OFFICE OF COMMUNICATIONS

Ultra Wideband

An input document for discussion at the ECC TG3#11 preparation group and gives the views of the UK on a way forward for a harmonised generic UWB solution for CEPT/EU

Publication date: **12 September 2005**

Contents

Section 1

Introduction and Summary of Proposal

Introduction

1.1 This document sets out the UK position for input to ECC TG3 meeting which has been tasked with developing a response to the EC mandate on UWB. The UK considers that it will be helpful to this process, and in the interests of European industry, to input to ECC TG3 its views on the appropriate technical parameters for UWB. This note sets out the UK view on these parameters and some of the background and issues associated with them.

Background to assembling the evidence

1.2 In parallel to the CEPT ECC TG3 work Ofcom has conducted an extensive consultation on UWB. The consultation process has included taking into account responses received by other EU administrations, international manufacturers and operators and other national stakeholders. The consultation process has also resulted in a number of UK commissioned research projects and studies. Some of the conclusions from these projects and studies have been taken account of when forming this input to the ECC TG3 process.

1.3 Other research projects that have been sponsored by Ofcom in the UK are nearing completion. Whilst the UK has not yet fully completed its research and analysis, the UK is making these preliminary views available to the CEPT TG3 meeting with proposals to be taken into account when ECC TG3 is developing an answer to the 2nd EC mandate with a view to making a European UWB regulatory framework.

Our proposed framework

1.4 In this section the UK sets out its proposed framework for UWB. The UK believes this proposed framework takes into account the deliverable requested in the 2nd EU mandate to CEPT on UWB, namely to provide the Commission with the necessary information to develop one or more technical implementing measures for harmonising the use of the radio spectrum to enable the timely introduction of UWB services.

1.5 The UK believes the proposals also give a clear direction for the future by providing a number of suggestions for the review process that should be adopted to evaluate the impact of the initial harmonisation measures.

Please note that the UK is still in the process of concluding studies on Radar (Aeronautical & Meteorological) that may affect these preliminary views. The UK will make these results available as soon as possible to the relevant European bodies. These results might affect the UK's recommendations in the frequency bands 2.7-3.1GHz and 9-9.5GHz.

Below are the main points of the preliminary views on the UK's preferences for the introduction of UWB:

- The UK believes that the current FCC limits do not give adequate protection to incumbent services within Europe as a result of the differences between incumbent services in the Europe and the US.
- Based on the economic analysis so far the UK concludes there is likely to be substantial benefit from the introduction of UWB provided the right mask can be selected. In order to maximise these benefits CEPT and the EC should move as quickly as possible to provide guidance for UWB manufacturers on a way ahead. If the right mask is adopted in a timely manner then it is likely that regulators throughout the rest of the world will move towards making UWB regulations similar to those being proposed in Europe. This would reduce the threat of large numbers of devices conforming only to US specifications entering the European market.
- Our assessment is that an in-band level of around -41dBm/MHz would be desirable to maximise the benefits available to the UWB industry. However the UK accepts that levels down to -45dBm/MHz may only marginally reduce the benefits from UWB and might bring some additional protection to existing users. A lower level than -45dBm/MHz reduces the performance of some UWB applications and restricts the overall market available for UWB applications. Some major chip set vendors have indicated that they will not develop products for the European market if a level below -45dBm is mandated. This will have the effect of increasing the cost of UWB devices for the European marketplace which may also stifle innovation in the Information Communications and Telecom (ICT) sector and lead to the possible influx of products designed to the FCC limits.
- The UK concludes that a Detect & Avoid (DAA) mechanism must be mandated in the band 3.1GHz to 4.2GHz. This must require that UWB devices in this band not transmit above a level of -85 dBm/MHz unless an adequate DAA mechanism or another mitigation technique that gives equivalent protection is employed. DAA mechanisms shall be designed to protect the BFWA device during its most vulnerable receive period as well as during the periods when it is transmitting. The mitigation techniques which can achieve the required protection levels are currently unproven and the details of how to achieve the required protection for BFWA services should be subject to regulatory approval before any ETSI standard is finalised.
- The UK believes that there is merit in mandating that UWB devices implement Transmit Power Control (TPC) in order to achieve at least a 3dB reduction in the overall aggregate interference power to other services. UK are recommending that to achieve this equipment should have a dynamic range that has a minimum level at least 8dB below the maximum PSD.
- CEPT studies have shown that by mandating a minimum Pulse Repetition Frequency (PRF) requirement on UWB devices of 1MHz, sharing with other services notably FSS downlinks and 5GHz RLAN is improved. Mandating this seems appropriate.
- The UK recommends that the DAA mechanism mitigation technique should be specified within an ECC Recommendation that can be developed in parallel with any draft Decisions being developed by the ECC and EU RSC meetings for regulating UWB in Europe.
- Studies have shown that if the UWB device use is limited to indoors only, then the interference potential to other services is reduced significantly. However, it is hard to see how this could be enforced in practice.

- The UK recommends that the use of UWB devices on board ships, aircraft and for fixed out-of-doors systems should be prohibited.
- UWB transmissions levels lower than -85dBm/MHz have been recommended below 1.6GHz. If these levels are chosen then account should be taken to differentiate the intentional transmissions from the UWB antenna and unintentional emissions from UWB circuitry.
- The rate of roll-off below 3.1GHz should be such that UWB devices can achieve a level of between -80 and -85dBm/MHz at 2.7GHz, this is also dependant on the results of the on-going studies into compatibility with Radar which may result in this being adjusted to a step function.
- The UK also requests that CEPT proposes that any EC Decision on UWB should be reviewed and if necessary amended at anytime at the request of the Radio Spectrum Committee (RSC). Administrations should be encouraged to present CEPT and EC any evidence that shows the need to revise the technical conditions within an EC/ECC decision.
- The UK also proposes that the process of amending any EC/ECC UWB Decisions should not take more than a year from the date of the RSC request. In order to achieve this any technical work underpinning revisions to the EC Decision undertaken by the CEPT under mandate from the European Commission should be completed as quickly as possible.
- That a mandatory review should be conducted 3 years after the introduction of any ECC decision. Part of the review process could include collecting data and evidence on the following:
    - Periodic measurements of the noise floor using equipment that can quantify the total increase due to UWB, provided that monitoring equipment with the necessary precision resolution can be developed.
    - These periodic measurements should then be compared with predicted levels given the penetration of devices and corrective action recommended as necessary. UK is currently developing an "automatic interference monitoring system" able to make such measurements and will be pleased to share the details of the system with other administrations in due course.
    - Commercial UWB devices should be evaluated, to determine how their technical and operational characteristics compare with the assumptions made in studies conducted by ECC TG3.
    - Market surveillance into the numbers and types of UWB devices being placed on national markets.
    - Collection of any evidence of interference caused to incumbent services by UWB devices.
- Any Decision should allow for the future developments in wireless systems. For example, part of a review process could include consideration of whether to introduce a DAA mechanism into any frequency bands which might be identified for systems beyond IMT 2000.
- The UK proposes that the regulatory framework should be “generic”, with some restrictions. In other words any general regulations for UWB devices should not be specific to certain types of product or applications. The definition of the term

"generic" should rather be exclusive of certain categories that present a significant interference potential to other radiocommunication services.

1.6 See Table 1 and Figure 1 for both tabular and graphical representations of our proposals for UWB devices operating in the 3.1GHz to 10.6 GHz bands. The desired mask is shown in red on Figure 1. Other possible solutions with notches that could be adopted as a result of studies are shown in different colours. The band by band impact analysis set out in annex 1 details the UK's thinking, and evidence where available, that has been used to reach these preliminary conclusions.

Figure 1

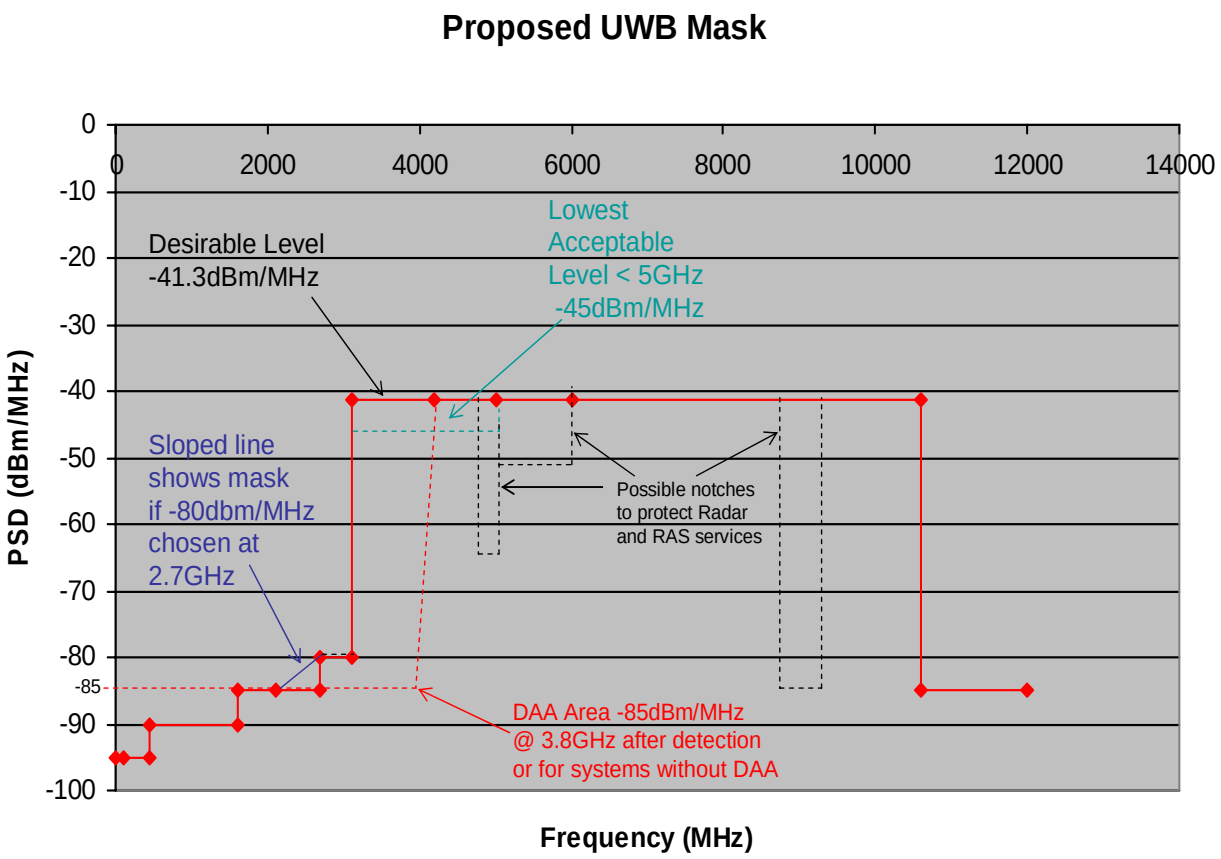

Table 1 Proposed Mask in tabular format

	Frequency range (MHz)	Report 64 EIRP limit (dBm/MHz)	UK's proposal (dBm/MHz)
Range 1	Below 230 MHz	-95	-85 or lower if measurement methods can be resolved
Range 2	230 – 1600 MHz	-90	-85 or lower if measurement methods can be resolved
Range 3	1600 – 2100 MHz	-85	-85
Range 4	2100 – 2700 MHz	-85	-85 or Sloped from -80 to -85
Range 5	2700 – 3100 MHz	-70	Stepped from -80 dBm/MHz @ 3.1GHz unless the results of practical studies on radar systems confirmed a lower value would be acceptable
Range 6	3100 – 4200	*Proposal 1* : -70 *Proposal 2* : Between -55 and -41 plus detect and avoid mechanism	Between -41.3 & -45 with detect and avoid mechanism reducing levels to -85dBm/MHz when BFWA signal is detected (-85dBm/MHz without DAA)
Range 7	4200 - 5000	*Proposal 1* : -70 *Proposal 2* : Between -55 and -41.3	-41.3 to -45 to consider DAA in this band in the future for systems beyond IMT 2000 allocations. Possible notch to protect RAS in 4800 to 5000MHz.

Table 1 contd

Range 8	5000 - 6000	-70 or -65	-41.3 Values at 9 - 9.5GHz is subject to the results of practical studies to protect radar systems.
Range 9	6000 - 10600	Between – 55 and -41.3	-41.3 Possible notch at 9000 - 9500 MHz to lower levels to protect radar systems.
Range 10	Above 10600	-95	-85 or above

Annex 1

Band by band Impact Analysis - Analysis below 3.1GHz

A1.1 The limits proposed by ECC TG3 for bands below 1.6GHz are -90 dBm/MHz reducing to -95 dBm/MHz below 230MHz. The UK has proposed previously that TG3 should consider the limit of -85dBm/MHz be adopted below 1.6GHz. The reasoning behind this thinking was that at levels lower than this, it will be difficult to differentiate UWB unintended transmissions and unintentional radiation from UWB's circuitry when performing radiated measurements for compliance purposes. If this problem can be resolved then the UK would be willing to accept lower levels being regulated.

A1.2 ECC TG3 studies have assumed similar protection limits at these bands to those recommended in Report 64 and the UK commissioned Mason Communications report for existing 3G services. This equated to a level of -85dBm/MHz being required between 2.5 GHz and 2.69GHz. The UWB industries have indicated that a level of -80 dBm/MHz can be achieved at 2.7GHz with current UWB technology, to meet the -85dBm/MHz level at 2.7GHz, there would be extra cost to the UWB industry associated with applying better filtering technology.

A1.3 The UK's preliminary view is that a level between -80 and -85dBm/MHz can be mandated at 2.7GHz to protect the 3G expansion bands.

A1.4 Primary radar (10cm) operates at 2.7 - 3.1GHz. Current study shows that UWB EIRP density limit of -79.6dBm/MHz for single entry interference is required to protect radar used for safety services. Further studies are being carried out to determine the effect of single entry UWB interference into radar. Unless the results of the practical studies confirmed a lower value would be acceptable, the level required at 2.7 - 3.1GHz is -80dBm/MHz.

Figure 2 Conclusion in the Band below 3.1 GHz

	Frequency range (MHz)	Report 64 EIRP limit (dBm/MHz)	UK's proposal (dBm/MHz)
Range 1	Below 230 MHz	-95	-85 or lower if problems with measurements can be resolved.
Range 2	230 – 1600 MHz	-90	-85 or lower if problems with measurements can be resolved.
Range 3	1600 – 2100 MHz	-85	-85
Range 4	2100 – 2700 MHz	-85	-85 or Sloped from -80 to -85
Range 5	2700 – 3100 MHz	-70	Stepped from -80 dBm/MHz @ 3.1GHz unless the results of practical studies on radar systems confirmed a lower value would be acceptable

Annex 2

Impact Analysis in the frequency ranges 3.1 – 5 GHz

Band from 3.1 to 4.2GHz

A2.1 The UK proposes a level of between -41.3 and -45 dBm/MHz in the band 3.1 – 4.2 GHz mandating the implementation of DAA mechanism to protect BFWA. This will ensure that UWB devices can detect emissions from BFWA services in this band in order for them to modify their transmission behaviour to avoid causing interference to BFWA.

A2.2 The UK has published an independent technical evaluation of the effect of UWB on broadband wireless access in the 3.4GHz band undertaken by Indepen and Quotient From the work in this report the UK has concluded that the limit of -85dBm/MHz will be required to provide sufficient protection to indoor BFWA.

A2.3 Hence the UK proposes that UWB devices operating in this band without an adequate DAA mechanism or not employing a mitigation technique that gives equivalent protection should not transmit above a level of -85dBm/MHz up to 4.2GHz. Devices employing mitigation techniques must reduce their emissions to -85dBm/MHz upon detecting BFWA signals.

A2.4 The other radio services that could be affected in this band are fixed service and fixed satellite service.

A2.5 The two studies that have been submitted to ECC TG3 on the impact analysis of UWB devices on fixed outdoor services have produced divergent conclusions. One study concluded that an indoor UWB deployment with EIRP density of -41.3dBm/MHz and 1% activity factor will not produce harmful interference to outdoor fixed services for the urban and suburban case. The other study concluded that with similar assumptions, the protection limit for fixed service is exceeded by 15dB at 95% confidence for the urban model. The difference in the results is due to, different LOS and NLOS statistical assumptions used and the inclusion of shadowing effect in one study and not in the other. This highlights that there is a significant variation in the results that can be given by making slight changes to the assumptions made when modelling the impact in an urban environment.

A2.6 For the fixed satellite service, several different impact analyses have also been conducted using a number of different propagation models. Conclusions can be assumed for the suburban case where the protection criteria is met for all the studies, assuming that indoor only UWB deployment is mandated with TPC and 1% activity factor.

A2.7 The UK believes that the results for the urban case are still inconclusive due to the lack of empirical evidence to justify the urban propagation models being used. In all these aggregate studies it can be seen that even if there is any impact of UWB devices on outdoor fixed services and fixed satellite services, this will only become apparent for UWB device densities that correspond with a successful and mature UWB market. Evidence from similar technology roll outs in the past have shown that the market is not likely to mature within the first five years of UWB deployments.

A2.8 To accommodate these uncertainties while still facilitating the introduction of UWB, the UK proposes that regulation be reviewed by

2.8.1 Monitoring the actual take up of UWB

2.8.2 Measuring the duty cycle of UWB devices placed on the market.

2.8.3 Conducting periodical noise floor measurements in the vicinity of sensitive terminals such as fixed satellite earth stations located in urban areas.

2.8.4 Considering a change to the specification of future UWB devices if these steps suggest that the interference might become harmful when the market reaches maturity.

A2.9 Given that it is highly unlikely that UWB densities will reach the numbers assumed in the urban studies within the next 3 years, UK believes as an interim solution, that by adopting an EIRP density limit of between -41.3dBm/MHz to -45 dBm/MHz for UWB devices in conjunction with a mandatory review process after 3 years, the protection needs of the services can be met. Within that time, more information on the operation of UWB and evolution of the technology for cost effective operation at higher frequencies will be known.

Bands from 4.2 to 5GHz

A2.10 UK proposes a level of between -41.3 dBm/MHz to -45 dBm/MHz in this band. In addition to fixed service and fixed satellite service which have been considered in the previous section, RAS use the band 4800 – 4990 MHz and 4990 to 5000 MHz. UK have commissioned additional study on RAS which have shown that the results of interference can vary depending upon the type of measurements being taken by the RAS. If protection is required for spectral line observations, UWB EIRP density limit of -65dBm/MHz would be required. However, if it is assumed that the victim telescope is part of interferometer network used for continuum observations, then the EIRP limit increase to -45dBm/MHz. This may have an impact on the level finally chosen for the 4800 to 5000 MHz band and this may result in notching to a lower level to protect RAS.

A2.11 Airborne radar altimeter uses the band 4200 to 4400 MHz. Report 64 proposed UWB EIRP density limits of -48.7dBm/MHz assuming a 5% activity factor and 20% outdoor usage to protect aeronautical radar in the suburban case. Assuming indoor only deployment and 1% activity factor, additional study has shown that EIRP density limit of -37.21 dBm/MHz would be able to provide protection to airborne radar altimeter in the aggregate interference case. However, within Report 64, the single entry limit for Radio Altimeters is -47.3 dBm/MHz. Given that at low altitudes the radio altimeter signal will be large, the UK believes that their proposed values should be sufficient to protect radio altimeters.

Figure 3 Conclusion in the Band 3.1 to 5

	Frequency range (MHz)	Current ECC TG3 EIRP limit (dBm/MHz)	UK's proposal (dBm/MHz)
Range 6	3100 – 4200	*Proposal 1* : -70 *Proposal 2* : Between -55 and -41 plus detect and avoid mechanism	-41.3 to -45 with detect and avoid mechanism to reducing levels to -85dBm/MHz when signals detected (-85dBm/MHz without DAA)
Range 7	4200 - 5000	*Proposal 1* : -70 *Proposal 2* : Between -55 and -41	-41.3 to -45 to consider DAA in this band in the future for systems beyond IMT 2000 allocations. Possible notch to protect RAS in 4800 to 5000MHz.

A2.12 The bands within the frequency range 2.6 to 6GHz are being examined by ECC PT1 and ITU-R WP 8F to become candidate bands for systems beyond IMT-2000. There is concern that allowing the use of UWB within this band will prohibit the introduction of future system beyond IMT-2000. The UK has proposed that the detect and avoid requirement be reviewed to consider protection to future system beyond IMT-2000 after the WRC-07 if spectrum has been allocated to these services. This will allow first generation UWB devices to operate at the lower frequency band in the interim period whilst manufacturers study the evolution of the technology over time for cost effective operation at the higher frequencies.

Annex 3

Impact Analysis in the 5 - 6 GHz Band

A3.1 ECC Report 64 recommends a protection limit of -70dBm/MHz to protect incumbent services in this band. This level is chosen to provide protection to WAS including RLANs who operate in the bands. Report 64 also recommends a level of -65dBm/MHz to protect radar operations (specifically Meteorological Radar).

A3.2 Industry proposals so far have indicated that they will either notch out the range 5 – 6 GHz or implement a DAA mechanism to protect RLAN operations.

A3.3 Microwave Landing Systems use the band 5030 to 5150 MHz. Report 64 proposed UWB EIRP density limits of -44.7dBm/MHz assuming a 5% activity factor and 20% outdoor usage to protect MLS in the suburban case. Assuming indoor only deployment and 1% activity factor, additional study has shown that EIRP density limit of -33.25 dBm/MHz would be able to provide protection to MLS in the aggregate interference case. However within Report 64 the single entry limit for MLS is -43.3 dBm/MHz. Given that at low altitudes the MLS signal will be large the UK believes that their proposed values should be sufficient to protect MLS.

A3.4 Concerns have been raised that co-channel UWB devices operating in close proximity to 5GHz RLAN devices will cause a false trigger of the RLAN DFS mechanism. As the DFS mechanism RLANs will typically detect PRFs at a rate which is lower than 1MHz by mandating a minimum PRF for UWB devices the likelihood of false triggering of the DFS is negligible. In addition, as the DFS function will usually be undertaken by the Master device or access point, the probability of a UWB device being in close proximity to a master device is low and hence this reduces further any risk of false alarms.

A3.5 The UK believes that since the WAS including RLANs are normally allocated on a licence exempt basis and are designed to work in harsh radio environments that these systems should be able to maintain a reasonable service in the presence of UWB signals. UWB manufacturers have indicated that UWB transceivers co-located with RLAN devices would be overloaded due to the higher levels of the RLAN signal.

A3.6 Met radar primarily operates in the frequency band 5600 – 5650 MHz although there are allocations for radar use from 5250 -5850MHz. UK has carried out additional studies on the Met radar which shows that the UWB EIRP density limit of -41.3dBm/MHz would provide sufficient protection to Met radar in the aggregate interference case for indoor only deployment with 1% activity factor. Further studies are being carried out to determine the effect of UWB emissions for the single entry case into radar, where ECC report 64 concludes that a level of -51dBm/MHz is necessary. The results of these studies may result in the final level chosen for the 5000 to 6000 MHz band being lower than those proposed at present.

Figure 4 Conclusion in the 5 – 6 GHz Band

	Frequency range (MHz)	Current ECC TG3 EIRP limit (dBm/MHz)	UK's proposal
Range 8	5000 - 6000	-70 or -65	-41.3 Possible notch to lower levels to protect radar systems

Annex 4

Impact Analysis in the 6 - 10 GHz Band

A4.1 The services that may be affected in the 6 – 10 GHz band are fixed service, meteorological radar, radio astronomy, passive earth exploration satellite services and aeronautical radar.

A4.2 Studies have shown that, using similar assumptions to that used for sharing with outdoor fixed services below 5GHz, the UWB EIRP density limit of -41.3dBm/MHz would meet the protection criteria for outdoor fixed services between 6 to 10 GHz.

A4.3 Additional UK studies for meteorological radar in the 9300 – 9500 MHz have shown that the UWB EIRP density limit of -41.3dBm/MHz would provide sufficient protection to Met radar in the aggregate interference case for indoor only deployment with 1% activity factor in the suburban case. Further studies are being carried out to determine the effect of UWB emissions for the single entry case, where ECC Report 64 concludes that a level of -54 dBm/MHz is necessary. The results of these studies may have an impact on the final level chosen for this band.

A4.4 Radio astronomy operates in the 6650 – 6675.2 MHz band. However, there is no formal allocation for RAS in this band and it operates under the RR Footnote 5.149.

A4.5 Current studies show that UWB EIRP density limits of -44dBm/MHz is required to provide protection to EESS (passive) in the 6900 MHz band assuming indoor only deployment with 1% activity factor. The protection criteria for the EESS can be achieved when TPC is mandated for the UWB devices to achieve at least a 3dB reduction in the overall aggregate interference power to other services. It is also noted that EESS operates in this band under the RR Footnote 5.458 and there is no formal allocation for EESS in this band.

A4.6 Aeronautical radar operates in the 9000 – 9500 MHz band. Further studies are being carried out to determine the effect of single entry UWB interference into radar where ECC Report 64 recommends a level of -90 dBm/MHz for 3cm radar in this band.

A4.7 The UK has initially proposed a UWB EIRP density limit of -41.3dBm/MHz in the 6 – 10.6GHz band. The final value in the 9000 - 9500 MHz band is subject to the results of practical studies on radar systems. Ofcom are also willing to consider higher levels than this for the 6 - 10.6GHz band if further studies show that interference is manageable.

Figure 5 Conclusion in the 6 – 10.6 GHz Band

	Frequency range (MHz)	Current ECC TG3 EIRP limit (dBm/MHz)	UK's proposal
Range 9	6000 - 10600	Between – 55 and -41	-41.3 Values at 9 - 9.5GHz is subject to the results of practical studies to protect radar systems.

Annex 5

Impact Analysis above 10.6 GHz Band

A5.1 EESS (passive) is used in the band 10.6 to 10.7 GHz. Report 64 proposed UWB EIRP density limit of -57dBm/MHz to protect EESS (passive). The UK believes that the limit above 10.6GHz should not be set below -85dBm/MHz and that a less onerous roll-off may be appropriate in order not to place unnecessarily burden on the UWB industry when designing filtering for UWB devices.

A5.2 There is allocation for RAS at 10.6 – 10.7 GHz band, but this is not studied in Report 64. The UK-commissioned RAS study has concluded that UWB EIRP density limit of -85dBm/MHz will offer full protection to the RAS operating in this band.

Figure 6 Conclusion above 10.6 GHz Band

	Frequency range (MHz)	Current ECC TG3 EIRP limit (dBm/MHz)	UK's proposal
Range 10	above 10600	-95	-85 or above