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ULTRA-WIDEBAND SHORT-RANGE RADARS FOR AUTOMOTIVE APPLICATIONS

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1. INTRODUCTION

Ultra-wideband short-range radar (UWB SRR) for motor vehicles is a technology that uses radar transceivers mounted behind vehicle bumpers together with signal processing equipment inside the vehicle to enable the detection, location and tracking of movement of persons or objects at distances of up to 30 m from the vehicle. Unlike current automotive radar technologies, such as 76 GHz band longer-range automotive radar systems for advanced cruise control systems[1], UWB SRR technology uses very wide bandwidths of up to 5 GHz and is capable of much more precise object detection. This capability enables features such as:

- near collision avoidance (including Blind Spot Detection and Parking Assistance);
- improved air-bag activation; and,
- suspension systems that better respond to road conditions.

A group of automotive manufacturers and component suppliers known as the SARA (Short-range Automotive Radiofrequency Allocation) group is promoting UWB SRR technology as one of a number of next-generation measures that will achieve significant longer-term road safety benefits. In the European Community this has been adopted as part of the *e-safety* initiative that aims to accelerate the development, deployment and use of intelligent integrated safety systems that use information and technology, to improve road safety and reduce the number of accidents on Europe's roads.

The 24 and 79 GHz bands have been identified for possible use by UWB automotive radars. However, because 79 GHz band technology is less developed, and is currently much more expensive, it has been argued that introduction of UWB SRR should be in the 24 GHz band.

The United States of America, and more recently the United Kingdom other countries in Europe, and New Zealand have made regulatory arrangements that support the operation of 24 GHz Band UWB SRR systems. ACMA has been approached by a number of automotive suppliers and the Federal Chamber of Automotive Industries (FCAI) seeking the introduction of similar arrangements in Australia to support the inclusion of these devices as a feature in some 2006 luxury vehicles.

At least one luxury vehicle manufacturer has near-term plans to incorporate 24 GHz band UWB SRR as an optional feature in vehicles expected to reach the Australian market in 2006 (or earlier if possible). Other luxury vehicle manufacturers have indicated an intention to incorporate 24 GHz band UWB SRR as a feature in the next 18-24 months. Past motor vehicle industry experience suggests that as demand increases and economies of scale occur, features that are initially only offered on luxury vehicles tend to become available on most vehicles. Therefore, over time, it is possible that UWB SRR systems could become a relatively commonplace feature in motor vehicles.

This report examines overseas regulatory frameworks and contains compatibility studies between UWB SRR systems and potentially affected radiocommunications services and systems. The report concludes by recommending a radiocommunications licensing arrangement that could support the use of these systems in Australia.

[1] 76-77 GHz band vehicle radar systems for advanced cruise control systems are supported under the *Radiocommunications (Low Interference Potential Devices) Class Licence 2000.* For further information on the radiocommunication licensing aspects of this technology see Spectrum Planning Report SP 4/01.

2. OVERSEAS REGULATORY AND STANDARDS ARRANGEMENTS

2.1 US Federal Communications Commission Regulations (FCC)

The FCC, as a result of industry requests and its statutory mandate to encourage new technologies, in May 2000 requested comment from interested parties on proposed limits and regulatory requirements contained in a Notice of Proposed Rule Making on devices using UWB technology. Comments were received from a range of radiocommunications service providers and potential UWB equipment suppliers including members of the SARA group.

The FCC released its First Report and Order (rule making) on UWB in February 2002 [1] creating Subpart F, of Part 15 of the FCC Rules and Regulations dealing with unlicensed emissions from intentional and unintentional radiators. This new subpart sets out the rules that permit the marketing and unlicensed operation of range of products based on UWB technology including automotive short-range radar. Section 15.515 sets out the FCC's technical requirements for vehicular radar systems operating in the band (22-29 GHz). The following is a summary of Section 15.515 of the FCC Rules.

- The section 15.515 provisions deal with UWB field disturbance sensors mounted in terrestrial transportation vehicles. These devices shall operate only when the vehicle is operating, e.g. the engine is running. Operation shall occur only upon specific activation, such as upon starting the vehicle, changing gears, or engaging a turn signal.
- The UWB bandwidth for a vehicular radar system shall be contained between 22 and 29 GHz. In addition, the centre frequency, f_C, and the frequency at which the highest level emission occurs, f_M, must be greater than 24.075 GHz.
- Following proper installation, the vehicular radar systems shall attenuate any emissions within the 23.6-24.0 GHz band for equipment:

Imported or manufactured	At elevations greater than	Shall be attenuated by
Before 1 January 2005	38 degrees	25 dB below -41.3 dBm/MHz
After 1 January 2005	30 degrees	25 dB below -41.3 dBm/MHz
After 1 January 2010	30 degrees	30 dB below -41.3 dBm/MHz
After 1 January 2014	30 degrees	35 dB below -41.3 dBm/MHz

Table 2a: Vertical antenna pattern requirements

- This level of attenuation can be achieved through the antenna directivity, through a reduction in output power or any other means.
- The radiated emissions at or below 960 MHz from a device operating shall not exceed the emission levels in Section 15.209. The radiated emissions above 960 MHz shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-22,000	-61.3
22,000-29,000	-41.3
29,000-31,000	-51.3
Above 31,000	-61.3

Table 2b: Broadband unwanted or spurious emission limits

- In addition to the radiated emission limits specified above, UWB vehicular radar transmitters shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

Table 2c: Narrowband unwanted or spurious emission limits

- The limit on the peak level of the emissions contained in a 50 MHz bandwidth centred on the frequency at which the highest radiated emission occurs, f_M is 0 dBm EIRP.

The FCC in February 2003 adopted a Memorandum Opinion and Order and Further Notice of Proposed Rule Making. The Memorandum Opinion described two items raised by petitioners relating to changes to the rules and regulations for vehicular radar systems. These items related to arrangements to allow the use of low pulse repetition rate UWB vehicular radar in the 3.1- 10 GHz band and the use of frequency hopping modulation in UWB vehicular radar systems operating in the 22-29 GHz band. These petitions were denied but further comment was sought through a Further Notice of Proposed Rule Making.

A subsequent Second Report and Order and Second Memorandum Opinion and Order regarding UWB transmission systems was released in December 2004 [2]. This report discussed the comments received in regard to providing for low pulse repetition rate vehicular radar systems. The FCC decided that they would be accommodated in Part 15 under new arrangements for non-UWB wideband vehicular radar systems in the 5925-7250 GHz [15.250], 16.2-17.7 GHz and 23.12-29 GHz bands (excludes emission in 23.6-24.0 GHz) [15.252]. This Second Report and Order also introduced one change to part 15.515 covering UWB vehicular radar. That change provided emission level measurement methods for devices employing gated transmissions.

The pre-existing section 15.245 covers narrowband emissions from field disturbance sensors in the band 24075-24175 MHz. These emissions must:

- Have a maximum field strength 2500 millivolts per meter at 3m for the fundamental (32.7 dBm/MHz EIRP);
- Harmonic emissions below 17.7 GHz must meet the limits in section 15.209;
- Harmonic emissions above 17.7 GHz a limit of 7.5 mV/m (-17.7 dBm/MHz EIRP);
- Must not be continuous unless outside the restricted bands and meeting 15.209;
- Emissions other than harmonics must be at least 50 dB below the level of the fundamental, or conform to the general limits set out in section 15.209.

The 15.209 limit for emissions above 960 MHz is 500 mV/m at 3 m (-41.3 dBm/MHz EIRP). Section 15.249 covers emissions from any unspecified device operating in the band 24-24.25 GHz limiting them to 250 mV/m at 3 m (12.7 dBm/MHz EIRP).

2.2 European Conference of Postal and Telecommunications Administrations (CEPT)

The European Commission (EC) released a decision in January 2005 on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the European community [C(2005)34] [3]. This decision was part of a "package solution" of legal and regulatory provisions made in conjunction with the decision of the Electronic Communications Committee (ECC) of CEPT made in November 2004 [ECC/DEC/(04)10] [4]. This package of decisions was aimed at supporting the quick deployment of automotive short-range radar systems in the European community to improve road safety.

Specifically the arrangements support the use of the 24 GHz band (21.625-26.625 GHz) by automotive short range radar until 2013 after which all new automotive short range radar devices will be required to operate in the 79 GHz band (77-81 GHz) in line with the decision ECC/DEC/(04)03 [5]. The decisions were made based on the studies presented in ECC Report 023 [6] that indicated a need to provide additional protection for the Radio Astronomy and Earth Exploration Satellite Services.

The following is a summary of the EC and ECC requirements for 24 GHz automotive short-range radars.

- Operation shall be limited to the band 21.625-26.625 GHz for ultra wideband emissions and to the 24.05-24.25 GHz for any associated narrowband component.
- The ultra wideband emission shall have a maximum mean power density no greater than -41.3 dBm/MHz EIRP and a peak power density of no greater than 0 dBm/50 MHz EIRP except for frequencies below 22 GHz where the maximum mean power density shall be not greater than -61.3 dBm/MHz EIRP.
- Narrowband component may only consist of an unmodulated carrier with a maximum peak power of 20 dBm EIRP with a maximum duty cycle limited to 10% for peak emissions higher than -10 dBm EIRP.
- Emissions within the band 23.6-24.0 GHz that appear 30^{o} or greater above the horizontal plane shall be attenuated by at least 25 dB for devices placed on the market before 2010 and 30 dB thereafter.
- Devices with emissions higher than -57 dBm/MHz in the bands 22.01-22.5 GHz, 22.81-22.86 GHz, 23.07-23.12 GHz and 23.6-24.0 GHz shall be fitted with automatic deactivation after 1 July 2007 and before that date must have manual deactivation.
- The market penetration level of vehicles fitted with 24 GHz automotive short range radar shall not exceed 7.0% in each national market within the community. These requirements are subject to continuous review with a fundamental review carried out before December 2009 in regards to the proposed reference date of 30 June 2013.

2.3 European Telecommunications Standards Institute (ETSI)

ETSI, in support of the decisions of the EC and ECC, released in January 2005 the standard: EN 302 288-1 V1.1.1 (2005-01) [7]. It provides technical requirements and methods of measurement for short-range radar equipment operating in the 24 GHz range. This standard, and its associated part 2 that covers essential requirements of article 3.2 of the R&TTE Directive, sets the technical measurement methods and limits for this equipment, it also provides information on installation requirements.

The requirements of the standard differ in some areas from the limits indicated in the EC and ECC decisions. For example the scope refers to transmitters operating in the band 22.0 GHz to 26.625 GHz with levels outside this band reduced by no less than 20 dB and a mask is provided showing an emission roll off below 22.625 GHz and above 25.625 GHz at a rate of 20 dB per GHz. The radiated out-of-band emissions limit is specified as -61.3 dBm EIRP within a maximum measurement bandwidth of 1 MHz.

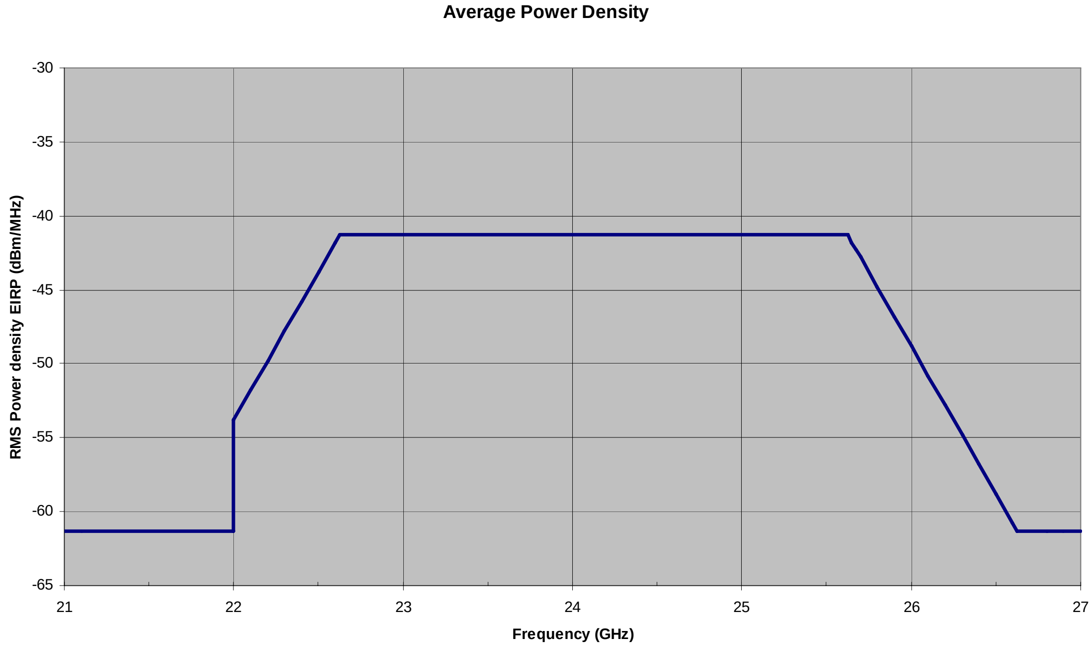

Figure 2a: ETSI EN 302 288-1 Mask for the UWB emission

The limits for radiated spurious emissions specified in the standard are listed in *Table 2d*. Spurious emissions in this case include harmonic and parasitic emissions, intermodulation and frequency conversion products but excluding out-of-band emissions. The maximum measurement bandwidth for frequencies < 1 GHz: is 120 kHz and for frequencies $\geq$ 1 GHz: is 1 MHz.

Frequency Range	Limit values
47 MHz to 74 MHz	-54 dBm
87.5 MHz to 118 MHz	-54 dBm
174 MHz to 230 MHz	-54 dBm
470 MHz to 862 MHz	-54 dBm
Otherwise in the band 30 MHz to 1 GHz	-36 dBm
1 GHz to 100 GHz (see below)	-30 dBm
Not applicable within the permitted range of frequencies 22.0 - 26.625 GHz	

Table 2d: Broadband spurious emission limits

These spurious emission limits are generic CEPT limits for short-range devices that can be found in CEPT ERC Rec 74-01 Spurious Emissions.

There is a normative requirement for the provision of manual deactivation for systems with emissions in the band 23.6-24.0 GHz. The standard also notes however that requirements for automatic deactivation and a list of sites where deactivation will be required will be specified in a future revision of the standard. Only frequency hopping systems that do not transmit in the Radio Astronomy bands are permitted by the standard but that this requirement and other parameters may be reviewed in a future revision.

Currently there is no ETSI standard for SRR in the 79 GHz band. The decisions of the EC and ECC are based on the ETSI technical report: ETSI TR 102 263 V1.1.2 2004-02 [8] that provides a system reference for automotive collision warning short range radar equipment operating in the 77 GHz to 81 GHz band. This document provides a technical and marketing justification for access to the spectrum in this band.

2.4 United Kingdom Office of Communications (Ofcom)

In response to the EC decision on 24 GHz Band UWB SRR, in April 2005 Ofcom undertook public consultation on a proposal to exempt the use of automotive short-range radar equipment at 24 GHz from Wireless Telegraphy licensing. In June 2005 Ofcom issued its decision to exempt the use of automotive short-range equipment in the 24 GHz Band from Wireless Telegraphy licensing [9]. The decision makes the band 21.65 to 26.65 GHz available for automotive short-range radar equipment without the need for users to hold a licence until 30 June 2013. Authorisation is on a non-interference and non-protected basis.

Summary of Ofcom requirements:

- The exemption applies to equipment established or installed in new vehicles, or replacement equipment for vehicles with previously installed equipment.
- The equipment must:
    - operate only when the vehicle in which it is established or installed is active;
    - only operate in the frequency band between 21.65 GHz and 26.65 GHz; and,
    - not cause undue interference to other users of the frequency band.
- Transmission from any ultra wideband part of the equipment must:
    - at frequencies between 22 GHz and 26.65 GHz, have a mean power density no greater than -41.3 dBm/MHz EIRP and a peak power density no greater than 0 dBm in any 50 MHz; and,
    - have a mean power density no greater than -61.3 dBm/MHz EIRP between 21.65 GHz and 22 GHz.
- Any narrow band emission component of the equipment must:
    - only operate in the frequency band 24.05 GHz to 24.25 GHz;
    - transmit with a peak power no greater than 20 dBm EIRP; and
    - where transmitting with a peak power greater than -10 dBm EIRP, have a duty cycle which does not exceed 10%.
- Any part of the emission in the frequency band between 23.6 GHz and 24.0 GHz shall be attenuated at 30° or greater above the horizontal plane by at least 25 dB.
- The exemption does not apply to emissions in the band 22.21 GHz to 24 GHz in exclusion zones. Equipment with emissions in the band 22.21 GHz to 24 GHz must either automatically deactivate and cease all emissions within an exclusion zone or be capable of manual deactivation so that all emissions cease within an exclusion zone.

  These exclusion zones with radii of radius 5 or 9 km have been placed around five major UK radio astronomy stations and were calculated on the following basis:
    - A radio astronomy protection level of -215 dBW/(m^2.Hz) for single dish spectral line observations and a protection level of -208 dBW/(m^2.Hz) for continuum measurements made with telescopes operating in the MERLIN network based on limits set out in ITU Recommendation ITU-R RA.769;
    - Standard off-axis radio telescope gain of 0 dBi (Recommendation ITU-R RA.769);

- Recommendation ITU-R P.452 propagation model ;
- Additional loss of 1 dB/km for atmospheric losses;
- An UWB EIRP of -41.3 dBm/MHz (-71.3 dBW/MHz); and
- A maximum density of 1 UWB device-per-square km.

2.5 International Telecommunication Union Radiocommunication Sector (ITU-R)

ITU-R Study Group 1 established a special task group (TG1/8) to look at regulatory arrangements and interference concerns raised by the widespread use of UWB technology. The general concern about the potential for interference is evidenced by liaison statements that have been received by Task Group 1/8 from most service-specific ITU study groups. TG1/8 held six meetings over the period from January 2003 till October 2005.

TG 1/8 has prodcued four draft new ITU-R Recommendations covering UWB system characteristics, guidance of development of regulatory frameworks, UWB compatibility assessments and measurement methods [10], [11], [12], [13]. In addition TG1/8 has compiled an ITU-R Report on UWB compatibility studies [14].

Proponents of existing services have argued that the widespread use of UWB devices could pose a significant interference risk based on conservative studies and assumptions. Countering these arguments, proponents of UWB devices have highlighted the need to take proper account of mitigation factors in the interference assessment studies.

In relation to automotive short-range radar operating in the 24 GHz band the potentially affected services are Radio Astronomy Service, the Earth Exploration-Satellite Services and the Fixed Service. The starting point for the TG1/8 discussions has been the detailed studies presented in ECC Report 023 [6].

2.6 Summary of Short range UWB Automotive Radar regulatory arrangements

Frequency Band	Limitations	Organisation
22–29 GHz	-25 dB at 30^{o} and -30 dB at 30^{o} after 1/1/2010 -35 dB at 30^{o} after 1/1/2014	FCC (USA)
21.650–26.650 GHz	Emissions below 22 GHz are restricted to -61.3 dBm/MHz -25 dB at 30^{o} before 2010 and then -30 dB at 30^{o} Max 7% market penetration No new installations after 30 June 2013 Automatic deactivation around RAS sites after 1July 2007	EC, ECC (Europe)
77–81 GHz	Proposed future band for European SRR after 2013	
22–26.650 GHz	-25 dB at 30^{o} before 2010 and then -30 dB at 30^{o}	ETSI (Europe)
21.650–26.650 GHz	Emissions below 22 GHz are restricted to -61.3 dBm/MHz -25 dB at 30^{o} No new installations after 30 June 2013 Automatic deactivation around RAS sites after 1July 2007	Ofcom (UK)

Table 2e: Frequency Bands and limitations supporting Short Range Automotive Radar

3. SUMMARY OF 24 GHZ AUTOMOTIVE SHORT RANGE RADAR CHARACTERISTICS

Device	Freq range (GHz)	Frequency of high power carrier in 24.05 - 24.25 GHz band (if present)	Max broadband radiated **average** power density (e.i.r.p) in 22.625-26.625 MHz	Max broadband radiated **peak** power density (e.i.r.p) in 22.625-26.625 MHz	Max radiated **average** power density (e.i.r.p) of emission below 22 GHz	Max radiated **average** power density (e.i.r.p) of emission Above 26.5 GHz	23.6-24 GHz band vertical plane emission limits
Device A	**23.2535-**25.3477 (short pulse) 23.3537-**25.7886** (long pulse)	Between 24.174 and 24.183 GHz	**-49.2 dBm/MHz** (±5.3 dB) @ 24.481 GHz (short pulse) **-46.4 dBm/MHz** (±5.3 dB) @24.264 GHz (long pulse)	-16.0 dBm/10 MHz (±5.3 dB) @ 24.366 GHz (short pulse) -14.0 dBm/10 MHz (±5.3 dB) @24.256 GHz (long pulse)	**-69 dBm/MHz** @ 22 GHz	**-68.6 dBm/MHz** @ 26.625 MHz	25 dB attenuation achieved for angles above horiz. > ≈25°
Device B	**23.967-24.977**	No higher power narrow band component.	**-50.8 dBm/MHz**	peak power EIRP = -50.8 dBm	22 GHz **-63.9 dBm/ MHz** @21.6 GHz (lower levels further from 22 GHz)	**-60.0 dBm/MHz** @ 26.29 GHz (but no spot measurements above 26.5 that are near 26.5 GHz)	total emission level is -78.1 dBm. This complies with post 1/1/2014 requirements.

Table 3a: Detailed 24 GHz UWB radar characteristics

4. <u>24 GHz BAND - SPECTRUM ALLOCATION AND USAGE</u>

A band-by-band summary of frequency allocations and usage is provided in Table A1 of **Annex 1**. Key regulatory documents, service allocations and usages are described below.

4.1 Regulatory instruments

4.1.1 Band Plans and Radiofrequency Assignment and Licensing Instructions

At this time ACMA has no frequency band plans in the frequency range 21.4–29.1 GHz.

The only Radiofrequency Assignment and Licensing Instruction (RALI) covering this frequency range is RALI FX-3, which includes channelling and other arrangements for point-to-point fixed links in the 21.2–23.6 GHz band. The 22.008–22.211 and 23.240–23.443 GHz portions of that band are heavily used by 3.5/7/14/28 MHz bandwidth point-to-point links that are typically used for mobile phone back haul links. Optus, Vodafone and Hutchison hold the bulk of licences in those bands.

4.1.2 Current Radiocommunications class licences

The band 24.0–24.25 GHz is subject to footnote 150, which indicates that it may be used by non-radiocommunications Industrial, Scientific and Medical (ISM) devices. Recognising the constraints of operations in a band where ISM devices may operate, ACMA has also authorised users to operate a variety of miscellaneous devices in that range under the *Radiocommunications (Low interference Potential Devices) Class licence 2000* under a "no interference, no protection from interference" basis.

4.1.3 Spectrum licensing

Ministerial designations have reserved spectrum in the 26.5–27.5 and 27.5–28.35 GHz ranges for spectrum licensing. This places important constraints on other uses of those bands.

As at 1 August 2005 the following spectrum licences have been allocated:

Band	Area	Licensee
26.5–26.85 GHz	Australia wide	Not yet allocated
26.85–27.35 GHz	Australia wide	XY ZED-LMDS Pty Ltd
27.35–27.5 GHz	All areas of Australia – except regional SA and regional WA	Not yet allocated
27.35–27.5 GHz	regional SA + regional WA	Shin Satellite
27.5–28.35 GHz	Australia wide	AAPT

Table 4a: Spectrum licences in the band 26.5 to 28.35 GHz

The allocation of spectrum for spectrum licensing constrains ACMA's ability to create class licences to authorise users to operate equipment across frequency ranges covered by the spectrum licence allocations.

Section 138 of the *Radiocommunications Act 1992* states

".. a class license that authorises operation of radiocommunications devices at frequencies that are within a part of the spectrum that is designated under section 36 to be allocated by issuing spectrum licences".

Unless and until the constraints imposed by section 138 of the Act are addressed ACMA would not issue a class licence covering parts of the 26.5–28.35 GHz frequency range.

4.2 Radiocommunications Services using the 24 GHz bands

4.2.1 Amateur service use

Amateur licences authorise operations across the 24–24.05 GHz range on a primary basis, and in the 24.05–24.25 GHz range on a secondary basis. Licensed radio amateurs may operate in these bands subject to the conditions of their licences including the *Radiocommunications Licence Conditions (Amateur Licence) Determination No. 1 of 1997.*

The Wireless Institute of Australia's voluntary "Australian Amateur Band Plans" (June 2005) [15] indicates that the band 24.00–24.05 GHz is intended for amateur satellite use, the 24.048–24.050 and 24.192–24.194 GHz segments are intended for narrow band emission modes while the band 24.05–24.25 GHz is intended for use by all permitted amateur emission modes. As indicated in Table A1 of Annex 1, a small number of Amateur beacons have been licensed in the 24.0–24.05 GHz band.

Amateur-satellites may operate in the 24–24.05 GHz band. The AMSAT web site indicates that OSCAR AO-40 and AMSAT-Phase 3 satellites may operate in this band on frequencies around 24.048 GHz[2].

4.2.2 Radio-astronomy service

Allocations to the Radio-astronomy service (RAS) exist in the bands 22.21–22.5 and 23.6–24 GHz bands. Those bands are important for radio-astronomy because they contain water vapour and ammonia absorption line frequencies. In the Australian Radiofrequency Spectrum Plan (ARSP) the 23.6–24.0 GHz band carries footnote 340 that prohibits emissions in the band[3]. The purpose of the footnote is to provide protection for measurement by passive sensors used by the radio-astronomy and Earth-exploration satellite services.

In addition to the 22.21–22.5 and 23.6–24 GHz bands, where Radio astronomy allocations have been made, radio-astronomy observations may be conducted at defined radio astronomy sites using very sensitive receiving stations on a "no protection" basis in the frequency range 21.4–27 GHz under the provisions of footnote AUS87 in the ARSP. It is noted however that, in the parts of this frequency range where radio-astronomy activities are able to be licensed (i.e. the 22.21–22.5 and 23.6–24 GHz bands), licences have only been taken out to provide protection for the CSIRO observatories at Parkes and Narrabri.

4.2.3 Earth-exploration satellite and Space research services

In addition to the allocation for the RAS, there are also allocations to the Earth-exploration satellite (EESS) (passive) and Space research (SRS) (passive) services in the 22.21–22.5 and 23.6–24 GHz bands. No Australian radiocommunications licences have been taken to protect EESS (passive) or SRS (passive) receivers and since most currently flying passive

[2] AMSAT website: http://www.amsat.org

[3] See section 7.4 regarding the requirement for revision of ARSP in respect to footnote 340.

sensors have not been notified to the Radiocommunications Bureau of the ITU[4] there is limited information available on the necessary protection requirements for these systems.

The Bureau of Meteorology has stated that the frequency range 23.6–24 GHz is a unique frequency that overflying EESS satellites can use to extract data on atmospheric water vapour content. Those data can be used as an input to weather forecasting and climate prediction models. While the value of such predictions to the Australian economy is difficult to quantify there appears to be a good case to preserve the quality of those predictions. As discussed later this may not require an absolute prohibition on emissions in relevant frequency bands but may entail reasonable steps to avoid overflying EESS (passive) sensors receiving interference from terrestrial automotive radar systems.

The band 25.5–26.5 GHz includes primary allocations to the Earth Exploration-Satellite Service (space-to-Earth) and the Space Research Service (space-to-Earth). Both these service allocations carry footnote 536A that indicates that these services shall not claim protection from Fixed and Mobile services and should operate taking account of ITU-R SA.1278 and SA.1625. The intention of this allocation is to provide for wide bandwidth data downlinks from space research or earth- exploration spacecraft.

In support of that potential application Embargo 24 was revised in January 2005 to allow licensing of receiving earth stations in the frequency range 25.5–26.5 GHz. However, while some preliminary expressions of interest have been received, as at 1 September 2005 no licences had yet been issued. However even when licensing does eventuate it is expected to limited to a relatively small number of sites (probably those currently associated with major space research facilities).

4.2.4 Fixed (and mobile) service

As noted above the frequency range 21.2–23.6 GHz is designated within RALI FX-3 for use by “22 GHz band fixed links”. The band is heavily used by 3.5/7/14/28 MHz bandwidth point-to-point fixed links that in the main provide backhaul links for mobile phone networks.

The frequency range 24.5–26.5 GHz is used in many countries for point-to-point fixed links or point-to-multipoint fixed service systems. However, in Australia the frequency range between 24.5–26.5 GHz is effectively unused at present[5]. Embargo 24[6] has, amongst other things, prohibited fixed service assignments in the range since January 2000. That embargo was put in place to preserve future planning options in the band that might include development of fixed service point-to-point or point-to-multipoint services. Up to this time demand has not justified development of detailed planning in those bands.

The Department of Defence in its Australian Defence Spectrum Strategic Plan [16] document has indicated an interest in accessing spectrum in the 25–27 GHz range. It is interested in using readily available military or commercial equipment to provide deployable broadband wireless communications in the battle-space. Defence has also expressed interest in use of the 26.5–27.5 GHz band in Australia for harmonised military use.

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[4] See ITU-R document TG1-9/80 (5 September 2005).
[5] At 1 August 2005 there was only one short-term scientific licence for non-UWB vehicle radar experiments.
[6] http://www.acma.gov.au/acmainterwr/radcomm/frequency_planning/spectrum_embargoes/emb24.pdf

4.2.5 Radiodetermination

In addition to the designation of the band 24.05–24.25 GHz for use by Industrial, Scientific and Medical devices (see footnote 150), the band is allocated to the Radiolocation service on a sole primary basis. In the Australian table of allocations that Radiolocation service allocation is qualified by footnote AUS11. That footnote indicates that the ".. service is intended to be used primarily for the purposes of defence. The Department of Defence is normally consulted in considering non-defence use of this service".

According to the Australian Defence Spectrum Strategic Plan the Department of Defence may operate radar systems in this band. This usage is authorised under the Defence apparatus licence that covers the 24.05–24.25 GHz band.

Another important radiodetermination service application in this band is for radar speed measurement equipment. Police forces in New South Wales, Queensland and the Northern Territory hold fairly large numbers of licences for radar speed measurement equipment in this band. Several other road traffic authorities and city councils also hold licences.

4.2.6 Satellite service usage

The band 21.4–22.0 GHz has been allocated on a co-primary basis to the Broadcasting Satellite Service (BSS) in ITU Regions 1 and 3 as a result of Resolution 525 of World Administrative Radio Conference WARC-92. The allocation comes into effect on 1 April 2007 and is subject to Resolution 739[7] of WRC03 regarding protection of adjacent band Radio Astronomy Services in the band 22.21–22.5 GHz. While Australia has no current plans to provide BSS services in this band it has made planning arrangements to preserve that option for the future. (This includes, for example, a note in RALI FX-3 that requires inclusion of a "band replanning" advisory note on assignments made in that range).

The bands 24.75–25.25 and 27.0–29.1 GHz have been allocated, on a co-primary basis, to Fixed –Satellite Service (FSS) uplinks. As at 1 September 2005, no assignments had been made in the 24.75–25.25 GHz range. In the 27.0–27.5 GHz frequency range a number of spectrum licence device registrations for uplink earth stations have been made.

The frequency range 28.6–29.1 GHz has been identified at WRC-03 (and subsequently in Embargo 24) for use by FSS uplinks in support of high density FSS usage. Originally this was seen as providing support for the proposed Teledesic system. Although that system is no longer seen as a short-term likelihood ACMA is maintaining the Embargo against the possibility of other similar systems developing.

[7] Resolution 739 (WRC-03) "Compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands"

5. 79 GHz BAND - SPECTRUM ALLOCATION AND USAGE

Band/ ARSP allocations	Regulatory provisions	Existing Services recorded in RRL[8] (including major clients and locations)
76 – 77.5 RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 149 AUS62	76-77 GHz LIPD class licence, item 47 Automatic Cruise Control radars 76-81 GHz Amateur LCD	1 x Radiodetermination (550 MHz centred on 77 GHz) University of Sydney/ Marulan
77.5 – 78 AMATEUR AMATEUR –SATELLITE Radio astronomy Space research (space-to-Earth) 149	76-81 GHz Amateur LCD	none
78 – 79 RADIOLOCATION Amateur Amateur-satellite Radio astronomy Space research (space-to-Earth) 149 560 AUS62	76-81 GHz Amateur LCD	none
79 – 81 RADIO ASTRONOMY RADIOLOCATION Amateur Amateur-satellite Space research (space-to-Earth) 149 AUS62	76-81 GHz Amateur LCD	none

Table 5a: 79 GHz Band Spectrum allocation and Usage

At this time there are no ACMA frequency band plans or Radiofrequency Assignment and Licensing Instructions (RALIs) that would provide more detailed allocation advice for these bands. At this stage no class or spectrum licensing arrangements apply in this band.

At 2 August 2005 ACMA had issued only one apparatus licence in the 77–81 GHz band. That licence was for an experimental purpose and does not necessarily represent a requirement that will translate into a widespread usage requirement in this band.

The Department of Defence has indicated potential future interest in use of the 78–81 GHz range through footnote AUS62 in the ARSP. However NATO has indicated [22] that there are no operational systems in the 79 GHz frequency range and that there are currently no plans to introduce such systems.

Amateur licences authorise operations across the 77–81 GHz range, on either a primary or secondary basis according to the band segment in question. The Wireless Institute of

[8] Recorded in RRL at 1 October 2005

Australia "Australian Amateur Band Plans" (June 2005) [15] does not provide detailed band planning recommendations for the use of the Amateur service allocation in the 75.5–81 GHz band (detailed plans exist up to around 24 GHz). There appears to be no amateur use of this band terrestrially in Australia at this time. There are no amateur satellites operating within this band[9].

Radio astronomy may be authorised through apparatus licences on either a primary or secondary according to the band segment in question, though no licences have been issued.

The European Community has indicated that in the longer term the 77–81 GHz band should be used for automotive radar systems and that new 24 GHz band systems would not be authorised in the period from 2013 onwards. The reasoning behind this strategy is that, while the 79 GHz band is seen as the best band in the longer term, the current cost of the radar modules make it unrealistic to commence deployment in that band. The 24 GHz band is seen as providing a band that would allow limited deployment of the basic technology (and achievement of the safety and other commercial advantages).

Given the lower vehicle numbers in Australia, no pressing requirement to commit to an explicit longer-term strategy for use of the 79 GHz Band is seen at present. Future reconsideration of this position would be shaped by progress in development of low cost radar modules and more particularly vehicles that incorporate such modules, however no need to set an explicit review timetable is thought necessary.

Noting that the 77–81 GHz band may be used for UWB SRR systems at some time in the future, Australian regulatory arrangements in this band should be kept under review in the light of international developments.

[9] AMSAT website: http://www.amsat.org

6. <u>24 GHz BAND COMPATIBILITY ANALYSES</u>

6.1 22 GHz band Fixed Service links

At 1 August 2005 there were almost 6300 licensed 22 GHz band fixed links in Australia. Of those almost 5500 were licensed to major Mobile Telephony Networks licensees: Hutchinson 3G Australia; Optus Mobile; and, Vodafone Network Pty Ltd. The median hop length for 22 GHz band point-to-point links is 2 km and almost 5500 of these links (over 87%) have hop lengths in the range 1 to 6 km.

Parameter	Range	Typical Value	Unit
Power:	0.001 - 1	0.05	W
Antenna diameter:	0.3 – 1.8	0.3 m	m
Antenna Gain:	34 – 49.7	35 dBi	dBi
Related antenna Gain:	34 - 50	35 dBi	dBi
Beamwidth:	1 - 10	3	°
Bandwidth:	2 - 50	28	MHz
Path Length:	1 – 23	2	km
Antenna Height:	2 - 275	20	m
Polarisation	Vertical/Horizontal	76% Vertical	

Table 6a: Fixed Link Parameters

6.1.1 Compatibility Assessment

22 GHz band point-to-point fixed links are designed to withstand considerable amounts of signal attenuation due to rain. Under clear-sky conditions these links will therefore have considerable "excess-margin" and will not be at risk from an interference increase due to UWB SRR.

The case that does need to be analysed is the situation where the link margin is being consumed by a rain attenuation event that is at, or near, the designed rain rate for the link. The situation of greatest concern is where the wanted point-to-point link signal is subject to rain attenuation but the potentially interfering signal from the UWB SRR is not subject to rain attenuation. An example of this situation is illustrated in *Figure 6b.*

A compatibility assessment between 24 GHz band UWB SRR and 22 GHz band point-to-point fixed links has been performed using the Noise Floor Protection Method described by ITU-R Task Group 1/8.

In the study, the FCC maximum emission spectral density limit of -41.3 dBm/MHz and a centre frequency of 23970 MHz (included in SRR data provided on the FCC web site) were assumed. The protection criteria provided to Task Group 1/8 by Working Party 9A of an I/N criteria of -20 dB for bands above 15 GHz was used. While this is very conservative (it implies a degradation of wanted fixed service signal level of less than 0.05 dB) it provides a useful initial "worst-case" starting point, that can be supplemented by more detailed analysis and consideration of mitigation factors if major problems are indicated.

The calculation estimates aggregate interference, using a model involving a 3 km straight stretch of four-lane roadway (two lanes in each direction). It was assumed that all vehicles had a direct line-of-sight to a victim fixed service receiver offset from the edge of the roadway by 30 metres. The fixed service antenna was assumed to have a radiation pattern similar to the notional 22 GHz band antenna given in Annex A to Appendix 10 of RALI FX-3, and was assumed to have an antenna height of 20 m above the roadway. The radiation pattern of the SRR transceiver was modelled as a parabolic approximation to a test report transmit elevation pattern provided to the FCC. A dense, but flowing, traffic model was assumed[10]. All lanes of the roadway were assumed to be occupied by 5 m long vehicles with 2 SRR transceivers per vehicle that point in the direction of the fixed link receiver, and that the vehicles were uniformly spaced with a separation of 20 m between vehicles.

The calculations include an estimate of the combined effect of a number of mitigating factors. These mitigating factors are described in greater detail in the following sections. The values assumed in the calculations are given in *Table 6c*.

Parameter	Value	Unit
Fixed Service point-to-point link receiver		
Frequency	23970	MHz
k (Boltzmann's Constant)	-228.6	dBW/K/Hz
T (Temperature) (27°C)	300	K
Reference Bandwidth	1	MHz
P (Thermal Noise Power) = kTB	-143.8	dBW/MHz
Receiver Noise Figure	6	dB
Receiver Noise Floor	-137.8	dBW/MHz
I/N	-20	dB
Interference Threshold	-157.8	dBW
FS receiver on-axis Antenna Gain	35	dBi
FS antenna RPE	22 GHz co-polar antenna pattern given in Appendix 10 of RALI FX-3	
UWB SRR transmitter		
EIRP of a single SRR device	-71.3	dBW/MHz
RPE used to model SRR emission	Parabolic approximation to EMCC Transmit Elevation Pattern Test Report of 24 GHz SLR Sensor Model MASRAU0025	
Aggregate interference factor including off-axis effects	-131.5	dBW/MHz
Net Mitigation Allowance	29	dB
UWB SRR signal level at receiver	-160.5	dBW/MHz

Table 6b: Compatibility Assessment – Noise Floor Protection Method

<u>Comments on the aggregate calculation</u>

1. Effect of roadway length

In the aggregate calculation included in this report, and in similar calculations reported in Figures 66 to 83 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ], it was found that beyond about 500 m from the fixed service receiver the incremental contributions from each additional SRR transmitter became very small and the overall

[10] TG1/8 studies note that this represents a higher interference risk (footnote 10 to Table 14 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ], see reference [14]). With higher vehicle densities, preceding cars are more likely to shield the interfering signal. It is also likely that very dense traffic will be in stop-go driving mode where vehicle radars would not operate, or would operate with a reduced duty cycle.

aggregate interference level reaches an asymptote value at distances which are typically less than 3 km.

2. Effect of FS antenna height

In the aggregate calculation included in this report, and in similar calculations reported in Figure 65 in Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ], the total aggregate interference level has an inverse relationship with height of the FS antenna. That figure indicates that as the FS antenna height increases from 20m to 30m the total aggregate interference reduces by approximately 4 dB.

3. Effect of number of lanes

Although not modelled in this analysis, TG1/8 studies[11] have shown that interference scenarios for one-lane and four-lane roads (and, by inference, for densely trafficked 6 or 8 lane roads) yield similar results if the shielding effect of vehicles in nearby lanes is taken into account. Those studies showed that for dense traffic distributions the dominant interference contribution comes from vehicles in the lane closest to the fixed link receiver.

<u>Net Mitigation allowance</u>

The net mitigation allowance is made up of a number of factors that are shown in *Table 6c.*

If worst-case values were assumed for each of these potential mitigating factors an extremely conservative, and unrealistic, model would be obtained. Therefore the following more realistic, though still conservative, assumptions were made:

Parameter	Range of values (dB)	Value assumed in Table 6b analysis (dB)
reduced SRR EIRP level	5 –10	5
Clutter loss	0 – 15	7
Bumper loss	3	3
Spray attenuation	0 – 3	0
Polarization loss	0 - 15	0
Car shielding	0 -25	0
Average activity factor	3	3
7 % market share	11	11
Total		29

Table 6c: Summary of mitigation factors

6.1.1 Reduced SRR transmitter EIRP level

A maximum emission limit of -41.3 dBm/MHz e.i.r.p. was used in the study described in the preceding section. However, data on currently approved SRR devices (see section 3) indicates that e.i.r.p. levels will be 5 to 10 dB below that value.

6.1.2 Bumper Loss

SRRs will be mounted behind plastic (Polybutylene Terephthalate) bumpers that have a typical thickness of 4 mm. Tests[12] have shown that the average/typical loss of the bumper is more than 3 dB.

[11] section A2.5.8.2.1 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ]. See reference [14].
[12] section A2.5.6.2 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ]. See reference [14].

6.1.3 Polarisation

An extract of fixed service licence data in the 22 GHz band showed that 24 % of links are horizontally polarised and the rest are vertically polarised. For the 24% of links that are horizontally polarised, a polarisation discrimination factor of up to 15 dB would apply with respect to vertical polarised SRR transceivers.

6.1.4 Car Shielding

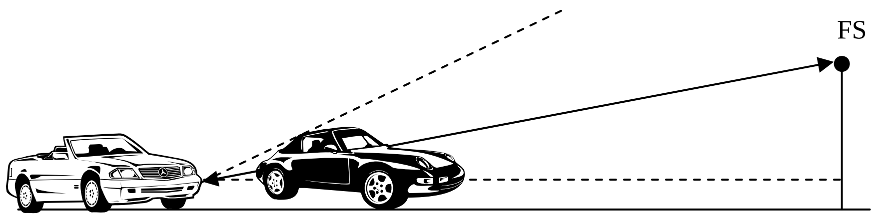

Figure 6a: Shielding

TG1/8 studies have shown that shielding occurs when vehicles are positioned in close proximity to each other such as in high traffic conditions. As illustrated in *Figure 6a,* the preceding vehicle blocks the signal path from the SRR on following car toward the FS victim antenna. The amount of attenuation due to this effect is in the order of several 10s of dBs [13].

6.1.5 Gating/Duty Cycles and average activity factor

SRR transmitters, like any radar transmitter, will be idle for a period of time when they stop transmitting while they are listening for reflected signals. It is reported[14] that the crest factor (i.e. the peak-to-average ratio) of the SRR signals, which should be approximately equal to the duty cycle, is 20 dB. However this factor is already built into the maximum average broadband radiated power value of –41.3 dBm/MHz.

In addition to this duty cycle effect, mitigation is available because, in accordance with different driving situations, SRRs will operate in several different modes that generate less interference than the nominal operating mode. The average effect of operation in the different SRR modes can be considered as a reduced activity factor that reduces the interference risk by approximately 3 dB[15].

6.1.6 Percentage Market Penetration

At this stage, only high-end class luxury cars are expected to be equipped with UWB SRR. An analysis that takes account of the possible long term market share of a range of different technologies that could provide similar functionality to that provided by 24 GHz UWB SRRs is provided in reference [10]. It concludes that in a market where no regulatory controls applied the market penetration of 24 GHz UWB SRR would reach a limit value of 40%.[16]

[13] section A2.5.6.5 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ]. See reference [14].
[14] section C3.1.1 of Draft New Recommendation ITU-R SM.[UWB.CHAR]. See reference [10].
[15] sections C3.1.2 and C3.1.3 of Draft New Recommendation ITU-R SM.[UWB.CHAR]. See reference [10].
[16] sections C3.1.4 of Draft New Recommendation ITU-R SM.[UWB.CHAR]. See reference [10].

The ECC has required that the percentage of vehicles that can operate with 24 GHz band UWB SRR in Europe may not exceed 7 % of cars, and that from 2013 new models would be equipped with 79 GHz SRR. Thus the percentage of 24 GHz UWB SRR should decline after 2013. It is expected that even without regulatory action in Australia, the percentage of 24 GHz band UWB SRR equipped vehicles would not be notably different from the European situation. If the number of 24 GHz band UWB SRR equipped vehicles is limited to 7% of the total vehicle fleet, this amounts to an 11 dB reduction in aggregate interference compared to the 100% of vehicles case.

6.1.7 Clutter

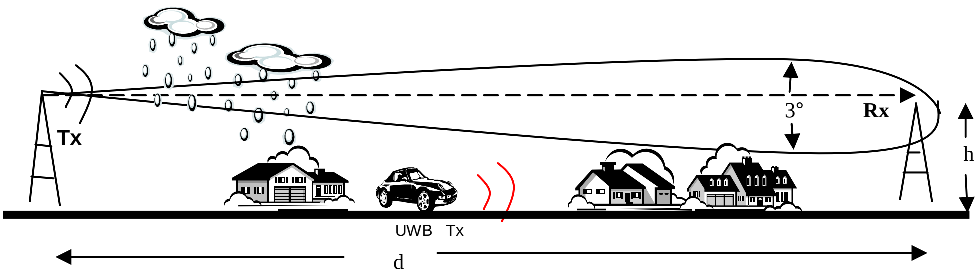

Figure 6b: Scenario of Clutter and Rain Fade

Clutter loss occurs due to obstructions such as traffic signs, bridges, guard-rails, buildings and trees. It can reduce the potential interference impact of SRR by up to 15 dB. Losses due to vegetation are very high in this band.

Typical hop lengths of 22 GHz band point-to-point fixed links range from about 1 km to 6 km. Realistically results depend on the location of the vehicle as attenuation due to clutter may have a significant impact. In the 22 GHz band fixed links have very directional antenna patterns with an average beamwidth of 3°. If the vehicle is distant from the fixed link antennas as in *Figure 6b*, then it is more realistic to assume that clutter from buildings would cause significant attenuation to the SRR signal and would therefore have minimal risk of interfering with the fixed link.

6.1.8 Spray Attenuation

Under wet conditions signals from UWB SRR will be attenuated by road spray thrown up by preceding vehicles. Although difficult to quantify, the attenuation due to the road spray may at times be much stronger than the rain itself. Some TG1/8 studies[17] suggest that spray attenuation could be up to 3 dB, though this will reduce as vehicle separation increases.

6.1.9 Summary

For interference to fixed links to occur, a number of unlikely events must occur at the same time. These include highway stretches of sufficient straight length with line-of-sight transmissions parallel to the road; no obstructing roadside clutter; episodes of torrential rain that consume the fixed link receiver interference margin – but not so much that the

[17] Section A2.5.6.4.2 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ]. See reference [14].

margin is exceeded regardless of the impact of automotive radar; and a sufficiently high number of 24 GHz band UWB radar-equipped vehicles operating during the downpour.

Calculations of the aggregate interference risk during the rain fade scenario described above, that have included realistic though still conservative assumptions about several mitigating factors, indicate that a 20 dB I/N margin will be maintained.

6.2 Possible Future Broadcasting Satellite Service (BSS) below 22 GHz

The 21.4–22 GHz band may be used for space-to-Earth BSS transmissions. As the BSS allocation has not yet come into effect typical values for system parameters are not available, however it is expected that protection will be is required for consumer terminal antennas with typical diameters of 0.6 m mounted on suburban roofs. The parameters used in the study below are based on equipment in adjacent spectrum.

Parameter	Value	Unit
Frequency	21800	MHz
Reference bandwidth	1	MHz
System noise figure	160	K
Noise power	-116.6	dBm/MHz
I/N	-20	dB
Acceptable interference level at the receiver	-136.6	dBm/MHz
Minimum antenna elevation	25	degrees
Typical antenna height	5	m
Proposed minimum separation distance	10	m
Off axis separation angle	51	degrees
Antenna off-axis gain as per ITU-R BO.1213	-5	dBi
Free space attenuation at minimum separation	79.2	dB
Maximum acceptable interferer emission level	-52.4	dBm/MHz
Proposed UWB emission limit in this band	-61.3	dBm/MHz
Available additional margin	8.9	dB

Table 6d: BSS Analysis

The above analysis finds that the interference risk is limited to a distance of 10 m or less. This separation distance is consistent with the boundaries of typical Australian suburban land holdings. This indicates that the –61.3 dBm/MHz UWB power spectral density limit for emissions in this band specified by the FCC in the United States (and in Europe by the EC, the ECC and CEPT) is sufficient to protect a BSS Earth station from a single UWB device. Further, the interference risk to Australian BSS earth stations would be lower than for similar stations in Europe, North Asia and North America as broadcasting-satellite service earth station elevation angles for Australia would be generally higher than for those locations (minimum values of 25° or more are expected).

<u>Other mitigation factors</u>
Factors that could be considered to reduce the interference risk further would be the interference-to-noise ratio (I/N) of -20 dB that has been used in the above analysis. This is a conservative assumption limiting any impact on the noise floor power density of the receiver to less than 0.06 dB. Such a change would be less than the typical manufacturing tolerance for the receiver noise floor performance in this band for this service.

Other mitigation factors that could be included in a more detailed analysis include losses through the vehicle bumper and polarization loss due to the use of circular polarisation for the BSS downlink.

Aggregate interference

While the above calculation did not take account of multiple UWB devices, the available additional margin is sufficient to account for a number of devices even at a separation distance of 10 m.

The proposed mounting height for the 24 GHz SRR UWB devices in the bumper bars of motor vehicles will typically be within 0.5 and 1.5 m above the ground with the majority of devices having a height of less than 1 m. At this height vegetation and terrestrial clutter losses will be significant with losses of 15 dB or more likely over relatively short distances say 0.1 km in suburban areas. This loss would effectively limit the range over which UWB devices might make significant contributions to the potential accumulative interference risk to the BSS.

In rural areas, while clutter losses will be less, larger separation distances will be available on-site and this in addition to the low vehicle density in these areas will minimise any aggregate effects. This leads to the conclusion that any interference risk is limited to a site management issue only.

6.3 Radio Astronomy Service (RAS) below 24 GHz

The bands 22.21–22.5 and 23.6–24.0 GHz are used by the radio astronomy service for passive measurements using sensitive earth station receivers. Recommendation ITU-R RA.769-1 "Protection criteria used for Radioastronomical Measurements" sets out the required level of protection for RAS measurements [17]. The following table of interference threshold level values has been extracted from that recommendation for the 22.21–22.50 GHz and 23.6–24.0 GHz bands.

Measurement Type			
Continuum	Spectral Line	VLBI[18]	Unit
23800	22200 & 23700	23800	MHz
-233	-215	-182	dBW/m^2.Hz
-252	-234	-201	dBm/Hz
-192	-174	-141	dBm/MHz

Table 6e: Interference Threshold Levels

Table 6f sets out the protection requirements for the Australian radio astronomy sites listed in the Australian Radiofrequency Spectrum Plan footnote AUS87. It includes an allowance for an assumed exclusion zone around each of the sites.

In addition to these sites, Australia is currently developing a Radio Quiet Zone around Mileura station in remote Western Australia to accommodate radio astronomy facilities such as the proposed Square Kilometre Array (SKA) radio telescope. Given the remoteness of the location, and the expectation that any exclusion zone would be largely contained within the property boundaries of the station (and therefore be managed by the

[18] VLBI Very long baseline interferometry

telescope operator), no explicit exclusion zone around that site is considered to be warranted.

Parameter	Contin.	Line	VLBI	VLBI	VLBI	VLBI	Unit
Earth station	Narrabri	Parkes	Mopra	Hobart	Ceduna	Tidbinbilla	
Antenna height	18	30	13	15	12	30	m
Off-axis gain[19]	-15	-10	0	0	0	0	dBi
Interference threshold level	-192	-174	-141	-141	-141	-141	dBm/MHz
Proposed separation distance	10	3	0.2	0.2	0.2	0.2	km
Free space loss	140	128	106	106	106	106	dB
Atmospheric absorption[20]	2	0	0	0	0	0	dB
Interference at separation distance	-35	-35	-35	-35	-35	-35	dBm/MHz
UWB level	-41.3	-41.3	-41.3	-41.3	-41.3	-41.3	dBm/MHz
Margin	6	6	6	6	6	6	dB

Table 6f: Interference analysis for Australian radio astronomy sites

Table 6f shows that required interference threshold levels can be achieved with a 6 dB margin for a single UWB interferer at the separation distance values noted in the table. From a regulatory viewpoint, exclusion zones would not be specified where the potential impact zones are small. In these situations it is expected that the impact would be contained within the boundaries of the radio astronomy facility, and would therefore be a site management matter for the telescope operator. (It is also noted that those facilities do not currently hold radiocommunications licences in the 22.21–22.5 and 23.6–24 GHz bands so it might be concluded that their operators have not seen a requirement for very high levels of protection at those sites in these bands).

Aggregate interference

As noted above, the single interferer analysis shows that a margin is available. That margin might be used to account for multiple devices. Calculation of aggregate effects over large geographic areas using uniform distributions of interferers can generate significant increases in predicted interference risk over that of a single device. However this approach would not provide a realistic indication of the interference risk around the two major Australian radio astronomy sites. These radio astronomy stations are located in rural areas where vehicle densities are low and the closest major arterial roads do not run radially towards the sites. Further beyond the separation distances indicated, atmospheric attenuation, clutter and vegetation losses on the radio path, accentuated by the fact that in most instances the radio astronomy site will be beyond the UWB device radio horizon, will significantly mitigate any potential aggregate interference risk from highway traffic.

Other mitigation factors

[19] These values were provided by CSIRO to ACMA for the calculation of notification areas. For Example the Parkes antenna has an effective elevation limit of 30° from the horizon. The gain of the RAS antenna at 30° from the main beam is given as –10 dBi from Recommendation ITU-R S.1428.

[20] In this band the atmosphere absorption due to oxygen and water vapour for terrestrial paths is approximately 0.18 dB/km. See Fig.5 Recommendation ITU-R P.676-5

Table 6f includes a proposed separation distance approach similar to that adopted for protection of key radio astronomy sites in the United Kingdom and Europe. The analysis did not include clutter or vegetation losses. However, attenuation due to clutter or vegetation is likely to be significant, especially as distance from the site increases. Some further reduction in potential interference risk may also be obtained due to restrictions on emissions above the horizon as proposed by both the FCC in the United States and by CEPT in Europe (again this factor was not included in the analysis in *Table 6f*).

Another mitigator that could be included in a more detailed analysis, and which has been included in some TG1/8 studies, is a 3 dB loss due to vehicle bumper bar attenuation. A further mitigator is the fact that the emission power densities for currently available UWB SRR are 5 to 10 dB below the value assumed in the calculations.

Further mitigation might be available due to the average activity factor consideration described in section 6.1.5. However if the potential interference is due to aggregate effects of a relatively small number of emitters outside the proposed exclusion zones these should be treated cautiously since the aggregation assumptions may not be valid for a small number of emitters.

6.4 Earth Exploration-Satellite Service (EESS) below 24 GHz

The band 23.6-24.0 GHz is used for the measurement of the total atmospheric water vapour content using sensitive passive sensors mounted on low Earth orbit satellites operating in the EESS (passive). Measurements are typically made at the zenith using high gain antennas. Emissions from UWB automotive radars are normally directed horizontally, however antenna pattern leakage and scatter from other vehicles will cause some emissions in the zenith direction.

The following table provides an analysis of the level of emissions from UWB automotive radars towards the zenith direction based on studies presented to TG 1/8.

Parameter		
UWB radiated power density	-41.3	dBm/MHz
	-71.3	dBW/MHz
Bumper attenuation	3	dB
UWB SRR average activity factor	3	dB
UWB antenna directivity[21]	35	dB
Direct path power density	-112.3	dBW/MHz
Scatter loss from other cars	19.8	dB
Other scatter effects	4.7	dB
Scatter path power density	-101.8	dBW/MHz
Total upward power density	-101.4	dBW/MHz

Table 6g: UWB SRR Power flux density in the zenith direction

The above analysis assumes that scattered signal is the major contributor to the total interference signal towards the satellite sensor. The scatter loss figure is an averaged

[21] This is the value that would apply for a fully mature 24 GHz UWB SRR market that would occur at some time after year 2014.

value based on 5% of vehicles within 10 m contributing a loss of 15 dB, 45% of vehicles between 10 and 30 m contributing a loss of 18 dB and 50% of vehicle at distances greater than 30 m contributing a loss of -25 dB. The other scatter effects item is an attempt to bring the scatter loss figure into line with the results of measurements.

Table 6h provides an analysis of the interference risk of this level of unwanted zenith direction emissions from UWB automotive radar transmitters to a selection of current and proposed EESS sensors operating in this band.

Parameter	PUSH Broom	Megha-trophic	EOS AMSR-E	CMIS	Unit
Satellite height	850	1336	1229	1336	km
Free Space Loss	178.6	182.5	181.8	182.5	dB
Atmospheric Losses	1	1.6	1.7	1.7	dB
Satellite Antenna Gain	45	40	45.6	52.1	dBi
Received power	-236.0	-244.9	-238.6	-232.8	dBW/MHz
Received power/200 MHz	-213.0	-221.9	-215.6	-209.8	dBW
Interference threshold Rec. ITU-R SA.1029-2	-166 dBW/ 200 MHz				
UWB contribution	5 %				
UWB contribution	-179 dBW/ 200 MHz				
Available margin	34.0	42.9	35.6	30.8	dB
No. of UWB to 5 % level	2500	19527	4551	1204	
No. of UWB to threshold	49990	390534	91023	24080	
Sensor ground coverage	206	984	588	195	km^2
Equiv. spot size - diameter	16.2	35.4	27.4	15.8	km

Table 6h: Interference analysis for a selection of EESS sensors

The antenna side-lobe performance of the sensors used in this band means that UWB devices operating outside the sensor ground coverage spot of the main beam will not significantly contribute to the interference power received by the sensor. The apportionment of 5 % of the interference threshold set down in ITU-R SA.1029 to 24 GHz UWB SRR does not identify what the other more significant interference contributors to this threshold level might be. Given there are no other intentional emitters in this band, 24 GHz UWB automotive radar might be expected to be the main contributor to the interference threshold. This raises the number of 24 GHz UWB SRR devices significantly as shown in the ‘No. of UWB to threshold’ item in *Table 6h*.

The numbers of vehicles using 24 GHz UWB automotive radar calculated in the above study using the full available threshold are only likely ever to occur in a handful of locations within the most densely urbanised cities in Australia. Further, population density and therefore vehicle densities in other parts of Australia is such that it is highly unlikely that any more than a small fraction of all measurements across Australia and adjacent ocean areas would be impacted even if low apportionment percentages are assumed.

<u>Other mitigation factors</u>

The emission power densities for currently available 24 GHz UWB SRR transceivers are 5 to 10 dB below the value used in the calculations shown above. This would significantly increase the numbers of vehicles that could operate before any impact was caused to EESS systems. It is also likely that the number of vehicles within fitted with 24 GHz UWB SRR devices within the equivalent spot size area of the EESS will not be reached in Australia before 79 GHz radar technology starts to take market share from 24 GHz equipment.

6.5 Services in the 24.0–24.25 GHz band

These bands are available for users operating: ISM devices; radiocommunications equipment operated under the authorisation provided in the LIPD Class Licence; and, apparatus licensed services operating under one of the allocations indicated in the allocation table in the ARSP.

Because of the designation of these bands for use by ISM devices, it would be inappropriate to operate radiocommunications services that require high levels of interference protection in these bands. Therefore, no band specific mitigation measures are considered necessary to protect services in the 24.0–24.25 GHz bands from any potential low level interference from UWB SRR devices.

6.6 Speed measurement radars in the 24.0–24.25 GHz band

CEPT Report 003 [21] provides information on studies of potential interference risk between UWB SRR and radar speed measurement (RSM) equipment.

Compatibility tests have been carried out on a number of RSM equipment operated in Europe. The effects of the UWB emission component of SRR to RSM equipment was investigated in a series of test performed in 2003 and no interference to the RSM equipment could be found. In further tests conducted in March 2004, the interference potential of the narrow-band component (i.e. residual carrier or optional Doppler radar signal) was investigated with one piece of RSM equipment.

The test results show that there will be no wrong or false speed readings at the RSM equipment due to the SRR residual/Doppler mode emission. However, the probability of suppressed speed readings due to residual carriers or Doppler mode signals emitted by UWB-SRR sensors that fall within the RSM receiver bandwidth is, as a first assessment, below 10^{-4}.

This low probability of interference is directly related to the type of narrow-band emission component of the 24 GHz SRR, which shall therefore be limited to an unmodulated carrier (e.g. residual carrier or optional Doppler radar signal).

<u>Mitigation methods</u>
To avoid blocking of the RSM (i.e. suppressed speed readings), CEPT concluded that the centre frequencies of the two systems should be decoupled by at least 25 MHz, and that the risk of harmful interference is low and will not create false speed measurements. They reported that manufacturers of vehicles using automotive short-range radar systems had committed themselves to continue taking appropriate steps to ensure that the risk of interference to radar speed meters is minimal. The reliability of radar speed meter equipment is therefore not expected to be affected by the operation of automotive short range radar to any significant extent.

Noting that currently operated RSM equipment is licensed to operate on centre frequencies of 24.125 or 24.15 GHz, the very small risk of suppressed speed readings could be avoided if the narrow-band emission component of 24 GHz SRR was to be confined to the band 24.175–24.25 GHz.

Test results of currently known UWB SRR equipment indicate that either: the equipment does not show any significant narrow-band emission component; or, where a narrow-band component exists the centre frequency of this emission is separated from the worst-case RSM licensed centre frequency by at least 25 MHz.

6.7 Possible Future EESS/SRS Gateway facilities in the 25.5–26.5 GHz band

The following study is based on the analyses in Recommendations ITU-R SA.1278 [18] and SA.1625 [19] that deals with the feasibility of sharing between the Earth Exploration-satellite and space research services in the space to earth direction and the fixed, inter-satellite and mobile services in the band 25.5–27.0 GHz.

These studies found that it was feasible to share this band with fixed services of significantly higher emissions than the proposed UWB devices. Despite their titles neither of these recommendations provides information in regard to sharing with mobile services. The following study is based on a worst-case interference threshold for the Space Research Service of -216 dBW/Hz for 0.1% of the time as used in ITU-R SA.1625. The interference threshold for the EESS used in Recommendation ITU-R SA.1278 is -145 dBW/MHz for 1% of the time.

Parameters		Unit
Worst case Interference level From ITU-R SA.1625 (SA.609)	-216	dBW/Hz
Apportionment of the Interference	10	%
Resulting interference level	-136	dBm/MHz
Minimum Antenna Elevation	10	degrees
Earth Station Antenna off axis gain As per ITU-R SA.509	+7	dBi
UWB permitted interference level	-143	dBm/MHz
UWB emission level	-41.3	dBm/MHz
Required Path loss	101.7	dB
Min Free Space distance	0.11	km
Actual off axis angle	14	degrees
Actual off axis gain	+3	dBi
Margin at 110 m	4	dB

Table 6i: SRS analysis

Apportioning the interference risk with other services, for example, with interference from fixed service stations that may operate in the band, increases the minimum requires a separation of 110 m from the SRS earth station. Earth stations in the SRS are typically located well away from urban and suburban areas so 110 m represents a typical on site distance making UWB emission control a site management issue only for these earth stations. The minimum separation distance without apportioning the interference level is 35 m.

Repeating the analysis using the protection requirement for an EESS earth station as in Recommendation ITU-R SA.1278 leads to minimum separation distances of 30 m and 10 m respectively. Interference control from 24 GHz SRR into an EESS earth station becomes a site control issue even if those stations were permitted to be located in suburban areas[22].

Other mitigation factors

There were no SRS or EESS gateway earth stations receiving in this band in Australia at the time this study was undertaken. If such stations are licensed in the future it should be possible to take account of potential interference effects from UWB SRR. Measures that could be considered include siting the antennae so that it is shielded from major roads, managing vehicle access within and near the SRS site and designing the earth station's link budget to include allowance for impacts from UWB SRR.

The analysis has not included the 3 dB bumper loss figure used in some studies presented to TG1/8. Other mitigators include vegetation losses and clutter losses associated with the low height of the automotive radar unit. Polarization differences between the automotive radar emission and the downlink (assumed to be circularly polarised) are likely to provide an additional 3 dB of isolation.

Aggregate interference

These down links will require sufficient margin to cope with high levels of rain fade in this band. The potential for interference from 24 GHz UWB SRR will only become important at major rain fade events when the available downlink margin is reduced. Under major rain fade events any aggregate contribution from distant UWB SRR devices is also likely to be reduced due to rain attenuation. Vehicular densities in rural areas are very low further reducing the interference risk for SRS earth stations. EESS earth stations more likely to be located in urban and suburban areas but are also likely to be shielded by buildings and vegetation from aggregate effects.

6.8 Potential fixed link or point-to-multipoint use in 24.5–26.5 GHz band

Currently there are no point-to-point or point-to-multipoint services in the 24.5–26.5 GHz band.

Nevertheless, it is expected that the characteristics of 26 GHz band point-to-point links would be similar to those of 22 GHz band systems. In the 26 GHz band, point-to-multipoint links are expected to use a base station technology that would be configured as multiple point-to-point links each having high gain directional antennas, rather than having base stations with broad beamwidth, lower gain panel antennas.

Therefore, because of the expected similarities between likely network architectures for potential future 26 GHz band point-to-point link or multiple point-to-multipoint usage and current 22 GHz band point-to-point usage, the 22 GHz point-to-point results are expected to be applicable to any future 26 GHz band usage.

[22] ACMA's policy is to discourage such stations from locating in suburban areas and thereby to avoid such "urban encroachment" issues.

Mitigation methods

Unlike the point-to-point fixed link case, where a percentage of point-to-point fixed links would run parallel to highways, the likely deployment scenario for point-to-multipoint links is that they are most likely to be sited on hills, away from major roads. TG1/8 studies[23] have shown that the interference risk due to point-to-point links running parallel to a major road or highway is approximately 7 dB worse than for a point-to-multipoint FWA system. Therefore no special analysis of a point-to-multipoint system has been performed since the point-to-point case presents the worst case.

But in either case, because there are no existing services in the band, 24 GHz UWB SRR would be part of the prevailing environment if fixed services were to be introduced at some future time so it is unlikely to require special sharing studies or co-ordination requirements.

Defence has indicated future interest in deployable broadband wireless systems in the battle-space in the 25–27 GHz bands. It is expected that the system parameters of this potential application would be similar to the civilian BWA applications though, given that a military battle-space system will need to be resistant to hostile activities, any low level interference from UWB automotive radar systems is not expected to present a concern.

6.9 Interference to UWB SRR devices

In addition to not causing interference to existing (or potential) radiocommunications services in bands between 22 and 26.5 GHz, to be viable 24 GHz band UWB SRR must be able to withstand potential interference from active services operating in those bands. The greatest risk to the UWB SRR receivers is likely to come from fixed service transmitters.

ECC Report 46 [23] addresses this topic. It indicates that UWB SRR systems could need to operate in environments with I/N ratios above +20 dB along fixed service paths. While this presents a significant challenge, UWB systems can achieve significant levels of processing gain so it may be achievable.

Nevertheless 24 GHz UWB SRR is a “no status” application that will only be permitted if they do not cause interference to, nor seek protection from, allocated radiocommunications services. Therefore the design of UWB SRR and their operating conditions must take account of the possibility of relatively high level signals being received from active radiocommunications services, most notably fixed service systems.

[23] section A2.5.10 of Attachment 2 to Draft New Report ITU-R SM.[UWB.XYZ]. See reference [14].

7. DISCUSSION

7.1 Frequency Band Requirements

From an examination of overseas regulatory and manufacturing developments, and the general product characteristics supplied by the Australian automotive community, it is clear that the 24 GHz band SRR is being developed as the primary band for automotive SRR applications, at least for the period until 2014.

US and European regulatory arrangements permit emissions across somewhat different frequency ranges. In the US, FCC regulations allow emissions across the frequency range 22–29 GHz. In Europe, emissions are permitted across the range 21.65–26.65 GHz. (But the European regulations include a requirement for a 20 dB reduction in emission levels in the 21.65–22 GHz range that effectively brings the lower limit into alignment).

At this stage a limited number of products are actually available, but measurement data on the available products indicates that they conform to the European arrangements, indeed they would even comply with a slightly truncated range of 22–26.5 GHz.

Current legislative constraints imposed by section 138 of the *Radiocommunications Act 1992*, and the presence of bands that have been subject to spectrum licensing reallocation declarations above 26.5 GHz, mean that at this stage it is necessary to limit the range to 22 –26.5 GHz. Should the legislative constraints be removed at some future time it would be useful from the viewpoint of standards alignment to extend the range to 22–26.65 MHz.

7.2 Sharing/Interference Risks

The most important potential interference issues for 24 GHz UWB automotive radar systems relate to the following services or applications:

- Passive sensing systems operating in the 23.6–24.0 GHz band on low earth orbiting satellites;
- Radio Astronomy Service stations in the 22.21–22.5 and 23.6–24 GHz bands;
- Fixed Services in the 21.2–23.6 GHz band; and,
- Radar Speed Measurement devices in the 24.05–24.25 GHz band.

<u>EESS</u>
Earth-exploration Satellite Service (passive) operations in the 23.6–24 GHz band provide important data that is used in weather monitoring and climate analysis. The analysis in chapter 6 shows that fairly large numbers of UWB devices would be required to potentially cause interference to the measurement of a single pixel of the measurement map.

These numbers of 24 GHz UWB devices are likely at only a small number of locations within major capital cities in Australia under worst-case conditions and that these numbers are only likely if 24 GHz UWB devices continue to be fitted to vehicles well into the future. In the longer term (post 2013) however the use of the 24 GHz band is likely to gradually decline as SRR automotive radar systems transition to the 79 GHz band.

Restrictions on emissions above the horizon by 24 GHz UWB devices as required under existing overseas regulation and likely 24 GHz UWB device densities minimises the potential for interference to overhead EESS satellite measurements.

RAS

Important radio astronomy observations are conducted at the Parkes and Narrabri radio astronomy sites. Analysis provided in this report (and similar analyses performed in relation to European radio-astronomy sites) indicates that there is a small risk for 24 GHz band UWB automotive radar systems to exceed the interference threshold level required for radio astronomy observations in the 22.21–22.5 and 23.6–24 GHz bands.

To mitigate this potential risk it is recommended that exclusion zones should be defined around the Parkes and Narrabri sites, similar to European approach. The proposed exclusion radii are 10 km around Narrabri and 3 km around Parkes. These exclusion zones do not include highways or major arterial roads. It is therefore considered that they would represent a minimal restriction on potential 24 GHz UWB SRR users and because of the low vehicle densities a very small interference risk to radio astronomy sites. Maps of the proposed exclusion zones are shown in **Annex 2**.

22 GHz fixed links

Modelling of the aggregate interference risk indicates that, during rain fades the link margin of a 22 GHz band point-to-point fixed link system could be affected by 24 GHz UWB devices. However the modelling also shows that when realistic assumptions for several mitigating factors are included, that a 20 dB I/N margin can be maintained.

Therefore it is recommended that licensing of 24 GHz UWB SRR can proceed but if there are any problems to already licensed fixed links they should be dealt with on a case-by-case basis. A range of potential methods are available to resolve problems if they occur. These may include: increasing the transmit power, increasing transmit or receive antenna gain; and, changing the polarisation of vertically polarised links.

Further, if licensing of 24 GHz UWB SRR proceeds, it is recommended that an assignment note be added to RALI FX-3 to indicate that where links are close to, and run parallel to, roads with high vehicle densities, there could be some risk of reduced link margin during heavy rainfall events. It is noted that use of horizontal polarisation on the fixed link would greatly minimise the risk of link margin degradation during heavy rainfall events.

Radar speed measurement

Compatibility tests between radar speed measurement equipment and UWB SRR performed in Europe indicated no interference risk due to the UWB emission component of SRR to RSM equipment.

A test on one type of RSM showed that there would be no wrong or false speed readings at the RSM equipment due to the (non UWB) SRR residual/Doppler mode emission. However, even for this non-UWB mode the probability of suppressed speed readings due to residual carriers or Doppler mode signals can be avoided by decoupling the centre frequencies by at least 25 MHz. Given that currently operated RSM equipment have been licensed to operate on centre frequencies of 24.125 or 24.15 GHz, this decoupling could be achieved if the emission centre of any narrow-band emission of 24 GHz SRR is confined to the band 24.175–24.25 GHz. If RSM equipment becomes available that operates on centre frequencies above 24.15 GHz this conclusion may require further study.

Conclusion

The studies described in chapter 6 indicate that provided mitigation factors are taken into account, and specific measures for protection of Radio-astronomy and Earth-exploration satellite (space-to- Earth) services are taken, 24 GHz automotive short range radars should be able to operate in the band 22–26.5 GHz without causing compatibility concerns for current, or likely future, services in those bands.

7.3 Spectrum Plan

Currently the Australian Radiofrequency Spectrum Plan (the ARSP) reproduces footnote 5.340 of the ITU Radio Regulations. Amongst other bands, that footnote prohibits emissions in the band 23.6–24.0 GHz. To allow licensing to authorise the use of UWB automotive short range radar equipment that would span that frequency band it will be necessary to revise the ARSP to permit licensing in the 23.6–24 GHz band, while at the same time preserving the intent of the footnote to provide necessary protection against harmful interference of passive services in that band.

> As part of the package of regulatory arrangements for 24 GHz band UWB automotive radars, changes will need to be made to arrangements covering the band 23.6–24.0 GHz in the *Australian Radiofrequency Spectrum Plan*.

7.4 Licensing Considerations

UWB SRR systems are short-range devices activated, most probably unknowingly, by drivers when vehicles are operation. They operate across a wide range of spectrum that has been allocated to a number of radiocommunications services. However they operate at very low power so the interference risk to other services is intrinsically low. Their technical and operational characteristics are such that they present little risk to each other, or other users of the spectrum. These interference risks may be further mitigated by several measures described in section 6. Any one device could be used anywhere across Australia, in an uncoordinated manner. Recognising their ubiquitous application, licensing arrangements for the automotive use of UWB SRR devices in the 24 and 79 GHz bands need to be sufficiently flexible to be applied easily to the driver of the vehicle.

Conceptually, it does not seem sensible to be issuing drivers of motor vehicles with individual apparatus licences to enable them to lawfully operate UWB SRR devices in their vehicles. The licence fee for an Australia-wide apparatus licence for the use of an automotive radar system operating from 22 to 26.5 GHz would currently attract an annual fee of over $330,000 per driver. Such a fee would be incongruous with the short-range, ubiquitous, spectrum sharing, low interference risk, un-coordinated operation of these devices.

> Given the technical and operational aspects of these devices, authorisation under the ACMA’s radiocommunications class licensing regime is the preferred licensing approach.

Class licensing support should be on a no interference/no protection basis, as this would seem to be the only viable regulatory basis on which to resolve interference disputes involving uncoordinated use, in the unlikely event that interference might occur. This approach also provides appropriate regulatory protection to frequency coordinated receivers, such as radio astronomy or earth station receivers, that may in future be licensed in the same band.

Although UWB SRR include features that could improve road safety they are seen as a "safety aid" rather than a "safety-of-life" service as defined in the ITU Radio Regulations. On this understanding it is reasonable to allow their use in shared spectrum on a "no interference/no protection from interference" basis.

The "*Radiocommunications (Low Interference Potential Devices) Class Licence 2000*" (the LIPD class licence), which currently supports the licensed use of a wide range of short-range communications devices of benefit to the Australian community, would be the appropriate class licensing option.

8. CONCLUSIONS AND RECOMMENDATIONS

The 24 GHz band is being adopted by overseas regulatory bodies, and by international and regional standards bodies, for use by UWB SRR automotive applications intended for use in the near to medium term future. In the longer term UWB SRR automotive applications may migrate to the 79 GHz band.

Based on the analysis in chapter 6, and noting that mitigation measures are being proposed to ensure necessary protection to the radio astronomy and earth exploration satellite (passive) services, it is concluded that the interference risk presented by 24 GHz band UWB short-range automotive radar applications to other potential users is minimal.

1. It is recommended that ACMA proceed to licence 24 GHz band UWB Automotive Short-range radar systems on the following basis:

2. Given the expected ubiquity of this application, its low interference risk and the fact that most drivers will not be aware that by driving a UWB SRR equipped vehicle that they are operating a radiocommunications device, class licensing is considered to be the most appropriate way to licence these devices.

3. The LIPD class licence appears to be the most appropriate licensing option to authorise use of these devices Australia wide.

- Technical parameter values to be included in the class licence should be aligned with US and European values as far as practical. Recommended values are:
    - 3a Frequency range: 22–26.5 GHz
    - 3b Maximum radiated average power density: -41.3 dBm/MHz e.i.r.p
    - 3c Maximum broadband radiated peak power density: 0 dBm/50 MHz e.i.r.p

- 3d Conditions to provide for deactivation of the equipment in exclusion zones around radio astronomy sites at Parkes and Narrabri are required.

- 3e Conditions to limit upward emissions that could potentially impact on earth exploration satellites in the 23.6–24 GHz band are required.

- 3f Equipment standards for these devices should be assessed against the relevant European standard (EN 302 288 –1) suitably adjusted and incorporated into Australian equipment standards arrangements.

4. When legislative changes to allow Class licences to be made within spectrum that has been Spectrum Licensed are passed, this should be extended to 22–26.65 GHz to ensure better alignment with European regulatory and standards arrangements.

5. Arrangements in the Australian Radiofrequency Spectrum Plan (ARSP) currently pose some regulatory questions about whether authorisation to use 24 GHz UWB SRR would be consistent with the ARSP. Therefore, it is recommended that a proposal to modify the ARSP should also be included as part of the public consultation on 24 GHz UWB SRR.

6. At this time no action is recommended with regard to licensing or regulation of 79 GHz band automotive short range radar systems. It is however recommended that technology and regulatory developments relating to 79 GHz systems should be kept under review. In particular, outcomes of the proposed 2009 review by CEPT's Radio Spectrum Committee should be studied when they become available.

Bibliography

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[3] Community Decision of 17 January 2005 on harmonisation of the 24 GHz range radio spectrum band for the time limited use by automotive short-range radar equipment in the Community. Document number [C(2005)34].

[4] Electronic Communications Committee (ECC) Decision of 12 November 2004 on the frequency bands to be designated for the temporary introduction of Automotive Shot Range Radars [ECC/DEC/(04)10].

[5] Electronic Communications Committee (ECC) Decision of 19 March 2004 on the frequency band 77 – 81 GHz to be designated for the use of Automotive Short Range Radars ECC/DEC/(04)03.

[6] ECC Report 023 "Compatibility of automotive collision warning Short Range Radar operating at 24 GHz with FS, EESS and Radio Astronomy", Cavtat, May 2003

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[9] Ofcom's decision to exempt the use of automotive short-range equipment in the 24 GHz band from Wireless Telegraphy licensing; Statement and Statutory Regulations (14 June 2005).

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[12] ITU-R Study Group 1, document 1/85, “Framework for the introduction of devices using ultra-wideband technology”, Draft New Recommendation ITU-R SM.[UWB.FRAME], Geneva, October 2005.

[13] ITU-R Study Group 1, document 1/83, “Measurement techniques of emissions from devices using ultra-wideband technology”, Draft New Recommendation ITU-R SM.[UWB.MES], Geneva, October 2005.

[14] ITU-R Study Group 1, document 1/90, “Impact of devices using ultra-wideband technology on radiocommunication services”, Draft New Report ITU-R SM.[UWB.XYZ], Geneva, October 2005.

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[16] Australian Defence Spectrum Strategic Plan (Concise Version), Chief Information Officer, Department of Defence. May 2004.

[17] Recommendation ITU-R RA.769-1, ‘Protection criteria used for Radioastronomical Measurements” sets out the required level of protection for RAS measurements’.

[18] Recommendation ITU-R SA.1278, ‘Feasibility of sharing between the Earth Exploration-satellite service (space to Earth) and the fixed, inter-satellite and mobile services in the band 25.5-27.0 GHz’.

[19] Recommendation ITU-R SA 1625, ‘Feasibility of sharing between the space research service (space-to-Earth) and the fixed, inter-satellite, and mobile services in the band 25.5-27 GHz’.

[20] Recommendation ITU-R SA.509-2, ‘Generalized Space Research Earth Station and Radio Astronomy Antenna Radiation Pattern for use in interference calculations, including coordinating procedures.’

[21] CEPT Report 003, ‘Harmonise Radio Spectrum to facilitate a co-ordinated EU Introduction of Automotive Short Range Radar Systems’, 9 July 2004.

[22] ECC Report 056, “Compatibility of automotive collision warning Short Range Radar operating at 79 GHz with Radiocommunications services”, Stockholm, October 2004.

[23] ECC Report 046, “Immunity of 24 GHz Automotive SRRs operating on a Non Interference and Non-Protected basis from Emissions of the Primary Fixed Service operating in the 23 GHz and 26 GHz Bands”, Galati, May 2004.

Table A1: Summary of Australian Allocations, regulations, current and possible future usage

Band/ ARSP allocations	US	Europe	Regulatory provisions	Existing Services recorded in RRL[24] (including major clients and locations)	Other Possible/future uses
21.4 – 22 FIXED MOBILE BROADCASTING-SATELLITE 347A 530 531 AUS87		21.65 – 26.65 GHz	RALI FX-3 22 GHz fixed link band 21.65–22.0GHz portion (50 MHz channels – lightly used) (Note 5 of RALI FX-3 22 GHz arrangements indicates that 21.4-22 GHz assignments shall be subject to Advisory Note BN)	74 x Point to Point 13 x TOB (all 24/32 MHz analogue FM emissions licensed to Telstra)	BSS
22 – 22.21 FIXED MOBILE except aeronautical mobile 149 AUS87	22 – 29 GHz		RALI FX-3 22 GHz fixed link band 22.008-22.211GHz portion (3.5/7/14/28 MHz channels-heavily used)	3133 x Point-Point Major licensees: Optus, Vodafone Hutchinson, AAPT	
22.21 – 22.5 EARTH EXPLORATION SATELLITE (passive) FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive) 149 532			RAS RALI FX-3 22 GHz fixed link band 22.21-22.85 GHz portion: mid band gap	2x Earth Rx (CSIRO: Parkes, Narrabri)	
22.5 – 22.55 FIXED MOBILE AUS87			RALI FX-3 22 GHz fixed link band 22.21-22.85 GHz portion: mid band gap	None	

[24] Based on RRL extractions taken at 1 October 2005

22.55 – 23.55 FIXED INTER-SATELLITE MOBILE 149 AUS87			RALI FX-3 22 GHz fixed link band 22.21-22.85 GHz portion: mid band gap 22.85-23.2 GHz portion: (50 MHz channels- lightly used) 23.240-23.443 GHz portion: (3.5/7/14/28 MHz channels – heavily used)	14 x TOB (Telstra) 3201 x Point to Point Major licensees: Hutchinson, Optus, Vodafone -mainly Capital Cities	
23.55 – 23.6 FIXED MOBILE AUS87				None	
23.6 – 24 EARTH EXPLORATION SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 340			RAS	2 x Earth Rx (CSIRO: Parkes, Narrabri)	
24 – 24.05 AMATEUR AMATEUR-SATELLITE 150 AUS87			ISM LIPD Class Licence Amateur Amateur-satellite	3 x Amateur Beacons (Amateur groups: Ardross WA, Townsville Qld, Elizabeth SA)	
24.05 – 24.25 RADIOLOCATION AUS11 Amateur Earth exploration satellite (active) 150 AUS87			ISM LIPD Class licence Amateur Defence	693 x Radiodetermination (Police speed radars: NSW(453), Qld (207), NT(18)) 1 x Defence Aus-wide	
24.25 – 24.45 RADIONAVIGATION FIXED MOBILE AUS87				None	

24.45 – 24.65 FIXED INTER-SATELLITE MOBILE RADIONAVIGATION 533 AUS87			24.5-26.5 GHz Embargo 24 possible fixed band	None	
24.65 – 24.75 FIXED INTER-SATELLITE MOBILE 533 AUS87			24.5-26.5 GHz Embargo 24 possible fixed band	1 x Scientific Assigned Vic Transport Accident Commission (non-UWB vehicle radar trial)	
24.75 – 25.25 FIXED FIXED-SATELLITE (Earth-to-space) 535 MOBILE AUS87			24.5-26.5 GHz Embargo 24 possible fixed band	None	25 – 27 GHz Defence interest in deployable broadband wireless comms as part of Network Centric Warfare (NCW)
25.25 – 25.5 FIXED INTER-SATELLITE 536 MOBILE Standard frequency and time signal-satellite (Earth-to-space) AUS87			24.5-26.5 GHz Embargo 24 possible fixed band	None	25.25-27 GHz Interest in EESS/SRS wideband downlinks to gateway Earth Stations 25 – 27 GHz Defence interest in deployable broadband wireless comms as part of NCW

25.5 – 27 EARTH EXPLORATION-SATELLITE (space-to-Earth) 536A FIXED INTER-SATELLITE 536 MOBILE SPACE RESEARCH (space-to-Earth) 536A Standard frequency and time signal-satellite (Earth-to-space) AUS87			25.5-26.5 GHz Embargo 24 possible fixed band 26.5-26.85 GHz reserved for Spectrum Licensing (but not yet allocated) 26.85-27 GHz Spectrum Licensed to XY ZED-LMDS Pty Ltd	12 x device registrations (receive) Optus Sites	25.25-27 GHz Interest in EESS/SRS wideband downlinks to gateway Earth stations 25 – 27 GHz Defence interest in deployable broadband wireless comms. as part of NCW
27 – 27.5 FIXED FIXED-SATELLITE (Earth-to-space) INTER-SATELLITE 536 537 MOBILE			27-27.35 GHz Spectrum Licensed to XY ZED-LMDS Pty Ltd 27.35 – 27.5 GHz Spectrum Licensed to Shin Satellite (regional SA- incl. Broken Hill + regional WA)	24 x device registrations (transmit) 12: larger metro cities+ Dubbo 12: Broken Hill &Kalgoorlie (apparently on behalf of Shin Satellite) 6 x device registrations (transmit) Broken Hill and Kalgoorlie	
27.5 – 28.5 FIXED FIXED-SATELLITE (Earth-to-space) 484A 516B 539 MOBILE 538 540			27.5 – 28.35 GHz Spectrum Licensed to AAPT LMDS Pty Ltd – Aus-wide	171 x device registrations *(171 device registrations as at 1/9/03 ACT, NSW (metro Sydney), Qld (metro Brisbane), SA (metro Adelaide), Vic (metro Melb and larger regional centres), WA (metro Perth)*	
28.5 – 29.1 FIXED FIXED-SATELLITE (Earth-to-space) 484A 516B 523A 539 MOBILE Earth exploration-satellite (Earth-to-space) 541 540			28.6-29.1 GHz Embargo 24 future MSS system uplink	None	

Figure A2.1 Exclusion Zone around the Parkes Radio Telescope

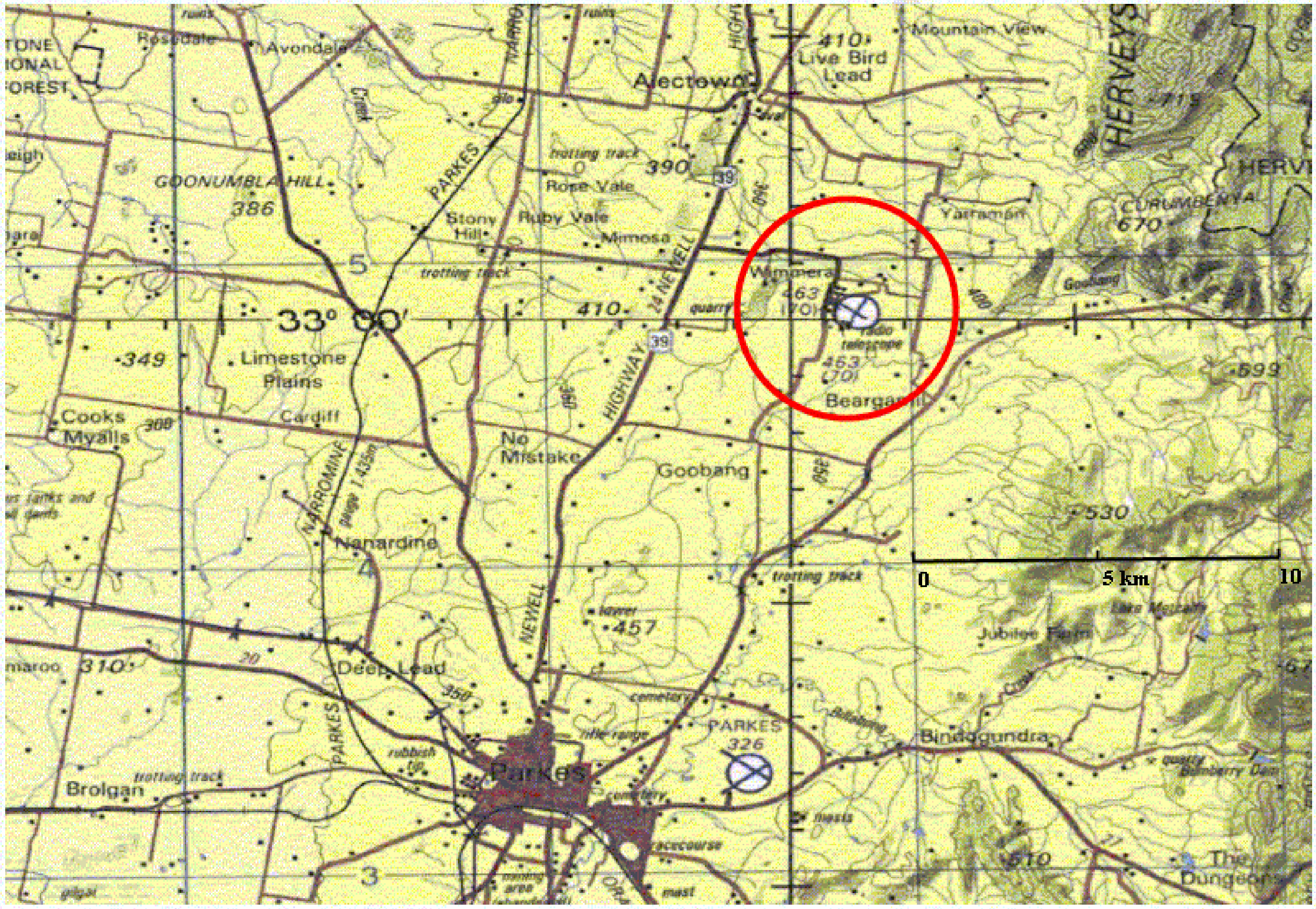

Figure A2.2 Exclusion Zone around the Narrabri Radio Telescope