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POSSIBILITY OF SHARING BETWEEN FIXED LINKS AND SNG IN THE 14.25 - 14.5 GHz BAND

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1. BACKGROUND

The frequency band 14.25 - 14.5 GHz is allocated in Europe with a primary status to the Fixed Service together with the Fixed Satellite Service (uplink). There are at least four CEPT countries currently using this band for FS: France, Germany, Italy and UK. Germany announced that they intend to relocate their transportable fixed links in another band in case of unacceptable interference to the fixed service.

It has been envisaged that VSAT and SNG be used in this band. In particular, SNG operators are keen to have the opportunity of using EBU transponders operating in this frequency band.

A SE19 report and a French contribution previously presented at SE meetings concluded that the sharing between FS and uncoordinated VSAT or SNG was not feasible. On the other hand, interfering distances were considered sufficiently short to enable the operation of SNG in coordinated or pre-coordinated sites.

2. COORDINATION PROCEDURES BETWEEN SNG AND THE FIXED SERVICE

Two countries, France and UK, have successfully defined coordination procedures enabling SNG to coordinate with fixed links.

The French procedure aims to coordinate regularly used sites. In the case of special events not in regularly used sites, but which are known in advance, the same procedure applies.

The UK procedure will also enable SNG to operate if they are outside coordination zones surrounding all FS receivers. Additionally, SNG operations could be allowed from within a coordination zone when sufficient path loss exists between the SNG transmitter and the FS receiver. This path loss will be assessed from measurements of the power received at the SNG location, emitted by the FS transmitter.

The detailed French and UK procedures are provided in Annex 1 and Annex 2.

3. CHANNEL ARRANGEMENTS

Included within this report in Annex 3 is a possible radio frequency channel arrangement for the band 14.25 - 14.5 GHz, which has been adopted by some countries. This channel plan will assist in the sharing and compatibility studies with other services.

4. CONCLUSION

Despite their differences, these two coordination procedures are demonstrating that it is possible to arrange sharing between SNG and the Fixed Service in the 14.25 - 14.5 GHz band.

The coordination procedures applied to SNG could also be applied to VSATs. It can therefore be concluded that coordinated VSATs can also share the 14.25 - 14.5 GHz band.

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ANNEX 1

DESCRIPTION OF FRENCH METHOD OF COORDINATION

1. INTRODUCTION

A steadily increasing network of more than 600 digital fixed links (FL) in the band 14.25 - 14.5 GHz implemented all over the country made compulsory a coordination procedure when it was decided in France to authorise, in the same band, the operation of transmitting earth stations (ES) for satellite news gathering (SNG).

2. THE DIFFERENT STEPS IN THE PROCEDURE

The aim followed here is to identify regularly or permanently used or envisaged SNG sites and clear them to transmit in the band 14.25 - 14.5 GHz providing they meet the specifications established for the protection of the reception of existing or planned fixed links in the same band.

2.1. In this context the first step was made by the DGPT, the French regulatory body, which sent a questionnaire to all the operators likely to be interested in SNG operation, asking them to indicate the concerned events which would need the use of SNGs with detailed information on location, duration, satellites and frequencies envisaged. The information provided by the interested operators enabled the DGPT to draw a list of sites, sorted by date of occurrence of the programmed events. For example, the firsts events on the list are the Cannes festival (05/95), Roland Garros tennis tournament (06/95), Palais de l'Elysée in Paris / Presidential elections (05/95).

2.2. Because the interested operators are rarely able to provide precise information about the exact location from which the ES will transmit, a visit of the site by the team working for the DGPT is almost always necessary. In this manner, more information is obtained from the authority responsible for the organisation of the event about the location of the area dedicated to the installation of the transmitting equipment. GPS is then used to confirm the coordinates given by the operator (to 100 m accuracy) and a precise elevation of the horizon in all azimuths (from 0° to 359°) from the specified area(s) is established. When necessary, pictures of important azimuths are taken.

2.3. By use of purpose designed software, a calculation is then carried out. It enables the identification of all the FLs potentially interfered by the planned ES and the consequent constraints concerning the satellites that can be identified, i.e.: the range of frequencies; the maximum E.I.R.P. (including the diameter of the ES antenna); and the dedicated area while transmitting.

2.4. This information forms the basic elements of the response sent by the DGPT to the applicant. In the case of a permanent clearance given to the site, this information will also be used to establish the official documents which will be the requirements any SNG operator must meet. Hence, any extension of the existing FL network will take into account the presence and the characteristics of the ES, considered as permanent.

3. NECESSARY TECHNICAL PARAMETERS

In order to calculate the potential interference caused to the FL receivers by the transmitting ES certain technical parameters concerning each service (FS and FSS) have to be entered in the software.

3.1. ES parameters

Unless different parameters are given by the applicant operator, the set of parameters concerning the ES used for the calculation is described below:

antenna diameter	2.4 m
maximum antenna gain	48 dBi
antenna pattern	meets ETSI ETS 300 327 requirements
maximum antenna height	8 meters above ground
maximum E.I.R.P.	78 dBW
maximum bandwith	36 MHz
frequency range	14250 - 14500 MHz
pointing	GEO arc from 50°W to 63°E

Coordinates and altitude of the site including elevation of the horizon in all azimuths are also introduced in the software.

3.2. FLs parameters

All the existing and planned fixed links are described in the database connected with the software. So, the parameters attached to them used during the calculation are not generic but correspond to the reality. The main characteristics are listed below:

coordinates and altitude of the FL transmitting and receiving stations
antenna diameter
antenna gain
antenna diagram
antenna height above the ground
feeder losses
connection losses
attenuator (if used)
FKTB of the receiving equipment
carrier frequency and bandwidth

3.3. Geographical parameters

The data terrain model from the National Geographic Institute is also used to determine the influence of the natural masks, when they exist, between the ES and the interfered FL.

4. CALCULATION PROCESS

The rule followed to determine if a FL receiver is harmfully interfered by the planned ES is to check that the level of interference arriving at its flange is at least 10 dB lower than the FKTB.
ITU-R 847 and 526 are mainly used in this process.

In the first step, only the free space propagation model on a supposed flat earth is used. This lists all the potentially interfered fixed links, taking into account the antennas discrimination, connection and feeder losses.

In the second step, the calculation takes into account the additional attenuation linked to the correction due to the effective angle of horizon in the direction of the interfered FL receivers and provides modified levels of interference.

If it appears that a FL would suffer interference, the use of data terrain model gives the value in dB of the loss from natural obstacles between the ES and the receiver of the FL. In this case, the correction due to the angle of the horizon is no longer taken into account. The initial levels of interference are consequently modified.

If it still appears that a FL receiver would suffer interference, it becomes necessary to determine the less stringent constraints for the applicant. Depending on the case, it can affect the frequency range, the pointing range on the GEO arc, the maximum E.I.R.P., etc.

The ES and its parameters (including the eventual constraints) are registered in the data base and will be taken into account if any extension of the FLS network is to be planned.

5. FIRST RESULTS

Up to April 1995, about ten sites had been successfully studied, mainly in the region of Paris. In only two cases, relatively minor restrictions concerning the E.I.R.P. or the pointing range had to be specified to the applicants. Some of the ESs are already in action, and no quality impairment of the FLs has been reported.

These first encouraging results are mainly due to the presence of a relatively high protection provided by artificial masks (buildings) around the planned sites.

6. CONCLUSION

The coordination process described here is one of the solutions enabling FLs and programmed SNG transmitting ESs to share the band 14.25 - 14.5 GHz. The first results give the feeling that this method works well, providing that some elementary engineering rules applied to ESs are respected, particularly in looking for sites surrounded by natural or artificial obstacles.

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ANNEX 2

DESCRIPTION OF UK METHOD OF COORDINATION

1. INTRODUCTION

The frequency band 14.25 - 14.5 GHz is used in the UK for point-to-point terrestrial Fixed Links (FLs) and for satellite uplinks from permanent and Transportable Earth Stations (TESs). Arrangements already exist to coordinate permanent earth stations with FLs, but there is potential for TESs to cause interference to FL receivers. This document describes the procedures to be adopted by the Radiocommunications Agency (RA) and UK TES operators to minimise the risks of causing interference.

2. REGULARLY USED TES SITES

Some sites are used by TES operators on a regular, predictable basis. Examples of such sites are racecourses and sports stadiums. The RA will clear these sites for TES operation and fixed links will be coordinated with the site as if a permanent earth station existed.

2.1. Generic TES parameters

A generic set of TES parameters are required to coordinate Regularly Used Sites.

Antenna gain pattern	Rec. ITU-R S.465
Antenna gain	47 dBi
E.I.R.P.	72 dBW
Max power density into antenna	-40.5 dBW/Hz
Max bandwidth	36 MHz
Frequency range	14.0 - 14.5 GHz
Antenna height	4m agl
Pointing	Whole GEO arc above 20° elevation

2.2. Treatment of Regularly Used Sites

A site defined as "Regularly Used" will be coordinated with existing fixed links in the conventional manner. New fixed links will need to coordinate with the Regularly Used Site assuming the generic TES parameters. New fixed links may still be licensed even if it is predicted that the FL receiver would suffer interference from a TES. The FL operator could choose to accept such an allocation, but cannot expect protection from the TES operating within the generic TES parameters.

3. UNPREDICTABLE TES SITES

A large number of TES sites cannot be coordinated in advance. For applications such as Satellite News Gathering, clearance is required quickly at new and unpredictable sites. To perform this task, the RA rapid clearance system will coordinate proposed TES sites with fixed link receivers.

3.1. Space Coordination

The clearance procedure will be implemented on the RA rapid clearance system. The coordination with fixed links will be performed using a software tool "FLATCO"[1].

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[1] FLATCO (Fixed Link and TES Co-ordination) is the name given to the software tool which the RA coordinator will use to assist in coordination of TESs with fixed links. This tool is currently being developed.

The TES operator will include the following parameters in his application to the RA:

Intended location (National Grid Reference)
Frequency
Transmission bandwidth
Analogue or digital modulation

The RA coordinator will enter the TES parameters into FLATCO and will be shown a map of the surrounding area indicating the proposed position of the TES and coordination zones of nearby, affected fixed links. If the proposed TES position is within a coordination zone, the TES operator may choose to try a different transmission frequency or try a different location. The coordinator will be able to suggest alternative sites.

Using an assumed antenna mask of 32 - 25 log φ (dBi) and a minimum elevation of 20°, the TES antenna gain in the direction of any fixed link is assumed to be -0.5 dBi. If the TES is using analogue modulation, the e.i.r.p. density in the direction of any fixed link is assumed to be -40 dBW/Hz. If the TES is using digital modulation, the e.i.r.p. density is assumed to be -49 dBW/Hz.

The interference criterion for the fixed link has been determined, noting that the TES transmits from any location for short periods of time. The criterion for most fixed links is a I/N threshold of 9 dB. (For a few links with a fade margin less than 16 dB, the threshold is reduced). The actual side-lobe performance of a fixed antenna is often much better than the mask in the type approval specification. Manufacturers' guaranteed antenna masks will be used where possible.

An implementation of Recommendation ITU-R PN.452 will be used for the propagation model. This will include an addition for clutter loss, dependent on the type of terrain.

3.2. Frequency Coordination

Another coordination method is the ability of the TES operator to select a transmission frequency which purposefully avoids the nearby FL receiver frequencies. It is recognised that a choice of frequency is not available to most TES operators. However, judicious frequency selection is a simple and effective coordination method and full advantage should be taken where possible.

Tables are available (in the RA's MPT specifications) which model the performance of the fixed link receiver filter in combination with the interfering signal spectrum. These tables can be used to estimate the isolation introduced by a frequency offset between wanted and unwanted carrier. An example is shown in Figure 1.

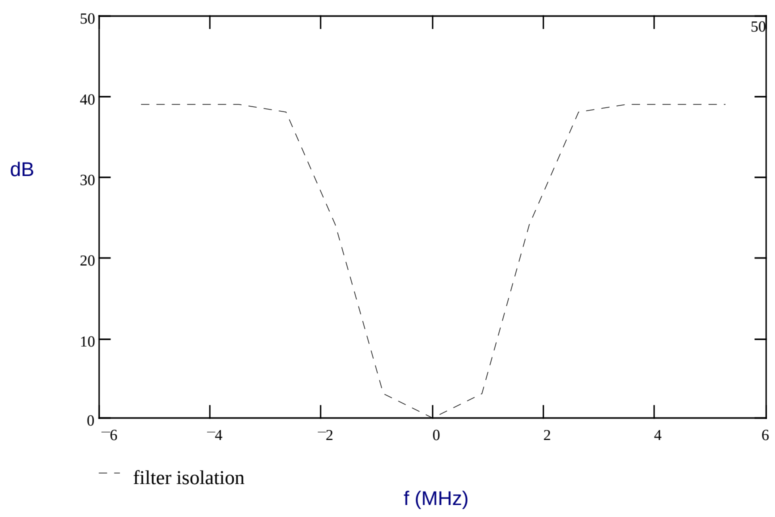

Figure 1 Filter isolation for 2 Mbit/s receiver

By taking account of the isolation introduced, fixed link receivers on a different frequency to the TES will have much smaller coordination zones. If a proposed TES position is within a coordination zone, a change of TES frequency could reduce the size of the zone, resulting in the TES position becoming an acceptable transmission site.

4. MEASUREMENT COORDINATION

The method of producing coordination zones around each fixed link receiver will require assumptions or approximations to be made, for example the calculation of path loss or the estimation of the antenna side-lobe gain. Thus a TES positioned inside a coordination zone may in fact be able to transmit without causing excessive interference. Measurement coordination gives a more precise measure of the path loss and FL antenna side-lobe gain and thus allows a more exact analysis of the likelihood of causing interference.

The method can only work with fixed links of sufficiently high transmitter power so the option of measurement coordination will not always be available. Measurement Coordination requires interaction between the TES operator and RA coordinator - the FLATCO tool will assist in this process.

4.1. Measurement Coordination Process

The TES operator must be positioned at the proposed transmission site, inside a coordination zone. He must be equipped with a measuring receiver capable of measuring the power of FL emissions in the range 14.25 - 14.5 GHz.

The TES operator must be informed of the frequency, polarisation and approximate azimuth of the affected fixed links. He will then measure the level of the FL emissions at the proposed TES site. With knowledge of the FL transmitter power, an accurate assessment can be made of the path loss from the FL feed to the TES position and this can be compared with the minimum path loss necessary to protect the fixed link receiver. If sufficient path loss exists, the TES can be authorised to transmit.

5. DESCRIPTION OF COORDINATION PROCESS

1) The TES operator will contact the RA in the usual manner, including the following parameters:

Operator name, address, phone and fax number
Operation start and finish time
Location name and National Grid Reference
Satellite name and orbital position
Antenna: gain, azimuth, elevation, height asl, height agl
Frequency (if above 14.25 GHz)
Transmission bandwidth
Analogue or digital modulation

2) The RA will use the given parameters of the TES and generic TES parameters to run through the process shown in Figure 2.

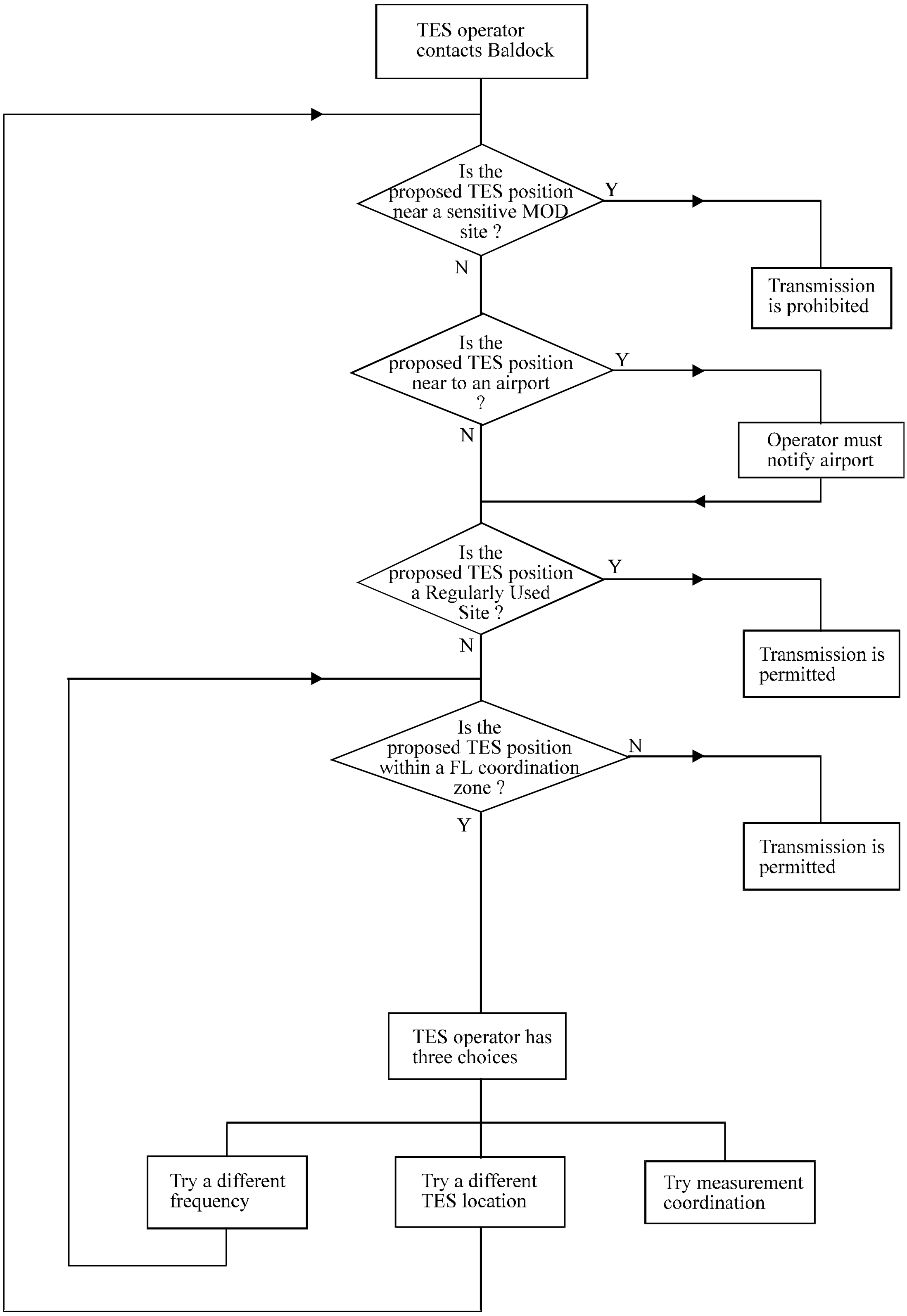

Figure 2 Flow diagram of co-ordination process

6. EXAMPLE COORDINATION ZONES

Figures 3-6 give an indication of the size of coordination zones which can be expected. The zones were constructed using a propagation tool employing Recommendation PN.452 and a 50m resolution terrain database. A factor to account for local clutter loss was included, based on the category of the terrain at the TES position (e.g. Urban, Suburban, trees, fields, etc.) and the height above ground level of the TES.

The coordination zone is shown as a black outline around a fixed link position shown as a cross. The shading shows terrain height in 50m contours. The four FL positions were chosen to represent a variety of terrain types in the UK. (Note that the scale varies between figures.)

The assumptions for the fixed link are:

Application:	8 Mbit/s
Interference threshold:	I/N of 9 dB
Noise:	-121.5 dBW
Antenna:	1.2m diameter, gain 42.5 dBi
Side-lobe pattern:	As per manufacturer's guaranteed mask
Pointing:	due north
Height:	30m agl

The assumptions for the TES are:

Horizontal e.i.r.p.:	-40 dBW/Hz
Bandwidth:	4 MHz
Height:	4m agl

The zones may be regarded as pessimistic for two reasons:

- The patterns assume that the interference arrives on the azimuth cut of the antenna pattern - the elevation angle of arrival of the interference is not considered

- Polarisation discrimination is not considered

7. CONCLUSION

The zones produced by the UK's coordination tool (currently under development) will in general be smaller than the examples shown here. These coordination zones, when considered alongside the permanent clearance of regularly used sites and the options of frequency and measurement coordination, should present no major restrictions for the TES operators.

By taking the approach described in this document, the UK feels that the frequency band 14.25 - 14.5 GHz can be successfully shared between the fixed service and transportable earth stations, and can continue to be shared with the anticipated expansion of the two services in the future.

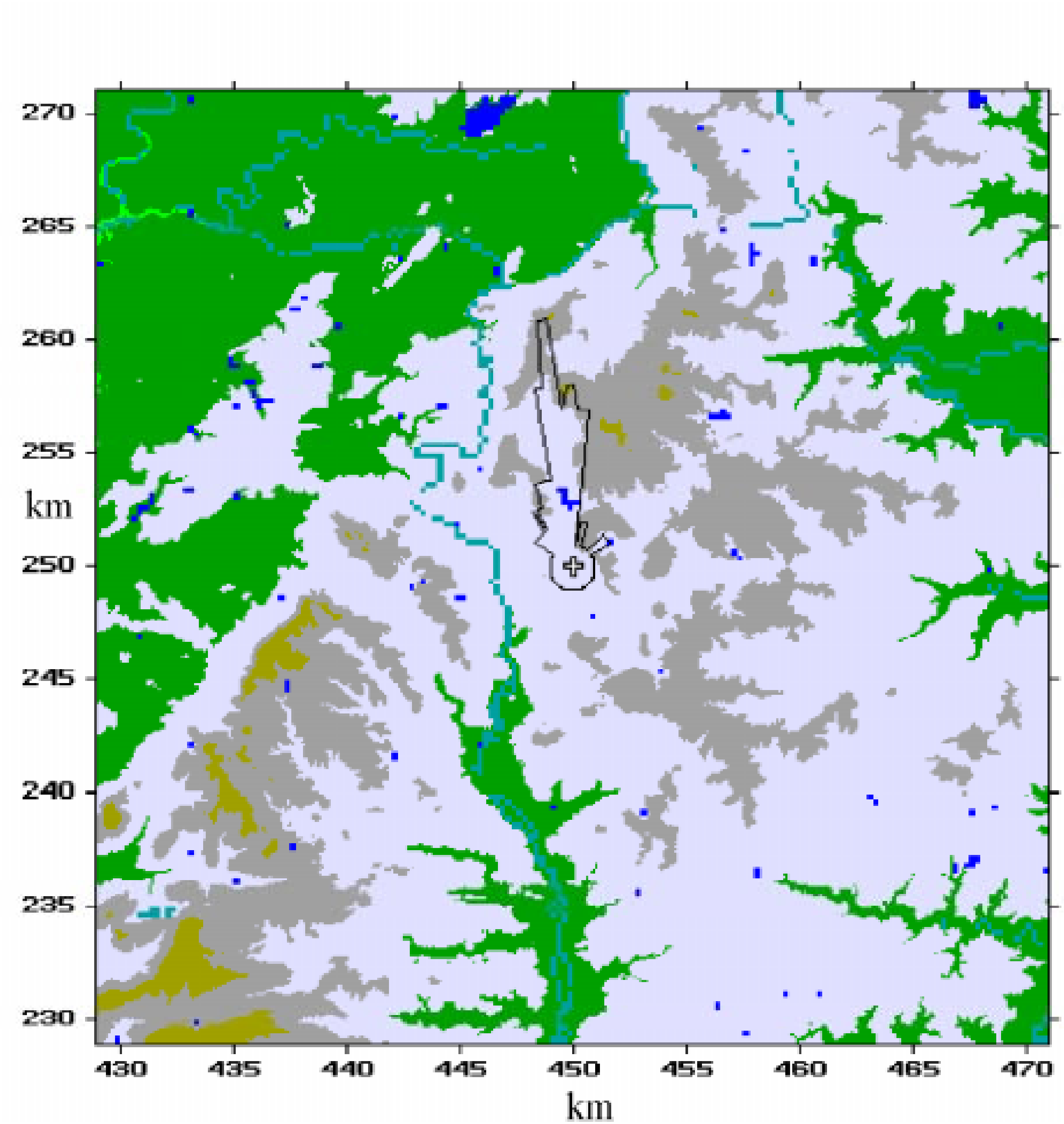

Figure 3 Example coordination zone for fixed link in rural area of Midlands (SP500500)

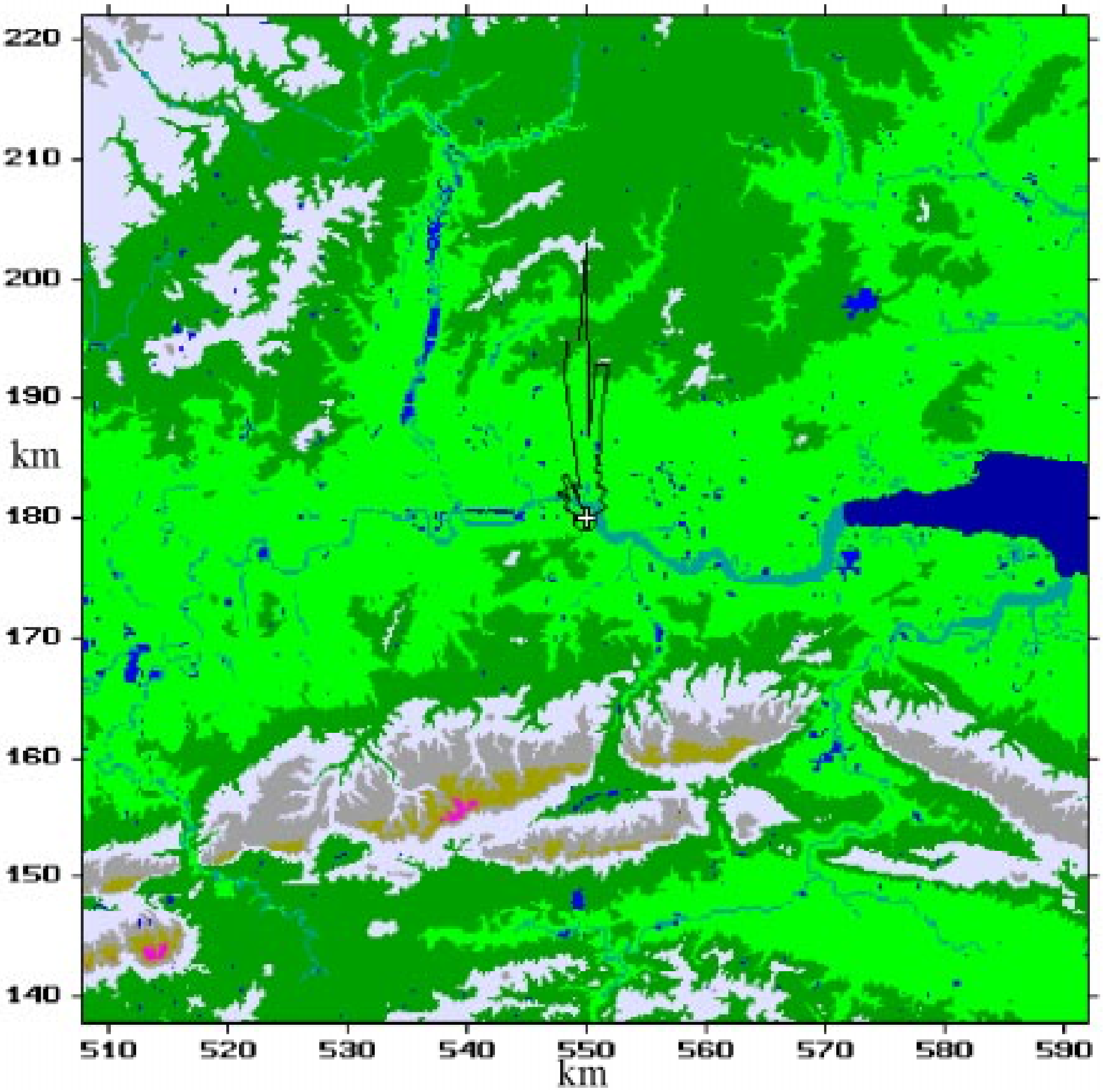

Figure 4 Example coordination zone for fixed link in urban area of East London (TQ500800)

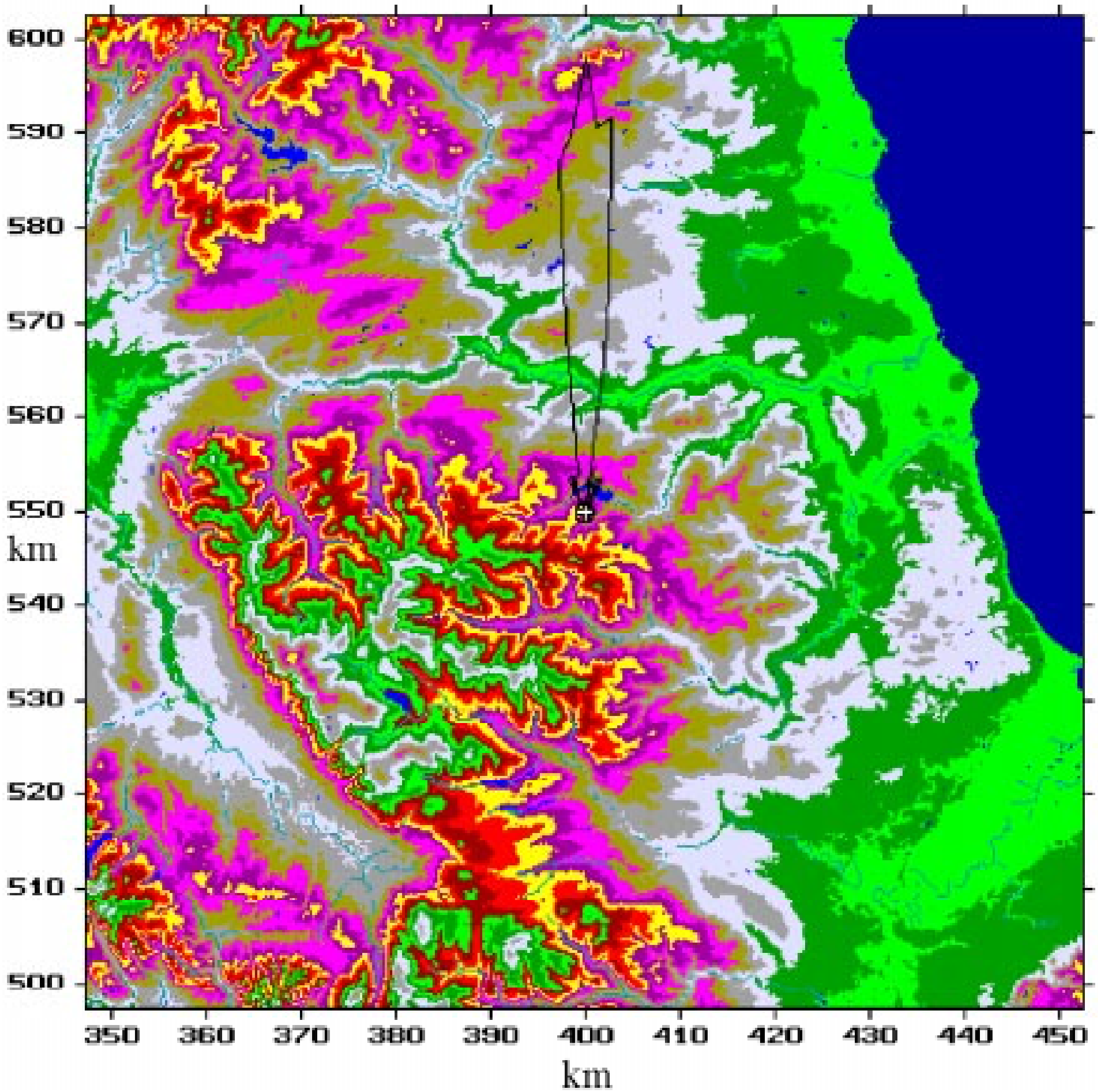

Figure 5 Example coordination zone for fixed link on rural high ground on East Pennines (NZ000500)

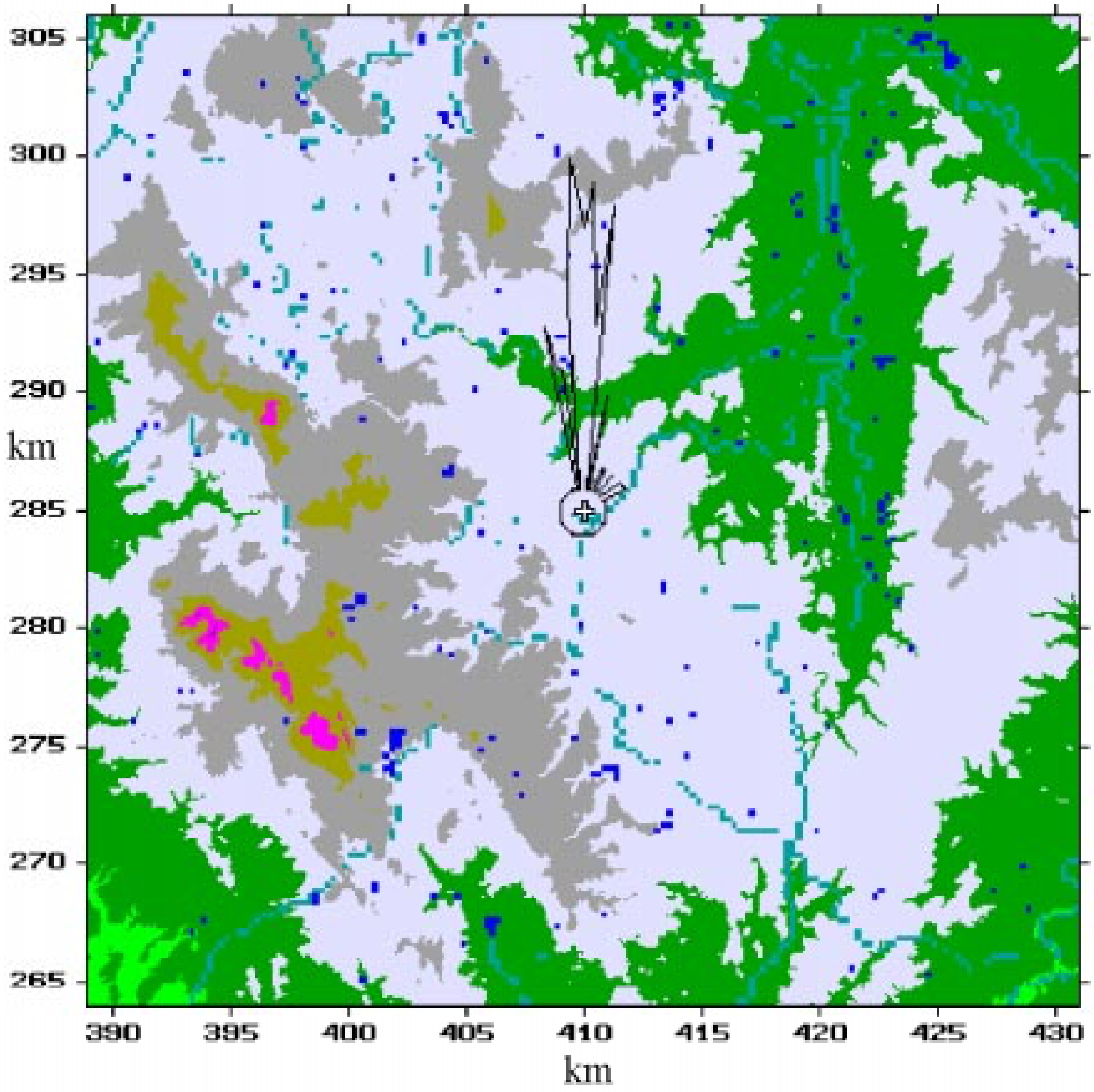

Figure 6 Example coordination zone for fixed link in urban area in Birmingham (SP100850)

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ANNEX 3

POSSIBLE RADIO FREQUENCY CHANNELS TO BE USED IN THE BAND 14.25 - 14.5 GHz

For the band 14.25 GHz to 14.5 GHz the radio frequency channel arrangements for carrier spacings of 28 MHz, 21 MHz, 14 MHz, 7 MHz, 3.5 MHz and 1.75 MHz shall be derived as follows:

Let f_o be the reference frequency of 14375 MHz
f_n be the centre frequency (MHz) of a radio frequency channel in the lower half of the band
f'_n be the centre frequency (MHz) of a radio frequency channel in the upper half of the band

The frequencies of individual channels are expressed by the following relationships:

(a) For systems with a carrier spacing of 28 MHz
Lower half of band: $f_n = (f_o - 133 + 28n)$ MHz
Upper half of band: $f'_n = (f_o + 7 + 28n)$ MHz
where $n = 1,2,3$

(b) For systems with a carrier spacing of 21 MHz
Lower half of band: $f_n = (f_o - 129.5 + 21n)$ MHz
Upper half of band: $f'_n = (f_o + 3.5 + 21n)$ MHz
where $n = 1,2 \ldots 5$

(c) For systems with a carrier spacing of 14 MHz
Lower half of band: $f_n = (f_o - 126 + 14n)$ MHz
Upper half of band: $f'_n = (f_o + 14 + 14n)$ MHz
where $n = 1,2 \ldots 7$

(d) For systems with a carrier spacing of 7 MHz
Lower half of band: $f_n = (f_o - 122.5 + 7n)$ MHz
Upper half of band: $f'_n = (f_o + 17.5 + 7n)$ MHz
where $n = 1,2 \ldots 14$

(e) For systems with a carrier spacing of 3.5 MHz
Lower half of band: $f_n = (f_o - 124.25 + 3.5n)$ MHz
Upper half of band: $f'_n = (f_o + 15.75 + 3.5n)$ MHz
where $n = 1,2 \ldots 30$

(f) For systems with a carrier spacing of 1.75 MHz
Lower half of band: $f_n = (f_o - 125.125 + 1.75n)$ MHz
Upper half of band: $f'_n = (f_o + 14.875 + 1.75n)$ MHz
where $n = 1,2 \ldots 62$

Table 1. Calculated parameters according to ITU-R Recommendation 746

XS MHz	n	f_1 MHz	f_n MHz	f'_1 MHz	f'_n MHz	Z_1S MHz	Z_2S MHz	YS MHz	DS MHz
28	1,2,3	14270	14326	14410	14466	20	34	84	140
21	1,2 ... 5	14266.5	14350.5	14399.5	14483.5	16.5	16.5	49	133
14	1,2 ... 7	14263	14347	14403	14487	13	13	96	140
7	1,2 ... 14	14259.5	14350.5	14399.5	14490.5	9.5	9.5	49	140
3.5	1,2 ... 30	14254.25	14355.75	14394.25	14495.75	4.25	4.25	38.5	140
1.75	1,2 ... 62	14251.625	14358.375	14391.625	14498.375	1.625	1.625	33.25	140

XS Separation between centre frequencies of adjacent channels
YS Separation between centre frequencies of the closest go and return channels
Z_1S Separation between the lower band edge and the centre frequency of the first channel
Z_2S Separation between the centre frequency of the final channel and the upper band edge
DS Duplex Spacing (f'_n - f_n)

Table 2. Occupied spectrum: 14.25 - 14.5 GHz band