ComReg is of the view that National Block licensing within the 26 GHz band has offered high volume spectrum users greater flexibility for effective network planning and spectrum use. National block licensing allows operators to quickly deploy and efficiently manage their 26 GHz fixed links, without the need to submit an application and wait for technical processing by ComReg. This flexibility encourages operators to utilise their 26 GHz National Block allocations.

31 With regard to BTs request that ComReg should consider allowing operators with contiguous National Blocks to deploy 56 MHz channels in their assignments, ComReg notes that the 26 GHz National Block guidelines[15] state *"…the maximum channel size that can be used is 28 MHz. However ComReg will consider all written requests for channel sizes greater that 28MHz from operators with contiguous block assignments"*. Recommendation T/R 13-02[16], Annex B allows for the introduction of channels sizes of 56 MHz.

[14] ComReg Document 09/89 - Guidelines to Applicants for Radio Links Licences - 27 November 2009. http://www.comreg.ie/_fileupload/publications/ComReg_0989.pdf
[15] ComReg Document 06/37cR1 - Guidelines for National Point-to-Point and Point-to-Multipoint Block Licences in the 26 GHz Band - 6th June 2008.
[16] Recommendation T/R 13-02 (Montreux 1993, amended Tromsø, May 2010) - Preferred Channel Arrangements for Fixed Service Systems in the Frequency Range 22.0 - 29.5 GHz.

32 Higher bandwidths are necessary to deal with the increased demand for data across mobile networks. ComReg considers that allowing National Block licensees to utilise 56 MHz channel spacing in the 26 GHz band, would encourage the efficient use of the spectrum.

33 With the introduction of 56 MHz channels for operators who have contiguous blocks of spectrum, the number of fixed links is likely to increase within the National Block allocations.

34 ComReg will allow the use of 56 MHz channels in the 26 GHz band, but only where the licensee has a National Block licence containing contiguous blocks of spectrum. However opening new frequency bands permitting 56 MHz channel bandwidths and higher will ensure that all operators will have access to high channel bandwidths if required.

35 As stated in ComReg's Spectrum Management Strategy Statement[17], the 26 GHz band has potential for further release of National Block Licences. ComReg will consider reopening the 26 GHz National Block licensing scheme for a further round of assignments subject to market demand.

3.3 Higher Bandwidths for Existing Bands

36 On foot of responses received to document 11/28[18] in relation to allowing higher bandwidths in Table 1 below, ComReg posed the following question in its survey:

Frequency Band (GHz)	Raster (MHz)	CEPT/ERC/REC	Minimum Transmission Capacity
13	56	12-02 E	2 x STM-1
15	56	12-07 E	2 x STM-1
18	110	12-03 E	4 x STM-1
23	112, 56	T/R 13-02 Annex 1	4 x STM-1, 2 x STM-1
38	112, 56	T/R 12-01 E	4 x STM-1, 2 x STM-1

Table 1: Potential new bandwidths for frequency bands, which are currently open

[17] ComReg Document 11/89 - Spectrum Management Strategy Statement - published 22 November 2011.
[18] ComReg Document 11/88 - Response to consultation 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013 - published 22 November 2011.

Q. 3 What are your views regarding the potential for permitting higher bandwidths in current fixed links bands as shown in Table [1]?

3.3.1 Views of Respondents

37 Five respondents, Aviat, BT, eircom, UPC and Vodafone broadly supported the potential for permitting higher bandwidths in current fixed links bands.

38 Aviat proposed that the channel occupancy for 112 MHz channels be the same as the 56 MHz channel occupancy, as the technology for bandwidths of order 112 MHz is still under development. Furthermore, Aviat recommended that the minimum capacity should be stated as an aggregate capacity (in Mbps) as 4 × STM1 could mean anything between 622 and 760 Mbps (4 × 180).

39 BT stated that permitting higher bandwidths would increase the potential use of spectrum and make fixed link transmission more competitive against fibre delivery to transmission sites.

40 eircom supported the opening of higher bandwidths to allow for high speed broadband roll out at radio served exchanges.

41 UPC stated that 56 MHz channel spacing is supported by most equipment manufacturers and dual polarised links utilising 56 MHz Bandwidth would allow operators meet their capacity requirements while ensuring spectrum efficiency.

42 Vodafone stated that the improvements in mobile technology, such as High Speed Packet Access (HSPA) and Long Term Evolution (LTE), are driving the requirement for higher fixed links bandwidths.

3.3.2 ComReg's Position

43 ComReg does not agree with Aviat's proposal that channels with 112 MHz bandwidth should have the same minimum channel occupancy as channels with 56 MHz bandwidth. The purpose of the minimum transmission capacity is to ensure that the channel bandwidths are efficiently utilised and spectrum hoarding is discouraged. Frequency bands currently in use with bandwidths greater than 28 MHz have minimum transmission capacities attached to ensure spectrum efficiency and prevent spectrum hoarding. For example; 55 MHz bandwidth channels in the 18 GHz band can only be assigned when spectrum efficiency can be justified, i.e. 2 x STM-1 minimum requirement.

44 In ComReg's view it is spectrally inefficient to allow a 112 MHz channel operate with the same minimum transmission capacity as that of a 56 MHz channel, where a 56 MHz channel will suffice for a given data rate. Allowing 112 MHz channels to have the same channel occupancy as 56 MHz channels would prevent other operators accessing the spectrum and cause unnecessary congestion in the frequency bands. Aviat put forward a similar argument for adopting spectrum efficiency in their response to question 2. In their response they stated "*… the owner of this block may not have sufficient traffic to fully utilise the amount of spectrum he now owns and as a result this spectrum is underutilised.*"[19]

While ComReg recognises that the technology for bandwidths of the order of 112 MHz is still under development, 112 MHz bandwidth channels have the potential to carry higher data rates compared with 56 MHz bandwidth channels. As such a minimum transmission capacity of 4 x STM-1 (622 Mbps) will be applied for 112 MHz bandwidth channels to prevent spectrum hoarding and to ensure spectrum efficiency.

45 Regarding Aviat's proposal that that the minimum capacity be stated in the fixed links guidelines as an aggregate capacity, as for example 4 x STM-1 could mean a capacity of between 622 to 760 Mbps. ComReg notes that STM-1 (Synchronous Transport Module level-1) is a transmission standard and has a recognised minimum data rate of 155.5 Mbps. Therefore, a minimum transmission capacity of 4 × STM-1 is taken as having a minimum data rate of 622 Mbps.

46 The technical conditions section in Annex 1 of the current fixed links guidelines set out the minimum transmission capacity in Mbps for each of the bands. Where a minimum transmission capacity is required for a particular bandwidth, this is set out in the notes column of the technical conditions section in Annex 1 of the Fixed Links Guidelines[20]. In the interest of clarification, ComReg will state in the technical conditions section that STM-1 is recognised as having a minimum data rate of 155.5 Mbps.

47 ComReg will permit the use of the higher bandwidths as shown in Table 1.

[19] ComReg Document 12/10s - Submissions to Fixed Links Survey - published XXXX.
[20] ComReg Document 09/89 - Guidelines to Applicants for Radio Links Licences - published 27 November 2009.

3.4 Future Fixed Links Bands

48 ComReg posed the following question in relation to new frequency bands and reflecting its Spectrum Management Strategy Statement[21]:

Q. 4 Would you welcome the opening of these three frequency bands? Are there any additional bands that ComReg should also consider? Support your answer.

3.4.1 Views of Respondents

49 Seven respondents, Aviat, BT, eircom, European Satellite Operators Association (ESOA), Inmarsat, UPC and Vodafone, provided comments in relation to Question 4.

50 Five of the respondents, Aviat, BT, eircom, UPC and Vodafone support the opening of the three new frequency bands (28 GHz, 31 GHz and 40 GHz); however, they did not comment on the other unopened frequency bands.

51 Two respondents, ESOA and Inmarsat, requested that the 28 GHz band not be opened for fixed link services stating that:

- there is demand at Ka-band (17.3 - 20.2 GHz and 27.5 - 30 GHz) for the provision of satellite applications;
- the current available Ka-bands, 19.7 - 20.2 GHz and 29.5 - 30.0 GHz are insufficient for satellite systems that are planned including the new Inmarsat Global Xpress; and
- the use of the band 29.0 - 29.5 GHz for fixed link services should be avoided to allow for the deployment of Inmarsat's Global Xpress satellite services in and around Ireland.

52 A survey by the Global VSAT Forum identified at least 26 Ka-band satellite systems in operation and a further 35 systems planned for launch over the next few years and these systems will operate in ka-band range 27.5 - 29.5 GHz, which is suggested by ComReg as a new fixed link band.

[21] ComReg Document 11/89 - Spectrum Management Strategy Statement - published 22 November 2011.

3.4.2 ComReg's Position

53 ComReg set out in document 11/28[22] its intention to open new frequency bands for fixed links services and stated in its Spectrum Management Strategy Statement[23] that three frequency bands (28 GHz, 31/32 GHz and 40 GHz) were to be opened for fixed links services.

54 Currently the band 27.5 – 29.5 GHz is allocated to both the Fixed Service and Fixed Satellite Service on a co-primary basis in the Radio Regulations. ECC/DEC/(05)01[24], designates the bands 27.8285-28.4445 GHz and 28.9485-29.4525 GHz for the use of fixed services (FS) and the frequency ranges 27.5-27.8285 GHz, 28.4445-28.8365 GHz, 28.8365-28.9485 GHz and 29.4525-29.5 GHz (Ka-band) for the use of uncoordinated Fixed-Satellite service (FSS) Earth stations.

55 The total amount of spectrum currently available for FSS in the 28 GHz band is 880 MHz, which represents 44 % of the band. This is in addition to the exclusive FSS allocation in the 29.5 – 30 GHz allocation in the adjacent band. ComReg would note that it has not seen a demand for FSS services in the 28 GHz band. To date ComReg has issued just 1 licence for FSS use in the 28 GHz band. The majority of satellite licences issued by ComReg have been for the 12-18 GHz frequency bands (Ku-band).

56 With regard to the opening of the 28 GHz band for FS ComReg would note that a number of CEPT countries have already made this band available for fixed services. In addition ECC Report 173[25] recognises the expected increase in demand for fixed services as mobile broadband network traffic continues to grow with a number of CEPT countries forecasting an increase in the use of the 28GHz band for fixed services. ComReg is therefore of the view that it is important that this band is opened for fixed services in accordance with ECC/DEC (05)01 to facilitate the growing trend in mobile technology.

57 ComReg does not consider that it is spectrally efficient to allocate the frequency range (29.0 – 29.5 GHz) to FSS on an exclusive basis given that the existing allocated frequency ranges (27.5-27.8285 GHz, 28.4445-28.8365 GHz, 28.8365-28.9485 GHz and 29.4525-29.5 GHz) of the 28 GHz band are already open and underutilised in Ireland. It would also be contrary to ECC/DEC (05)01 which seeks to harmonise the use of spectrum throughout CEPT countries.

[22] ComReg Document 11/88 - Response to consultation 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013 - published 22 November 2011.
[23] ComReg Document 11/89 - Spectrum Management Strategy Statement - published 22 November 2011.
[24] ECC/DEC/(05)01 - ECC Decision of 18 March 2005 on the use of the band 27.5-29.5 GHz by the Fixed Service and uncoordinated Earth stations of the Fixed-Satellite Service (Earth-to-space).
[25] ECC Report 173 - Fixed Service in Europe - Current use and future trends post 2011 – March 2012.

58 The 28 GHz band will be opened in line with Recommendation T/R13-02 Annex C[26]and ERC/DEC/(05)01[27].

59 The 32 GHz (31.8 - 33.4 GHz) band may be made available in the future for PP/PMP use, pending a review for the release of further spectrum and the demand on spectrum for PP use in the 31 GHz (31.0 - 31.3 GHz paired with 31.5 - 31.8 GHz) band.

60 There appears to be significant interest in the opening of the 28 GHz, 31-32 GHz and 40 GHz bands and as a result ComReg intends to initially open the frequency bands as set out in Table 2 below.

Frequency Band (GHz)	Raster (MHz)	CEPT/ERC/REC	Minimum transmission capacity (Mbps)
28 (27.9405 - 28.4445 paired with 28.9485 - 29.4525)	112, 56, 28, 14, 7, 3.5	T/R 13 02 Annex C	311 (56 MHz), 622 (112 MHz)
31 (31.0 - 31.3 paired with 31.5 - 31.8)	28, 14, 7, 3.5		4
40 (40.5 - 43.5)	112, 56, 28, 14, 7	(01)04	311(56 MHz), 622 (112 MHz)

Table 2: New frequency bands for point-to-point fixed links

61 Given the response received and the current lack of demand the frequency bands 49 GHz, 52 GHz, 56 GHz, 58 GHz and 65 GHz will not be made available at this time, but they may be made available in the future. ComReg will consider the release of further spectrum in the next spectrum strategy review period covering 2014-2016.

3.4.3 Other Issues Raised by Respondents

62 Vodafone stated that it believes that there is scope to assign blocks of spectrum in the 38 GHz band for use in congested areas.

[26] ECC Recommendation T/R 13-02 - Preferred Channel Arrangements for Fixed Service Systems in the Frequency Range 22.0 - 29.5 GHz – published May 2010.
[27] ECC/DEC/(05)01 - ECC Decision of 18 March 2005 on the use of the band 27.5-29.5 GHz by the Fixed Service and uncoordinated Earth stations of the Fixed-Satellite Service (Earth-to-space).

3.4.3.1 ComReg's Position

63 Spectrum in the 38 GHz band for fixed links has been licensed on an individual link basis since the band was originally opened. There are quite a number of multi user channels within the 38 GHz and the introduction of National Block licensing may result in operators having to change channel. This could result in operators having to replace existing equipment and there is no guarantee that a suitable alternative channel would be available, especially if the link is located in a congested area.

64 As such ComReg does not consider it appropriate to introduce National Block assignments in the 38 GHz band at this time, but will continue to assign fixed link licences on a case by case basis and will keep the possibility of block licensing in the 38 GHz band under review.

3.5 Point-to-Multipoint bands

65 ComReg received no responses to ComReg's consultation document 11/28[28] regarding opening new bands for Point-to-Multipoint (PMP) use. However, several queries were received outside of the consultation process regarding the use of Point-to-Multipoint systems.

66 Consequently, ComReg asked the following question in relation to new frequency bands for Point-to-Multipoint:

Q. 5 Please state your views regarding opening part of the new frequency bands for Point-to-Multipoint use.

3.5.1 Views of Respondents

67 Five respondents, Aviat, BT, eircom, UPC and Vodafone, provided comments to Question 5.

68 Aviat was not in favour of opening new bands for PMP use and stated:

- there are only two PMP vendors offering Frequency-Division Duplexing (FDD) systems that support Time-Division Multiplexing (TDM) and that in terms of the limited number of vendors in this market segment, this is potentially anti-competitive,
- that the opening of these bands for PMP licensed operations would not serve the user community significantly; and

[28] ComReg Document 11/28 - Review of the Period 2008 – 2010 & Proposed Strategy for Managing the Radio Spectrum: 2011 – 2013.- published 12 April 2011

- there are many PMP TDD systems on the market however these are not guaranteed service (carrier grade) systems and hence suited to unlicensed frequency use only.

69 BT stated it would be more beneficial to have lower frequency bands for PMP use and that the cell size reach and penetrations are considerably lower at the higher frequencies. However BT did not indicate which lower frequencies would be more beneficial. eircom stated that spectrum should only be opened for PMP if there is a market requirement and the current utilisation of PMP with 26 GHz block licensing might help inform ComReg's opinion.

70 UPC stated that the 28 GHz, 32 GHz and 40 GHz bands should be considered for PMP use in high usage urban areas and as the frequency bands in question are higher up the spectrum, there would be no economic benefit in licensing these bands for PMP links in rural parts of the country.

71 Vodafone stated it has no specific objections to operators using PMP technology in an assigned area of part of the bands.

3.5.2 ComReg's Position

72 ComReg would note that a number of CEPT countries have adopted EU guidelines[29] to allow for PMP applications in the certain frequency bands.

73 Currently, most fixed links equipment manufacturers concentrate on PP systems, and PMP equipment is available from a limited number of manufacturers.

74 However, according to ECC Report 173[30], a recent increase in demand for data over mobile networks and the evolution of mobile technologies could lead to effective commercialisation of PMP technology. The Report states that PMP systems have been deployed within CEPT countries and a new generation of PMP products *"have been developed and released in most of the popular P-MP bands including 10 GHz, 26, 28 GHz and 42 GHz"*. The report also goes on to say that regarding FS deployment in the 42 GHz band, *"12* [CEPT countries] *foresee use or have just started"* and the use of *"both P-P and P-MP are foreseen"* in the 42 GHz band.

[29] Revised ECC Recommendation (01)04 (Revised, Rottach-Egern, February 2010) Recommended Guidelines for the Accommodation and Assignment Of Multimedia Wireless Systems (MWS) and Point-To-Point (P-P) Fixed Wireless Systems In The Frequency Band 40.5 – 43.5 GHz; ECC Recommendation (11)01 - Guidelines for Assignment of Frequency Blocks for Fixed Wireless Systems in the Bands 24.5-26.5 GHz, 27.5-29.5 GHz AND 31.8-33.4 GHz – published January 2011.
[30] ECC Report 173 -Fixed Service in Europe Current use and future trends post 2011 March 2012 - http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCRep173.PDF

75 However ComReg would note that there is little demand from operators at present for PMP use. This is evidenced by the decision of Digiweb to surrender its 26 GHz National Block PMP allocation in 2009 and Telefónica Ireland's request to convert it two 26 GHz National Block allocations from PMP to PP use[31].

76 Accordingly, ComReg does not intend to make the 28 GHz, 31GHz or 40 GHz bands available for PMP use at this time. However, ComReg will keep the option of allowing future PMP use in certain frequency bands under review. To facilitate a future review of spectrum use, ComReg will open the three new frequency bands in line with the relevant CEPT Decisions and Recommendations which allow for flexible band segmentation and the possible future introduction of PMP.

77 ECC Recommendations (01)02 and (11)01 allow for the deployment of PP and PMP in the 32 (31.8 - 33.4) GHz band. Due to the 31 GHz and 32 GHz bands sharing similar propagation characteristics, the 31 GHz band will be opened initially to gauge the market demand for spectrum in the 31/32 GHz frequency range. The 32 GHz band will not be opened for fixed services at this time, however ComReg will consider making the 32 GHz band available in the future for PP/PMP use, pending a future review for the release of further spectrum and the demand on spectrum in the 31 GHz band.

78 ComReg's position is that the frequency bands 28 (27.5 - 29.5) GHz, 31 (31.0 - 31.3 paired with 31.5 - 31.8) GHz, 32 (31.8 – 33.4) GHz and 40 (40.5 - 43.5) GHz will not be opened for PMP use in the current spectrum strategy period 2011 - 2013.

3.6 Technical Conditions for Fixed Links

79 ComReg posed the following question regarding the current technical conditions for fixed links contained in the fixed links guidelines.

Q. 6 Please state your views regarding the current technical conditions for fixed links.

80 No views were put forward regarding the current technical conditions for fixed links.

3.6.1 Other issues raised by Respondents

81 Aviat stated that most manufacturers are moving away from smaller (3.5 MHz and narrower) channel sizes and that future band plans should take this into account.

[31] ComReg 12/64 - 26 GHz Change of use Request from Telefónica Ireland for change of use of its 26 GHz National Point-to-Multipoint block licences – 18 June 2012.

3.6.2 ComReg's Position

82 Although ComReg has seen a decrease in the number of licensed links with channel sizes of 3.5 MHz, currently there are 686 licensed links with a channel size of 3.5 MHz. There is still a demand for 3.5 MHz channels from smaller operators and ComReg needs to be mindful of the requirements of large and small operators and endeavour to meet their often differing requirements.

83 As such ComReg currently has no plans to close channels with a bandwidth of 3.5 MHz in any of the existing frequency bands or the new frequency bands.

4 Summary Of Conclusions Within Overall Context

84 Having carefully considered the views of all respondents to its Fixed Link Survey, ComReg will take the following steps:

- the High-Low search radii for the 23 GHz and 26 GHz bands will be reduced from 200 metres to 100 metres. The consensus of current licensees operating within the 23 GHz and 26 GHz bands is that the reduced radius will improve their spectrum planning and reuse, which will improve spectral efficiency;
- there will be no distinction between rural and urban areas concerning the High-Low search radius;
- the antenna size will be limited to 0.6 metres in both the 23 GHz and 26 GHz bands;
- ComReg will consider reopening the 26 GHz block licence scheme for a further round of National Block assignments, subject to market demand;
- ComReg will allow the use of 56 MHz channels in the 26 GHz band only where the licensee has a National Block licence containing contiguous blocks of spectrum;
- ComReg will permit the use of higher bandwidths as shown in Table 1. This is to facilitate the increase in data demands by mobile technology;
- ComReg intends to open the frequency bands shown in Table 2, as there is a significant demand for fixed links services in the 28 GHz, 31 GHz and 40 GHz band;
- the 32 GHz band may be made available for fixed links services at a later stage subject to its potential for future PP/PMP use and the demand on spectrum for PP use in the 31 GHz (31.0 - 31.3 GHz paired with 31.5 - 31.8 GHz) band;
- within the 28 GHz band, as per REC T/R 13-02 Annex C, the following frequency ranges will be made available for fixed links services 27.9405 - 28.4445 GHz and 28.9485 - 29.4525 GHz; and
- frequency bands 28 (27.5 - 29.5) GHz, 31 (31.0 - 31.3 paired with 31.5 - 31.8) GHz, 32 GHz and 40 (40.5 - 43.5) GHz will not be opened for PMP use in the current spectrum strategy period 2011 – 2013.

85 The new fixed links frequency bands and new channel bandwidths for existing fixed links frequency bands are shown in Annex 1.

86 The amendments set out in this document will come into effect upon the publication of the revised engineering guidelines, which will be published in due course.

Annex: 1 New Fixed links Frequency Bands & Channel Bandwidths

A 1.1 13 GHz - CEPT/ERC/RECOMMENDATION 12-02 E

Channel	MHz	MHz
1	12779	13045
2	12835	13101
3	12891	13157
4	12947	13213

Table 3: 56 MHz bandwidth

A 1.2 15 GHz - ITU-R F.636-4

Channel	MHz	MHz
1	14529	14949
2	14585	15005
3	14641	15061
4	14641	15061
5	14753	14173
6	14809	15229
7	14865	15285

Table 4: 56 MHz bandwidth

A 1.3 18 GHz - CEPT/ERC/RECOMMENDATION 12-03 E

Channel	MHz	MHz
1	17810	18820
2	17920	18930
3	18030	19040
4	18140	19150
5	18250	19260
6	18360	19370
7	18470	19480
8	18580	19590

Table 5: 110 MHz bandwidth

A 1.4 23 GHz - CEPT/ERC/RECOMMENDATION T/R 13-02 Annex A

Channel	MHz	MHz
1	22078	23086
2	22134	23142
3	22190	23198
4	22246	23254
5	22302	23310

6	22358	23366
7	22414	23422
8	22470	23478
9	22526	23534

Table 6: 56 MHz bandwidth

Channel	MHz	MHz
1	22078	23086
2	22190	23198
3	22302	23310
4	22358	23366
5	22470	23478

Table 7: 112 MHz bandwidth

A 1.5 28 GHz - CEPT/ERC/RECOMMENDATION T/R 13-02 E Annex C

Channel	MHz	MHz
1	27955.75	28963.75
2	27959.25	28967.25
3	27962.75	28970.75
4	27966.25	28974.25
5	27969.75	28977.75
6	27973.25	28981.25
7	27976.75	28984.75
8	27980.25	28988.25
9	27983.75	28991.75
10	27987.25	28995.25
11	27990.75	28998.75
12	27994.25	29002.25
13	27997.75	29005.75
14	28001.25	29009.25
15	28004.75	29012.75
16	28008.25	29016.25
17	28011.75	29019.75
18	28015.25	29023.25
19	28018.75	29026.75
20	28022.25	29030.25
21	28025.75	29033.75
22	28029.25	29037.25
23	28032.75	29040.75
24	28036.25	29044.25
25	28039.75	29047.75
26	28043.25	29051.25
27	28046.75	29054.75
28	28050.25	29058.25
29	28053.75	29061.75
30	28057.25	29065.25

31	28060.75	29068.75
32	28064.25	29072.25
33	28067.75	29075.75
34	28071.25	29079.25
35	28074.75	29082.75
36	28078.25	29086.25
37	28081.75	29089.75
38	28085.25	29093.25
39	28088.75	29096.75
40	28092.25	29100.25
41	28095.75	29103.75
42	28099.25	29107.25
43	28102.75	29110.75
44	28106.25	29114.25
45	28109.75	29117.75
46	28113.25	29121.25
47	28116.75	29124.75
48	28120.25	29128.25
49	28123.75	29131.75
50	28127.25	29135.25
51	28130.75	29138.75
52	28134.25	29142.25
53	28137.75	29145.75
54	28141.25	29149.25
55	28144.75	29152.75
56	28148.25	29156.25
57	28151.75	29159.75
58	28155.25	29163.25
59	28158.75	29166.75
60	28162.25	29170.25
61	28165.75	29173.75
62	28169.25	29177.25
63	28172.75	29180.75
64	28176.25	29184.25
65	28179.75	29187.75
66	28183.25	29191.25
67	28186.75	29194.75
68	28190.25	29198.25
69	28193.75	29201.75
70	28197.25	29205.25
71	28200.75	29208.75
72	28204.25	29212.25
73	28207.75	29215.75
74	28211.25	29219.25
75	28214.75	29222.75
76	28218.25	29226.25
77	28221.75	29229.75

78	28225.25	29233.25
79	28228.75	29236.75
80	28232.25	29240.25
81	28235.75	29243.75
82	28239.25	29247.25
83	28242.75	29250.75
84	28246.25	29254.25
85	28249.75	29257.75
86	28253.25	29261.25
87	28256.75	29264.75
88	28260.25	29268.25
89	28263.75	29271.75
90	28267.25	29275.25
91	28270.75	29278.75
92	28274.25	29282.25
93	28277.75	29285.75
94	28281.25	29289.25
95	28284.75	29292.75
96	28288.25	29296.25
97	28291.75	29299.75
98	28295.25	29303.25
99	28298.75	29306.75
100	28302.25	29310.25
101	28305.75	29313.75
102	28309.25	29317.25
103	28312.75	29320.75
104	28316.25	29324.25
105	28319.75	29327.75
106	28323.25	29331.25
107	28326.75	29334.75
108	28330.25	29338.25
109	28333.75	29341.75
110	28337.25	29345.25
111	28340.75	29348.75
112	28344.25	29352.25
113	28347.75	29355.75
114	28351.25	29359.25
115	28354.75	29362.75
116	28358.25	29366.25
117	28361.75	29369.75
118	28365.25	29373.25
119	28368.75	29376.75
120	28372.25	29380.25
121	28375.75	29383.75
122	28379.25	29387.25
123	28382.75	29390.75
124	28386.25	29394.25

125	28389.75	29397.75
126	28393.25	29401.25
127	28396.75	29404.75
128	28400.25	29408.25
129	28403.75	29411.75
130	28407.25	29415.25
131	28410.75	29418.75
132	28414.25	29422.25
133	28417.75	29425.75
134	28421.25	29429.25
135	28424.75	29432.75
136	28428.25	29436.25

Table 8: 3.5 MHz bandwidth

Channel	MHz	MHz
1	27957.5	28965.5
2	27964.5	28972.5
3	27971.5	28979.5
4	27978.5	28986.5
5	27985.5	28993.5
6	27992.5	29000.5
7	27999.5	29007.5
8	28006.5	29014.5
9	28013.5	29021.5
10	28020.5	29028.5
11	28027.5	29035.5
12	28034.5	29042.5
13	28041.5	29049.5
14	28048.5	29056.5
15	28055.5	29063.5
16	28062.5	29070.5
17	28069.5	29077.5
18	28076.5	29084.5
19	28083.5	29091.5
20	28090.5	29098.5
21	28097.5	29105.5
22	28104.5	29112.5
23	28111.5	29119.5
24	28118.5	29126.5
25	28125.5	29133.5
26	28132.5	29140.5
27	28139.5	29147.5
28	28146.5	29154.5
29	28153.5	29161.5
30	28160.5	29168.5
31	28167.5	29175.5
32	28174.5	29182.5

33	28181.5	29189.5
34	28188.5	29196.5
35	28195.5	29203.5
36	28202.5	29210.5
37	28209.5	29217.5
38	28216.5	29224.5
39	28223.5	29231.5
40	28230.5	29238.5
41	28237.5	29245.5
42	28244.5	29252.5
43	28251.5	29259.5
44	28258.5	29266.5
45	28265.5	29273.5
46	28272.5	29280.5
47	28279.5	29287.5
48	28286.5	29294.5
49	28293.5	29301.5
50	28300.5	29308.5
51	28307.5	29315.5
52	28314.5	29322.5
53	28321.5	29329.5
54	28328.5	29336.5
55	28335.5	29343.5
56	28342.5	29350.5
57	28349.5	29357.5
58	28356.5	29364.5
59	28363.5	29371.5
60	28370.5	29378.5
61	28377.5	29385.5
62	28384.5	29392.5
63	28391.5	29399.5
64	28398.5	29406.5
65	28405.5	29413.5
66	28412.5	29420.5
67	28419.5	29427.5
68	28426.5	29434.5

Table 9: 7 MHz bandwidth

Channel	MHz	MHz
1	27961	28969
2	27975	28983
3	27989	28997
4	28003	29011
5	28017	29025
6	28031	29039
7	28045	29053
8	28059	29067

9	28073	29081
10	28087	29095
11	28101	29109
12	28115	29123
13	28129	29137
14	28143	29151
15	28157	29165
16	28171	29179
17	28185	29193
18	28199	29207
19	28213	29221
20	28227	29235
21	28241	29249
22	28255	29263
23	28269	29277
24	28283	29291
25	28297	29305
26	28311	29319
27	28325	29333
28	28339	29347
29	28353	29361
30	28367	29375
31	28381	29389
32	28395	29403
33	28409	29417
34	28423	29431

Table 10: 14 MHz bandwidth

Channel	MHz	MHz
1	27968	28976
2	27996	29004
3	28024	29032
4	28052	29060
5	28080	29088
6	28108	29116
7	28136	29144
8	28164	29172
9	28192	29200
10	28220	29228
11	28248	29256
12	28276	29284
13	28304	29312
14	28332	29340
15	28360	29368
16	28388	29396
17	28416	29424

Table 11: 28 MHz bandwidth

Channel	MHz	MHz
1	27982	28990
2	28038	29046
3	28094	29102
4	28150	29158
5	28206	29214
6	28262	29270
7	28318	29326
8	28374	29382

Table 12: 56 MHz bandwidth

Channel	MHz	MHz
1	28010	29018
2	28122	29130
3	28234	29242
4	28346	29354

Table 13: 112 MHz bandwidth

A 1.6 31 GHz - 31.0 – 31.3 / 31.5 – 31.8 GHz with 514 MHz Duplex Spacing

Channel	MHz	MHz
1	31018.75	31532.75
2	31022.25	31536.25
3	31025.75	31539.75
4	31029.25	31543.25
5	31032.75	31546.75
6	31036.25	31550.25
7	31039.75	31553.75
8	31043.25	31557.25
9	31046.75	31560.75
10	31050.25	31564.25
11	31053.75	31567.75
12	31057.25	31571.25
13	31060.75	31574.75
14	31064.25	31578.25
15	31067.75	31581.75
16	31071.25	31585.25
17	31074.75	31588.75
18	31078.25	31592.25
19	31081.75	31595.75
20	31085.25	31599.25
21	31088.75	31602.75
22	31092.25	31606.25
23	31095.75	31609.75
24	31099.25	31613.25
25	31102.75	31616.75
26	31106.25	31620.25

27	31109.75	31623.75
28	31113.25	31627.25
29	31116.75	31630.75
30	31120.25	31634.25
31	31123.75	31637.75
32	31127.25	31641.25
33	31130.75	31644.75
34	31134.25	31648.25
35	31137.75	31651.75
36	31141.25	31655.25
37	31144.75	31658.75
38	31148.25	31662.25
39	31151.75	31665.75
40	31155.25	31669.25
41	31158.75	31672.75
42	31162.25	31676.25
43	31165.75	31679.75
44	31169.25	31683.25
45	31172.75	31686.75
46	31176.25	31690.25
47	31179.75	31693.75
48	31183.25	31697.25
49	31186.75	31700.75
50	31190.25	31704.25
51	31193.75	31707.75
52	31197.25	31711.25
53	31200.75	31714.75
54	31204.25	31718.25
55	31207.75	31721.75
56	31211.25	31725.25
57	31214.75	31728.75
58	31218.25	31732.25
59	31221.75	31735.75
60	31225.25	31739.25
61	31228.75	31742.75
62	31232.25	31746.25
63	31235.75	31749.75
64	31239.25	31753.25
65	31242.75	31756.75
66	31246.25	31760.25
67	31249.75	31763.75
68	31253.25	31767.25
69	31256.75	31770.75
70	31260.25	31774.25
71	31263.75	31777.75
72	31267.25	31781.25

Table 14: 3.5 MHz bandwidth

Channel	MHz	MHz
1	31020.5	31534.5
2	31027.5	31541.5
3	31034.5	31548.5
4	31041.5	31555.5
5	31048.5	31562.5
6	31055.5	31569.5
7	31062.5	31576.5
8	31069.5	31583.5
9	31076.5	31590.5
10	31083.5	31597.5
11	31090.5	31604.5
12	31097.5	31611.5
13	31104.5	31618.5
14	31111.5	31625.5
15	31118.5	31632.5
16	31125.5	31639.5
17	31132.5	31646.5
18	31139.5	31653.5
19	31146.5	31660.5
20	31153.5	31667.5
21	31160.5	31674.5
22	31167.5	31681.5
23	31174.5	31688.5
24	31181.5	31695.5
25	31188.5	31702.5
26	31195.5	31709.5
27	31202.5	31716.5
28	31209.5	31723.5
29	31216.5	31730.5
30	31223.5	31737.5
31	31230.5	31744.5
32	31237.5	31751.5
33	31244.5	31758.5
34	31251.5	31765.5
35	31258.5	31772.5
36	31265.5	31779.5

Table 15: 7 MHz bandwidth

Channel	MHz	MHz
1	31024	31538
2	31038	31552
3	31052	31566
4	31066	31580
5	31080	31594
6	31094	31608
7	31108	31622

8	31122	31636
9	31136	31650
10	31150	31664
11	31164	31678
12	31178	31692
13	31192	31706
14	31206	31720
15	31220	31734
16	31234	31748
17	31248	31762
18	31262	31776

Table 16: 14 MHz bandwidth

Channel	MHz	MHz
1	31031	31545
2	31059	31573
3	31087	31601
4	31115	31629
5	31143	31657
6	31171	31685
7	31199	31713
8	31227	31741
9	31255	31769

Table 17: 28 MHz bandwidth

A 1.7 38 GHz - CEPT/ERC/RECOMMENDATION T/R 12-01 E

Channel	MHz	MHz
1	37086	38346
2	37142	38402
3	37198	38458
4	37254	38514
5	37310	38570
6	37366	38626
7	37422	38682
8	37478	38738
9	37534	38794
10	37590	38850
11	37646	38906
12	37702	38962
13	37758	39018
14	37814	39074
15	37870	39130
16	37926	39186
17	37982	39242
18	38038	39298
19	38094	39354

20	38150	39410

Table 18: 56 MHz bandwidth

Channel	MHz	MHz
1	37114	38374
2	37226	38486
3	37338	38598
4	37450	38710
5	37562	38822
6	37674	38934
7	37786	39046
8	37898	39158
9	38010	39270
10	38122	39382

Table 19: 112 MHz bandwidth

A 1.8 40 GHz - CEPT/ERC/RECOMMENDATION (01)04 Annex 5

Channel	MHz	MHz
1	40553.5	42053.5
2	40560.5	42060.5
3	40567.5	42067.5
4	40574.5	42074.5
5	40581.5	42081.5
6	40588.5	42088.5
7	40595.5	42095.5
8	40602.5	42102.5
9	40609.5	42109.5
10	40616.5	42116.5
11	40623.5	42123.5
12	40630.5	42130.5
13	40637.5	42137.5
14	40644.5	42144.5
15	40651.5	42151.5
16	40658.5	42158.5
17	40665.5	42165.5
18	40672.5	42172.5
19	40679.5	42179.5
20	40686.5	42186.5
21	40693.5	42193.5
22	40700.5	42200.5
23	40707.5	42207.5
24	40714.5	42214.5
25	40721.5	42221.5
26	40728.5	42228.5
27	40735.5	42235.5
28	40742.5	42242.5

29	40749.5	42249.5
30	40756.5	42256.5
31	40763.5	42263.5
32	40770.5	42270.5
33	40777.5	42277.5
34	40784.5	42284.5
35	40791.5	42291.5
36	40798.5	42298.5
37	40805.5	42305.5
38	40812.5	42312.5
39	40819.5	42319.5
40	40826.5	42326.5
41	40833.5	42333.5
42	40840.5	42340.5
43	40847.5	42347.5
44	40854.5	42354.5
45	40861.5	42361.5
46	40868.5	42368.5
47	40875.5	42375.5
48	40882.5	42382.5
49	40889.5	42389.5
50	40896.5	42396.5
51	40903.5	42403.5
52	40910.5	42410.5
53	40917.5	42417.5
54	40924.5	42424.5
55	40931.5	42431.5
56	40938.5	42438.5
57	40945.5	42445.5
58	40952.5	42452.5
59	40959.5	42459.5
60	40966.5	42466.5
61	40973.5	42473.5
62	40980.5	42480.5
63	40987.5	42487.5
64	40994.5	42494.5
65	41001.5	42501.5
66	41008.5	42508.5
67	41015.5	42515.5
68	41022.5	42522.5
69	41029.5	42529.5
70	41036.5	42536.5
71	41043.5	42543.5
72	41050.5	42550.5
73	41057.5	42557.5
74	41064.5	42564.5
75	41071.5	42571.5

76	41078.5	42578.5
77	41085.5	42585.5
78	41092.5	42592.5
79	41099.5	42599.5
80	41106.5	42606.5
81	41113.5	42613.5
82	41120.5	42620.5
83	41127.5	42627.5
84	41134.5	42634.5
85	41141.5	42641.5
86	41148.5	42648.5
87	41155.5	42655.5
88	41162.5	42662.5
89	41169.5	42669.5
90	41176.5	42676.5
91	41183.5	42683.5
92	41190.5	42690.5
93	41197.5	42697.5
94	41204.5	42704.5
95	41211.5	42711.5
96	41218.5	42718.5
97	41225.5	42725.5
98	41232.5	42732.5
99	41239.5	42739.5
100	41246.5	42746.5
101	41253.5	42753.5
102	41260.5	42760.5
103	41267.5	42767.5
104	41274.5	42774.5
105	41281.5	42781.5
106	41288.5	42788.5
107	41295.5	42795.5
108	41302.5	42802.5
109	41309.5	42809.5
110	41316.5	42816.5
111	41323.5	42823.5
112	41330.5	42830.5
113	41337.5	42837.5
114	41344.5	42844.5
115	41351.5	42851.5
116	41358.5	42858.5
117	41365.5	42865.5
118	41372.5	42872.5
119	41379.5	42879.5
120	41386.5	42886.5
121	41393.5	42893.5
122	41400.5	42900.5

123	41407.5	42907.5
124	41414.5	42914.5
125	41421.5	42921.5
126	41428.5	42928.5
127	41435.5	42935.5
128	41442.5	42942.5
129	41449.5	42949.5
130	41456.5	42956.5
131	41463.5	42963.5
132	41470.5	42970.5
133	41477.5	42977.5
134	41484.5	42984.5
135	41491.5	42991.5
136	41498.5	42998.5
137	41505.5	43005.5
138	41512.5	43012.5
139	41519.5	43019.5
140	41526.5	43026.5
141	41533.5	43033.5
142	41540.5	43040.5
143	41547.5	43047.5
144	41554.5	43054.5
145	41561.5	43061.5
146	41568.5	43068.5
147	41575.5	43075.5
148	41582.5	43082.5
149	41589.5	43089.5
150	41596.5	43096.5
151	41603.5	43103.5
152	41610.5	43110.5
153	41617.5	43117.5
154	41624.5	43124.5
155	41631.5	43131.5
156	41638.5	43138.5
157	41645.5	43145.5
158	41652.5	43152.5
159	41659.5	43159.5
160	41666.5	43166.5
161	41673.5	43173.5
162	41680.5	43180.5
163	41687.5	43187.5
164	41694.5	43194.5
165	41701.5	43201.5
166	41708.5	43208.5
167	41715.5	43215.5
168	41722.5	43222.5
169	41729.5	43229.5

170	41736.5	43236.5
171	41743.5	43243.5
172	41750.5	43250.5
173	41757.5	43257.5
174	41764.5	43264.5
175	41771.5	43271.5
176	41778.5	43278.5
177	41785.5	43285.5
178	41792.5	43292.5
179	41799.5	43299.5
180	41806.5	43306.5
181	41813.5	43313.5
182	41820.5	43320.5
183	41827.5	43327.5
184	41834.5	43334.5
185	41841.5	43341.5
186	41848.5	43348.5
187	41855.5	43355.5
188	41862.5	43362.5
189	41869.5	43369.5
190	41876.5	43376.5
191	41883.5	43383.5
192	41890.5	43390.5
193	41897.5	43397.5
194	41904.5	43404.5
195	41911.5	43411.5
196	41918.5	43418.5
197	41925.5	43425.5
198	41932.5	43432.5
199	41939.5	43439.5
200	41946.5	43446.5
201	41953.5	43453.5
202	41960.5	43460.5

Table 20: 7 MHz bandwidth

Channel	MHz	MHz
1	40557	42057
2	40571	42071
3	40585	42085
4	40599	42099
5	40613	42113
6	40627	42127
7	40641	42141
8	40655	42155
9	40669	42169
10	40683	42183
11	40697	42197

12	40711	42211
13	40725	42225
14	40739	42239
15	40753	42253
16	40767	42267
17	40781	42281
18	40795	42295
19	40809	42309
20	40823	42323
21	40837	42337
22	40851	42351
23	40865	42365
24	40879	42379
25	40893	42393
26	40907	42407
27	40921	42421
28	40935	42435
29	40949	42449
30	40963	42463
31	40977	42477
32	40991	42491
33	41005	42505
34	41019	42519
35	41033	42533
36	41047	42547
37	41061	42561
38	41075	42575
39	41089	42589
40	41103	42603
41	41117	42617
42	41131	42631
43	41145	42645
44	41159	42659
45	41173	42673
46	41187	42687
47	41201	42701
48	41215	42715
49	41229	42729
50	41243	42743
51	41257	42757
52	41271	42771
53	41285	42785
54	41299	42799
55	41313	42813
56	41327	42827
57	41341	42841
58	41355	42855

59	41369	42869
60	41383	42883
61	41397	42897
62	41411	42911
63	41425	42925
64	41439	42939
65	41453	42953
66	41467	42967
67	41481	42981
68	41495	42995
69	41509	43009
70	41523	43023
71	41537	43037
72	41551	43051
73	41565	43065
74	41579	43079
75	41593	43093
76	41607	43107
77	41621	43121
78	41635	43135
79	41649	43149
80	41663	43163
81	41677	43177
82	41691	43191
83	41705	43205
84	41719	43219
85	41733	43233
86	41747	43247
87	41761	43261
88	41775	43275
89	41789	43289
90	41803	43303
91	41817	43317
92	41831	43331
93	41845	43345
94	41859	43359
95	41873	43373
96	41887	43387
97	41901	43401
98	41915	43415
99	41929	43429
100	41943	43443
101	41957	43457

Table 21: 14 MHz bandwidth

Channel	MHz	MHz
1	40564	42064

2	40592	42092
3	40620	42120
4	40648	42148
5	40676	42176
6	40704	42204
7	40732	42232
8	40760	42260
9	40788	42288
10	40816	42316
11	40844	42344
12	40872	42372
13	40900	42400
14	40928	42428
15	40956	42456
16	40984	42484
17	41012	42512
18	41040	42540
19	41068	42568
20	41096	42596
21	41124	42624
22	41152	42652
23	41180	42680
24	41208	42708
25	41236	42736
26	41264	42764
27	41292	42792
28	41320	42820
29	41348	42848
30	41376	42876
31	41404	42904
32	41432	42932
33	41460	42960
34	41488	42988
35	41516	43016
36	41544	43044
37	41572	43072
38	41600	43100
39	41628	43128
40	41656	43156
41	41684	43184
42	41712	43212
43	41740	43240
44	41768	43268
45	41796	43296
46	41824	43324
47	41852	43352
48	41880	43380

49	41908	43408
50	41936	43436

Table 22: 28 MHz bandwidth

Channel	MHz	MHz
1	40578	42078
2	40634	42134
3	40690	42190
4	40746	42246
5	40802	42302
6	40858	42358
7	40914	42414
8	40970	42470
9	41026	42526
10	41082	42582
11	41138	42638
12	41194	42694
13	41250	42750
14	41306	42806
15	41362	42862
16	41418	42918
17	41474	42974
18	41530	43030
19	41586	43086
20	41642	43142
21	41698	43198
22	41754	43254
23	41810	43310
24	41866	43366
25	41922	43422

Table 23: 56 MHz bandwidth

Channel	MHz	MHz
1	40606	42106
2	40718	42218
3	40830	42330
4	40942	42442
5	41054	42554
6	41166	42666
7	41278	42778
8	41390	42890
9	41502	43002
10	41614	43114
11	41726	43226
12	41838	43338

Table 24: 112 MHz bandwidth