Electronic Communications Committee (ECC)
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ECC REPORT 165

COMPATIBILITY STUDY BETWEEN MSS COMPLEMENTARY GROUND COMPONENT OPERATING IN THE BANDS 1 610.0-1 626.5 MHz AND 2 483.5-2 500.0 MHz AND OTHER SYSTEMS IN THE SAME BANDS OR IN ADJACENT BANDS

Montegrotto Terme, May 2011

0 EXECUTIVE SUMMARY

This Report deals with the analysis of the compatibility between CGC (MSS Complementary Ground Component) operating in the bands 1610-1626.5 MHz and 2483.5-2500 MHz and other co-band or adjacent band systems. The band 1610-1626.5 MHz would be used by MSS/CGC associated with CDMA MSS systems for uplink (the terminal transmits, the satellite or CGC base station receives): the potential interference to victim systems comes mainly from MSS/CGC terminal emissions and out of band emissions. However, part of this band could also be used by CGC associated with TDMA MSS systems for downlink. In this case, the potential interference to victim systems could also come from CGC base stations. The band 2483.5-2500 MHz is used by MSS/CGC associated with CDMA MSS systems only for downlink: the satellite or CGC BS transmits and the terminal receives. The potential interference is from CGC BS emission and out of band emission to IMT reception above 2500 MHz.

The following compatibility scenarios are studied based on interference analysis and simulations:

a) Potential interference from CGC BS transmission in 2483.5-2500 MHz to IMT BS reception above 2500 MHz;

b) Potential interference from CGC BS transmission in 2483.5-2500 MHz to terrestrial services operating in the band 2483.5-2500 MHz, for example, hand-held radio cameras and the associated broadcast auxiliary services used for video programme making and video transmission (SAB/SAP);

c) Potential interference from CGC BS to RNSS receivers in 2483.5-2500 MHz;

d) Potential interference from CGC terminal to RNSS receiver around 1.6 GHz;

e) Potential interference from CGC terminal to Radioastronomy Service in band 1610.6-1613.8 MHz

Interference simulations and analysis lead to the following conclusions:

<u>For the band 1610-1626.5 MHz:</u>

1) Based on the assumptions for RNSS and CGC operations, the compatibility between a CGC terminal and RNSS receiver around 1.6 GHz may require large separation distances between CGC transmitters and RNSS receivers to ensure the protection of RNSS equipment. The aggregate impact of CGC devices was not studied, but would give rise to increased separation distances in some cases such as multiple line-of-sight paths. However, in urban environments the aggregate impact may be mitigated by significantly increased propagation losses compared to free-space.

2) The band 1610.6-1613.8 MHz is allocated to radio astronomy service (RAS), the interference analysis with prediction and statistical simulations between CGC and RAS as indicated in Section 8 above show that because of the differences in the terrain models around the affected radio telescopes, CGC base stations in the 1.6 GHz band should be coordinated on a case by case basis with RAS Earth stations (including across borders). Deployment of CGCs in the RAS band 1610.6-1 613.8 MHz would lead to the need for separation distances of several hundred of kilometres and should be avoided. Frequency separation between the RAS and CGCs and a possible reduction in the CGC base station power might be helpful for the protection of the RAS in some cases. Alternatively, reduction of unwanted emission with appropriate filtering can also improve the compatibility.

3) It was considered that since the actual density of MSS terminals was much lower than expected before the development of the unwanted emission masks for MSS terminals, no change to these masks would be necessary to accommodate the increase of terminals due to the operation of CGCs.

<u>For the frequency band 2483.5-2500 MHz:</u>

4) Compatibility between CGC BS operating in the band 2483.5-2500 MHz and IMT above 2500 MHz is difficult, deploying CGC BS as cellular network layout is not possible based on the co-existence conditions from CEPT Report 19:
   - The main interference mechanism is the IMT BS adjacent band selectivity and blocking, in order to protect IMT uplink reception above 2500 MHz, CGC BS transmit power at the BS output should be limited to -10.5 dBm in the frequency range 2495-2500 MHz with a 100 m separation distance, in a macro cellular environment. Since this is not feasible, a restriction of CGC operations to the band 2483.5-2495 MHz is therefore required.
   - The analysis shows that in the general case, the transmit EIRP of the CGC base stations in the 2480 to 2495 MHz band should be limited to 15.5 dBm, which would effectively preclude the implementation of a CGC macro cellular network in areas with macro cellular IMT networks.
   - In some circumstances (e.g. between a single CGC BS with an EIRP of 13 dBW and a single IMT BS), it may be possible to mitigate the interference by leveraging on several factors: space/angle isolation between the CGC BS

antenna and IMT BS antenna (provided that the physical separation, horizontally and vertically, is sufficient), frequency separation between closely located CGC BS and IMT, increased propagation losses and lower IMT BS gains in certain environments. However, considering that IMT network is deployed as cellular layout, the coordination would remain difficult.

5) Some administrations already deploy terrestrial services operating in the band 2483.5-2500 MHz, for example, hand-held radio cameras and the associated broadcast auxiliary services used for video programme making and video transmission (SAB/SAP), these services have successfully operated in this band for many years without interference from MSS downlink signals. However, if CGC base stations are deployed within the countries that deploy SAB/SAP in these bands (4 of the 48 CEPT countries), then as described in Section 10 this will place significant constraints on the SAB/SAP to the extent that they may become unusable, even though such systems are generally deployed on an occasional basis with a very low deployment density. This situation will not exist in the majority of CEPT countries where these SAB/SAP services are not deployed in this band.

6) Interference analysis between CGC base stations and RDSS show that the distance needed to protect RNSS receivers used under the RDSS allocation against interference from CGC base stations exceeds the typical cell radius in the case of both macro and micro cell base stations. It is concluded therefore, that RDSS systems and CGC networks will not be compatible in the band 2483.5-2500 MHz.

As a general conclusion, and according to the above results, the introduction of CGC in the MSS bands of 1610-1626.5 MHz and 2483.5-2500 MHz is not compatible with the systems in the same band such as RDSS or SAP/SAB where these systems are deployed, and would be very difficult with some systems deployed in adjacent band such as RNSS or IMT. In addition, the deployment of CGC shall be avoided in the RAS band 1610.6-1613.8 MHz.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ACLR	Adjacent Channel power Leakage Ratio
ACS	Adjacent Channel Selectivity
ATC	Ancillary Terrestrial Component
BEM	Block Edge Mask
BWA	Broadband Wireless Access
CGC	Complementary Ground Component
MES	Mobile Earth Station
MSS	Mobile Satellite Service
PCS	Personal Communications Services
RAS	Radio Astronomy Service
RDSS	Radio Determination Satellite Service
RNSS	Radio Navigation Satellite Service

Compatibility study between MSS complementary ground component operating in the bands 1610.0-1626.5 MHz and 2 483.5-2 500.0 MHz and other systems in the same bands or in adjacent bands

1 INTRODUCTION

WRC-07 Recommendation 206 (WRC-07) proposed that studies should be carried out into the use of Complementary Ground Component (CGC), to enhance Mobile Satellite Systems (MSS). This document deals with CGC in the bands 1610.0-1626.5 MHz and 2483.5-2500.0 MHz, used by non-GSO MSS systems. The CGC systems are referred to as MSS-ATC (MSS-Ancillary Terrestrial Component) in the United States and Canada.

This Report is dedicated to the compatibility study between MSS CGC and other co-band or adjacent band systems. The objective of this study is to check from compatibility point of view if it is possible to allow the introduction of mobile satellite Complementary Ground Component) in the frequency bands 1610.0-1626.5 MHz and 2483.5-2500.0 MHz.

The frequency band allocation table of the band 1559-1660 MHz and the band of 2450-2520 MHz are given in section 2. These frequency allocation tables allow identifying the adjacent band systems adjacent to MSS bands of 1610-1626.5 MHz and 2483.5-2500 MHz.

The MSS CGC Base Station and Terminal characteristics that are used for the following compatibility studies are presented in section 3. A list of possible technologies, such as GSM, CDMA IS95, UMTS, etc is listed as possible candidate technology for CGC. It should be pointed out that the compatibility study results are dependent on the considered assumptions and scenarios.

Compatibility study scenarios and cases are listed and summarised in section 4. The interference analysis between MSS CGC and RNSS in the band 1559-1610 MHz is described in section 6. The main interference to RNSS at 1610 MHz is from MSS CGC terminal emissions.

Section 6 gives a brief description of the situation of Fixed Service in the band 2483.5-2500 MHz, it is not considered as necessary to analyse the potential interference from CGC BS to Fixed Service.

The band 1610.6-1613.8 MHz is allocated to radioastronomy. The analysis of potential interference from MSS CGC terminal to radioastronomy is described in section 7.

Section 8 provides a brief description of the situation related to mobile satellite service in the bands 1610-1626.5 MHz and 1626.5-1660.5 MHz, it is not considered to perform compatibility study between adjacent MSS systems since the compatibility might be obtained by the coordination between adjacent band MSS operators.

Section 9 describes the analysis of potential interferences from CGC BS to mobile broadcast (SAB/SAP and ENG/OB) in the band 2483.5-2500 MHz.

The interference analysis from CGC BS to radio determination receiver in the band 2483.5-2500 MHz is provided in section 10.

Section 11 is dedicated to the interference analysis from CGC BS in the band 2483.5-2500 MHz to IMT BS reception above 2500 MHz. The analysis is limited to LTE BS system parameters. The potential interference from CGC BS to TDD WiMAX BS and the interference from TDD WiMAX BS to CGC BS are not considered.

The conclusions can be found in section 12.

Compatibility between pseudolites below 1610 MHz and ISM (WLAN/Bluetooth etc) below 2483.5 MHz has not been studied.

2 ALLOCATIONS IN THE BANDS 1.6 AND 2.4 GHz

Table 1 and Table 2 quote the different allocations existing in the radio regulations in the bands 1559-1660 MHz and 2450-2520 MHz.

Table 1: Frequency allocations in the band 1 559-1 660 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 559-1 610	AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.208B 5.328B 5.329A 5.341 5.362B 5.362C	
1 610-1 610.6 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610-1 610.6** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372
1 610.6-1 613.8 MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.371	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) 5.149 5.341 5.364 5.366 5.367 5.368 5.370 5.372	**1 610.6-1 613.8** MOBILE-SATELLITE (Earth-to-space) 5.351A RADIO ASTRONOMY AERONAUTICAL RADIONAVIGATION Radiodetermination-satellite (Earth-to-space) 5.149 5.341 5.355 5.359 5.364 5.366 5.367 5.368 5.369 5.372
1 613.8-1 626.5 MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5.208B 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.371 5.372	**1 613.8-1 626.5** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION RADIODETERMINATION-SATELLITE (Earth-to-space) Mobile-satellite (space-to-Earth) 5. 208B 5.341 5.364 5.365 5.366 5.367 5.368 5.370 5.372	**1 613.8-1 626.5** MOBILE-SATELLITE (Earth-to-space) 5.351A AERONAUTICAL RADIONAVIGATION Mobile-satellite (space-to-Earth) 5. 208B Radiodetermination-satellite (Earth-to-space) 5.341 5.355 5.359 5.364 5.365 5.366 5.367 5.368 5.369 5.372
1 626.5-1 660	MOBILE-SATELLITE (Earth-to-space) 5.351A 5.341 5.351 5.353A 5.354 5.355 5.357A 5.359 5.362A 5.374 5.375 5.376	

Table 2: Frequency allocations in the band 2 450-2 520 MHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>2 450-2 483.5
FIXED
MOBILE
Radiolocation
5.150 5.397</td><td colspan="2">2 450-2 483.5
FIXED
MOBILE
RADIOLOCATION
5.150</td></tr>
<tr><td>2 483.5-2 500
FIXED
MOBILE
MOBILE-SATELLITE (space-to-Earth) 5.351A
Radiolocation
5.150 5.371 5.397 5.398 5.399 5.400 5.402</td><td>2 483.5-2 500
FIXED
MOBILE
MOBILE-SATELLITE (space-to-Earth) 5.351A
RADIOLOCATION
RADIODETERMINATION-SATELLITE (space-to-Earth) 5.398
5.150 5.402</td><td>2 483.5-2 500
FIXED
MOBILE
MOBILE-SATELLITE (space-to-Earth) 5.351A
RADIOLOCATION
Radiodetermination-satellite (space-to-Earth) 5.398
5.150 5.400 5.402</td></tr>
<tr><td>2 500-2 520
FIXED 5.410
MOBILE except aeronautical mobile 5.384A
5.405 5.412</td><td>2 500-2 520
FIXED 5.410
FIXED-SATELLITE (space-to-Earth) 5.415
MOBILE except aeronautical mobile 5.384A
5.404</td><td>2 500-2 520
FIXED 5.410
FIXED-SATELLITE (space-to-Earth) 5.415
MOBILE except aeronautical mobile 5.384A
MOBILE-SATELLITE (space-to-Earth) 5.351A 5.407 5.414 5.414A
5.404 5.415A</td></tr>
</table>

It has to be noted that there is no allocation to the mobile service in the bands 1610 – 1626.5 MHz under which the CGC base stations would be able to operate under a license authorisation. These base stations would therefore have to be operated either:

- under the MSS. This means that CGC base stations transmitting in this frequency range would do so on a secondary basis.
- under 4.4. This means no interference to and no protection from other services, including MSS itself.

WRC-11 Agenda Item 1.18 deals with a possible worldwide primary allocation to the radiodetermination service which is today only primary in Region 2 as well as a limited number of countries in Regions 1 and 3.

The services to be considered within CEPT countries are summarized in the tables.

The 1.6 GHz band (1610-1626.5MHz) is used by two different MSS technologies, these are:

- CDMA using Frequency Division Duplex (FDD) in the lower part of the band.
- TDMA using Time Division Duplex (TDD) in the upper part of the band.

In the case of CDMA, the 1.6 GHz band is used for Earth to space direction with a primary status. The corresponding space to Earth path uses the 2.4 GHz band (2483.5 -2500 MHz) with primary status. The band 2483.5-2498 MHz within CEPT was identified for MSS using CDMA technologies.

In the case of TDMA, both Earth to space and space to Earth use the 1.6 GHz band. However, only the Earth to space direction has primary status. The space to Earth downlink uses the secondary allocation for the band 1613.8-1626.5 MHz. The band 2498-2500 MHz was identified within CEPT for “S-PCS using TDMA technologies”.

3 CHARACTERICTICS OF MSS CGC

3.1 CGC associated with MSS systems using TDMA

The MSS system using a TDD air interface could easily be adapted for use in a CGC system. The TDD mode would enable the CGC to be deployed in a single band.

Table 3: TDD UE (satellite mode) and CGC BS characteristics

Nominal TDD characteristics[1]	
Channel bandwidth	41.7 kHz
Timeslot / frame	8 ms / 90 ms
Burst e.i.r.p.	8.5 dBW
Average e.i.r.p.	-2 dBW
Voice activity factor	40% (-4 dB)

Table 4: Unwanted emissions performance of the UE and BS (ETSI standard EN 301 441)

Out of band domain (outside the MSS band)		
Frequency band	**Emission limit (dBW)**	**Measurement bandwidth (kHz)**
1559 – 1605	-70	1000
1605 - 1610 *	-70 to -10	1000
In band domain (in the MSS band)		
Frequency offset (kHz)	**Emission limit (dBW)**	**Measurement bandwidth (kHz)**
0 – 160	-35	30
160 – 225	-35 to -38.5	30
225 – 650	-38.5 to -45	30
650 – 1365	-45	30
1365 – 1800	-53 to -56	30
1800 – 16500	-56	30
*Note: linearly interpolated in dBW vs. frequency offset. A continuous transition between the in-band domain and the out-of-band domain will be used (see the example below).		

Table 5: Unwanted emissions of the UE and BS for a CGC carrier at 1618.25MHz (ETSI standard EN 301 441)

Frequency band	Emission limit (dBW)	Measurement bandwidth (kHz)
1559 – 1605	-70	1000
1605 - 1607.5	-70 to -40	1000
1607.5 - 1616.45 *	-56	30
1616.45 - 1616.885	-56 to -53	30
1616.885 - 1617.6	-45	30
1617.6 - 1618.025	-45 to -38.5	30
1618.025 - 1618.09	-38.5 - 35	30
1618.09 - 1618.25	-35	30
*Note: ETSI EN 301 441 specifies a higher permitted limit in the frequency range 1607.5-1610 MHz. However, for the purposes of the CGC compatibility study, it was assumed that CGC emissions decrease continuously towards the RNSS band.		

It was noted that these are specified as average values.

3.2 CGC associated with MSS systems using CDMA

[1] These characteristics apply to the user terminal in satellite mode.

The initial CGC system proposal using CDMA is based on the IS-95 standard.[2]

Table 6: Characteristics of the Big LEO CGC systems

Item	**Units**	**IS-95 Characteristics**
Mobile Terminal		
e.i.r.p.	(dBW)	0.2-1.0
Carrier separation	(MHz)	1.25
Channel Bandwidth	(MHz)	1.2288
Out-of-Band Emission Level		>900kHz -42 dBc/30 kHz >1.98 MHz -54 dBc/30 kHz
Base Station		
e.i.r.p.	(dBW)	32.0
Antenna Gain	(dBi)	19.0
Out-of-Band Emission Level		>750 kHz -45 dBc/30 kHz >1.98 MHz -60 dBc/30 kHz

Table 7: Unwanted emissions performance of the CDMA MES (ETSI standard EN 301 441)

Frequency offset from edge of nominated carrier (kHz)	Average e.i.r.p. density (dBW/30 kHz)
0 – 70	-6 to -20
70 – 600	-20 to -28
600 – 2000	-28 to -45
2 000 – 5000	-45 to -69
5 000 – 16500	-69

3.2.1 Base stations

For its CGC service, the CDMA MSS operator plans to utilize terrestrial base stations and antennas very similar to those currently deployed by terrestrial PCS and broadband wireless systems. The CGC base station and antennas will transmit in the 2.4 GHz band and receive in the 1.6 GHz band where an FDD technology is deployed. MSS and CGC operations will share the same frequency band. The MSS/CGC control centre, which will be integrated into the existing MSS control centre, will allocate frequencies to MSS and CGC so that "MSS only" frequency(ies) will exist within CGC coverage zones if self-interference would otherwise become too great. This ensures that MSS-only users will be served when in CGC coverage. The MSS CDMA operator will require that the base station and base station antenna supplier(s) provide equipment and any necessary filtering in order to comply with the applicable requirements. One example of CDMA CGC base stations will operate with the following characteristics.

Specifically:

- CGC base stations will not exceed a peak e.i.r.p. of 32 dBW in 1.25 MHz.
- CGC base stations will not exceed out-of-channel emission of -44.1 dBW/30 kHz at the edge of the authorized assignment.
- CGC base stations will also not exceed the following out-of-band emission limits:
- -43 dBW/1% of carrier bandwidth offset from the band edge of the Globalstar's authorized assignment
- -43 dBW/MHz at 1 MHz offset from the band edge for any size carrier
- -45 dBm/MHz above 2500 MHz.

[2] Globalstar May 29, 2002 *Ex Parte* Letter, Attach. A at 2-3.

3.2.2 Terminals

MSS/CGC services will evolve as second-generation constellations and the CGC networks are deployed. In all phases of the evolution, integrated MSS/CGC service dual-mode MSS/CGC terminals should be able to communicate with both the MSS network and the MSS CGC component. The MSS/CGC terminal will transmit in the 1.6 GHz band for MSS and FDD CGC mode. The terminal will receive, for both MSS and FDD CGC modes, in the 2.4 GHz band. There should be no simultaneous transmission in CGC and MSS modes for these devices. Both the MSS and CGC antennas will be housed within the device and will not be removable.

A call in progress could be dropped if the In-call hand off between the MSS mode and the CGC mode is not possible, if a user crosses a service boundary between CGC coverage and MSS coverage. The indicators on the handset display will advise the user that the mode has changed.

Table 8: CGC terminal characteristics

Phone Type and Mode	Max Tx Power available (dBW)	Peak Antenna Gain (dBic or dBi)	Max e.i.r.p. (dBW)	Max e.i.r.p. Density (dBW/1.25 MHz)	Max e.i.r.p. Density (dBW/4 kHz)
Handheld CGC terminal	-7.0	2.0	-5.0	-5.0	-29.9
Fixed CGC (external antenna) terminal	-7.0	12.0	5.0	1.0	-19.9

4 COMPATIBILITY ANALYSIS

The following compatibility scenarios have been identified:

- Scenario 1: Compatibility of CGC networks operating on adjacent frequencies, within the same service or coverage areas.
- Scenario 2: Compatibility of a CGC network operating in one coverage area with co-frequency MSS systems serving a different coverage area and whether CGC implementation could meet international ITU satellite co-ordination and protection obligations.
- Scenario 3: Interference to other radio services from CGC networks.

The in-band compatibility scenarios 1 & 2 are considered an issue between MSS operators to be dealt with through bilateral coordination, but subject to common minimum out of band requirements.

Interference into other services from:

- the MSS satellite,
- the CGC base station,
- the user handset.

Interference from the MSS satellite is not changed in any way by the introduction of CGC and need not be considered in this study. Interference from CGC base stations, on the other hand, is a potential issue. Field strengths close to a station will be significantly greater than those received from the satellite. This can, therefore, be considered as the main issue to be studied. In the case of interference from a user handset, the interference path is essentially the same regardless of whether the handset is transmitting to the satellite or a CGC base station. However, the introduction of CGC and the associated improvement in the availability of the service is likely to promote an increase in its use and consequently a higher density of handsets. The aggregate interference from handsets may, therefore, increase. This aspect should be considered in the studies.

With regard to unwanted emissions, it should be noted that:

The increase of terminals of MSS systems using TDMA is likely to have no influence on systems from services below 1610 MHz as such terminals would be limited to the band 1613.8-1626.5 MHz where there is a downlink allocation. Therefore a 3.8 MHz guard band is available.

If one service is protected when using the same band as the CGC network it is assumed that the same provision will protect the same service from interference from unwanted emissions of CGC. This is for example the case of fixed in the band 2483.5-2500 MHz and in the adjacent bands 2450-2500 and 2500-2520 MHz.

These considerations are summarised in Table 9.

Table 9: Studies to be performed

Band	Victim	Interferer	Comment
1559-1610	RNSS	CGC BS	Unwanted emissions
		Terminals transmitting to a CGC BS	
	Aeronautical radionavigation	CGC BS	Unwanted emissions – Not currently used within CEPT
		Terminals transmitting to a CGC BS	
1610-1626.5	Fixed (See 5.359)	CGC BS	Fixed service is not allocated in the European Common Allocation (ECA) table and was therefore not studied.
		Terminals transmitting to a CGC BS	
	Aeronautical radionavigation	CGC BS	Not currently used within CEPT. Possibility of ground-based RNSS augmentation systems
		Terminals transmitting to a CGC BS	
	RAS (1610.6-1613.8 MHz)	CGC BS	
		Terminals transmitting to a CGC BS	
1626.5-1660	GSO MSS satellite	CGC BS	Unwanted emissions
		Terminals transmitting to a CGC BS	
2450-2483.5	Radiolocation (See 5.397)	CGC BS	Unwanted emissions The allocation is primary only in France. The usage of the band by radiolocation systems in France will end by 2012.
2483.5-2500	Radio determination satellite	CGC BS	
	Radio location	CGC BS	
	Fixed	CGC BS	
	Mobile	CGC BS	
2500-2520	IMT TDD and FDD Base Station	CGC BS	Unwanted emissions (See Annexe IV to amended CEPT Report 19 and related ECC Report 131 (BEM) in the band 2500-2690 MHz)
	IMT TDD terminal	CGC BS	

5 RADIO NAVIGATION SATELLITE SERVICE IN THE BAND 1559-1610 MHz

The band below 1610 MHz is allocated to RNSS (Space to Earth). RNSS systems include general-purpose navigation devices for domestic and commercial use, industrial tracking devices for high value cargoes and high-reliability systems for aeronautical navigation and landing assistance (including "safety-of-life" applications).

The band above 1610 MHz is used by CDMA and TDMA MSS handsets to uplink to the satellite, and may also be used to link to a CGC base station. Part of the band above 1610 MHz is used to downlink from the satellite to an MSS handset, and may also be used to downlink from a CGC base station to a handset.

This section considers the compatibility of CGC with two distinct applications of RNSS:

(i) General-purpose and tracking applications, where occasional loss of RNSS signal is expected and does not impact overall performance, and

(ii) Aeronautical "safety-of-life" applications, where the integrity requirement for the RNSS signal is greater.

5.1 RNSS receiver characteristics

RNSS reception masks are extracted from ICAO annex 10[3]. They are given in the following figure.

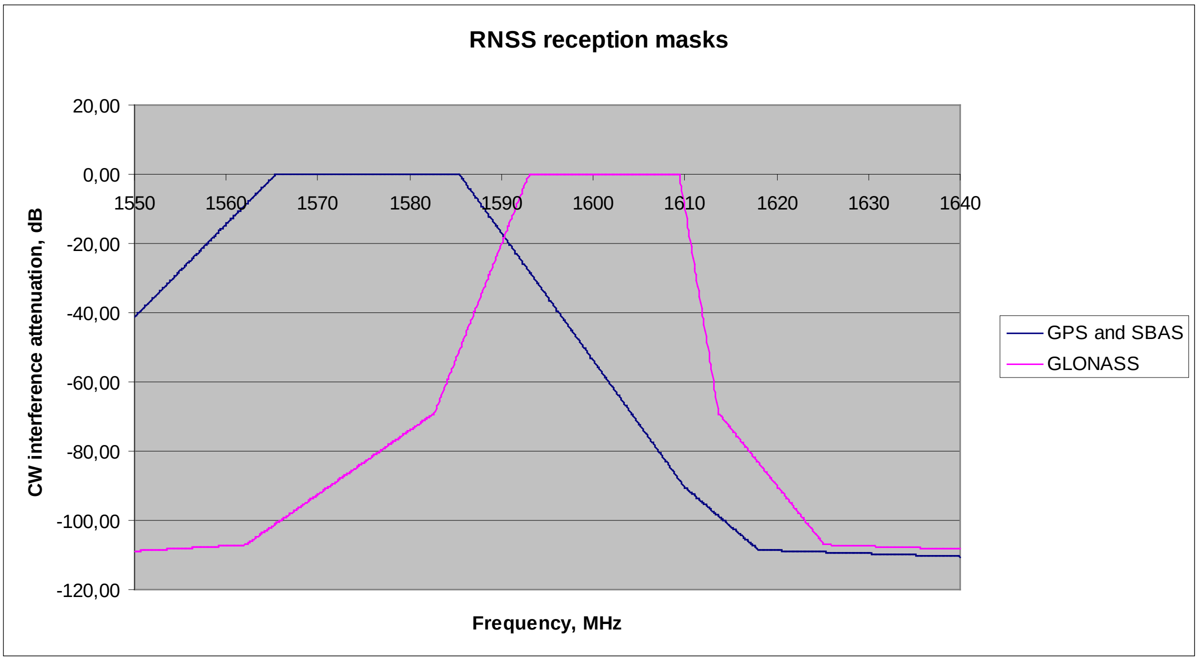

Figure 1: RNSS reception masks

Note: the GLONASS mask is shown in figure with a passband of 1595 – 1609 MHz, corresponding to the FDMA signals of that system.

The following protection parameters are extracted from the draft new Recommendation ITU-R M.[1477_new]:

[3] ICAO Annex 10 to the Convention on International Civil Aviation, Volume I, Radio Navigation Aids (sixth edition, amendment 84)

Table 10: RNSS protection criteria

Parameters	Aeronautical receivers	Non aeronautical receivers
Acquisition mode threshold power density level of aggregate wideband interference at the passive antenna output	-147.4 dBW/MHz	-146 to -148 dBW/MHz
Safety margin	6dB	0dB
Apportionment	10% or 10 dB	10% or 10dB[4]
Protection level	-163.4 dBW/MHz	-156 to -158 dBW/MHz

5.2 Results of compatibility studies

Considering first the single-entry case of a CGC transmitter and a RNSS receiver, the RNSS receiver and CGC emissions masks were convolved together to calculate the effective isolation between the two, assuming neither separation nor margins. Aiming to achieve the RNSS protection criteria from section 6.1, free-space loss was assumed to derive the minimum separation distance between the RNSS and CGC devices.

- User equipments with TDMA

The RNSS receiver and CGC emissions masks were convolved together to calculate the effective isolation between the two, assuming neither separation nor margins. Aiming to achieve the RNSS protection criteria from section 6.1, free-space loss was assumed to derive the minimum separation distance between the RNSS and CGC devices. These distances are presented in the following Figure 2.

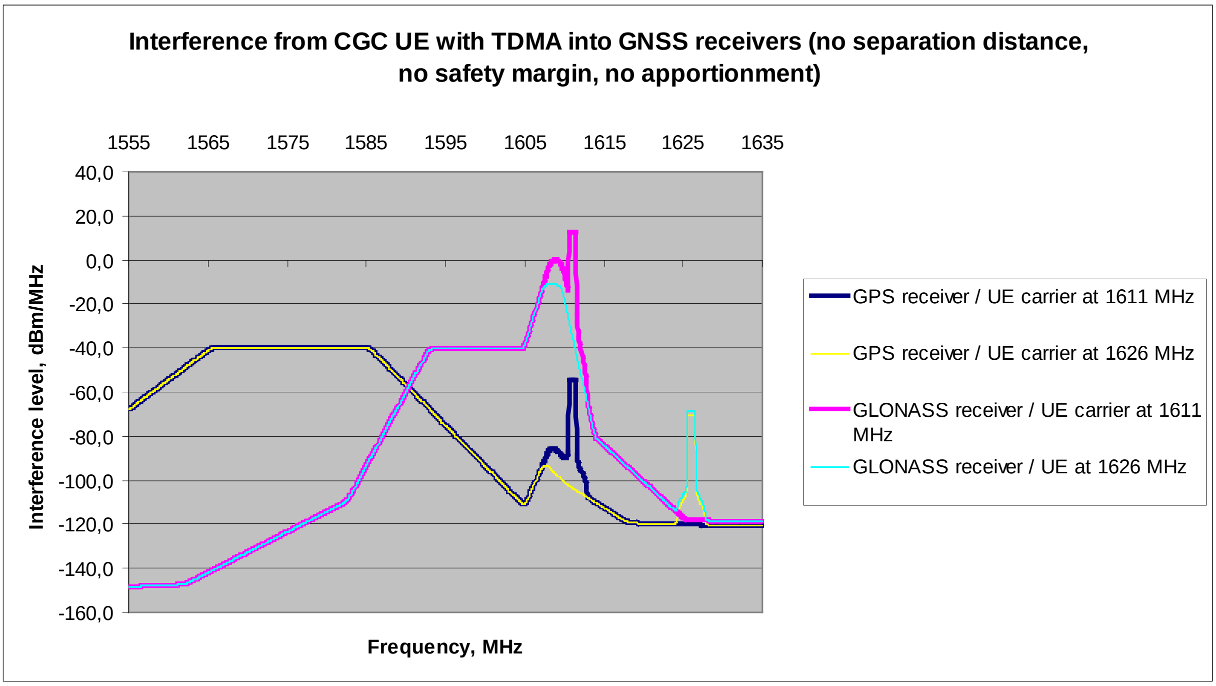

Figure 2: Interference from CGC UE with TDMA into GNSS receiver

[4] For short separation distances (for example less than 20 m) in the general case apportionment may not be needed.

Table 11: Interference from CGC UE with TDMA into GNSS receiver

Parameters	Aeronautical RNSS receiver	Non aeronautical RNSS receiver
Protection criteria	-133.4dBm/MHz	-126dBm/MHz to -128dBm/MHz
CGC carrier at 1611MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1611MHz vs GLONASS		
Worst case interference level	13 dBm/MHz	13 dBm/MHz
Necessary separation distance between CGC and RNSS	311 km	167 km
CGC carrier at 1626MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1626MHz vs GLONASS		
Worst case interference level	-11 dBm/MHz	-11 dBm/MHz
Necessary separation distance between CGC and RNSS	20 km	11 km

Considering the case of a CGC transmitter and an aeronautical RNSS receiver, to meet compatibility in the RNSS passband with no further filtering, some separation distance is required. Using a simple assumption of free-space loss this distance would be between 700 m and 311 km, depending on the CGC carrier frequency considered and on the type of RNSS system (GPS or GLONASS).

Considering the case of a CGC transmitter and a non aeronautical RNSS receiver, the above distance would be reduced to 370 m in the best case but could still reach 167 km.

- User equipments with CDMA

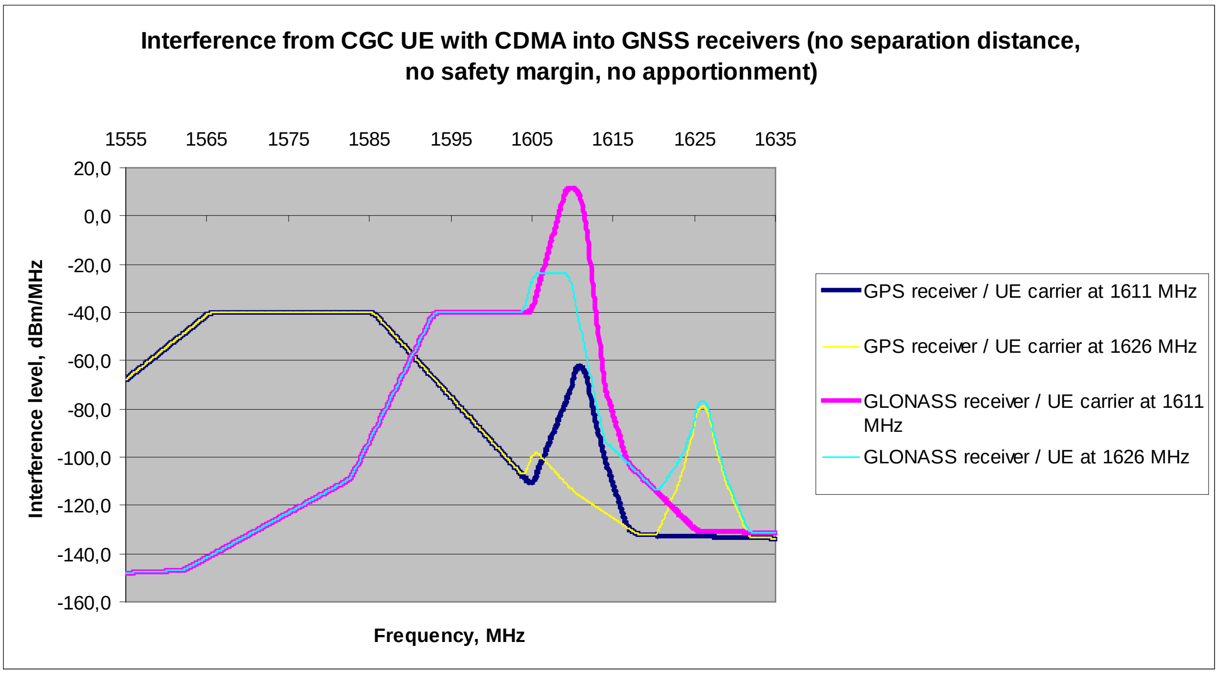

Figure 3: Interference from CGC UE with CDMA into GNSS receiver

Table 12: Interference from CGC UE with CDMA into GNSS receiver

Parameters	Aeronautical RNSS receiver	Non aeronautical RNSS receiver
Protection criteria	-133.4dBm/MHz	-126dBm/MHz to -128dBm/MHz
CGC carrier at 1611MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1611MHz vs GLONASS		
Worst case interference level	11 dBm/MHz	11 dBm/MHz
Necessary separation distance between CGC and RNSS	247 km	133 km
CGC carrier at 1626MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1626MHz vs GLONASS		
Worst case interference level	-24 dBm/MHz	-24 dBm/MHz
Necessary separation distance between CGC and RNSS	4.4 km	2.4 km

To meet compatibility in the RNSS passband with no further filtering, some separation distance is required. Using a simple assumption of free-space loss this distance would be between 370 m and 133 km (see the

Table 12 above).

Considering the case of a CGC transmitter and an aeronautical RNSS receiver, it is necessary to assume free-space loss propagation due to line-of-sight paths to an aircraft. The minimum separation distance required to meet the protection criteria would be between 700 m and 247 km, depending on the frequency separation between the CGC carrier and the RNSS reception bandwidth.

- Base stations with TDMA

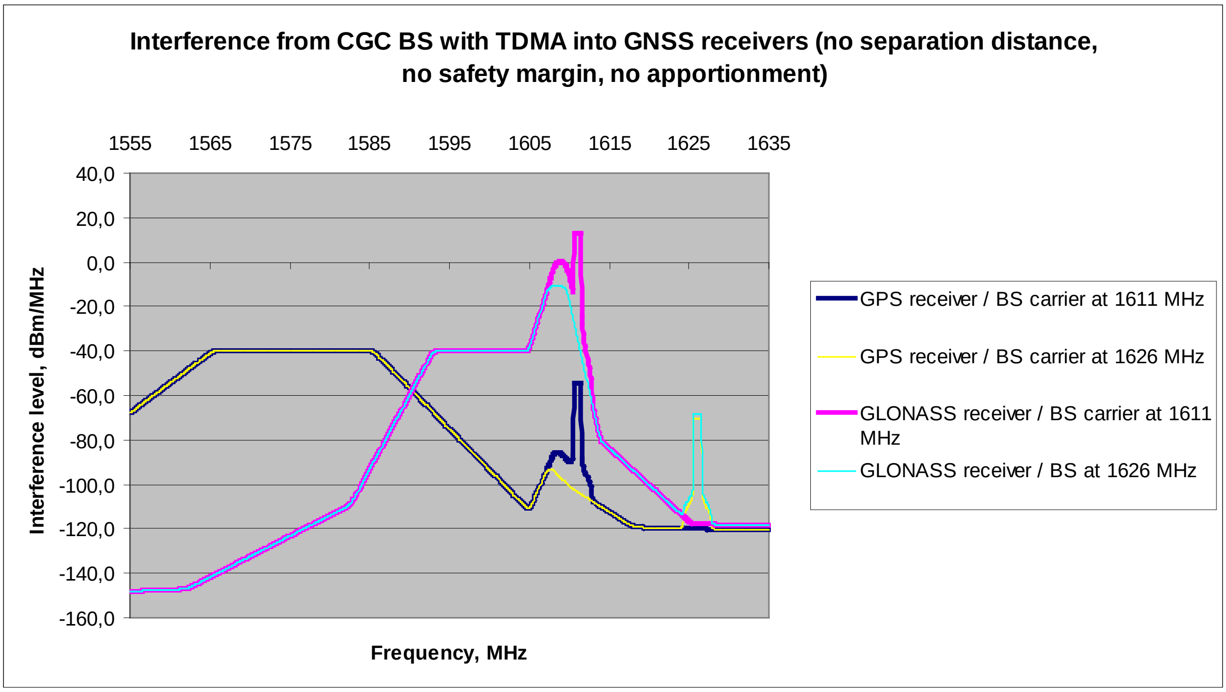

Figure 4: Interference from CGC BS with TDMA into GNSS receiver

Table 13: Interference from CGC BS with TDMA into GNSS receiver

Parameters	Aeronautical RNSS receiver	Non aeronautical RNSS receiver
Protection criteria	-133.4dBm/MHz	-126dBm/MHz to -128dBm/MHz
CGC carrier at 1611MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1611MHz vs GLONASS		
Worst case interference level	13 dBm/MHz	13 dBm/MHz
Necessary separation distance between CGC and RNSS	311 km	167 km
CGC carrier at 1626MHz vs GPS		
Worst case interference level	-40 dBm/MHz	-40 dBm/MHz
Necessary separation distance between CGC and RNSS	700 m	370 m
CGC carrier at 1626MHz vs GLONASS		
Worst case interference level	-11 dBm/MHz	-11 dBm/MHz
Necessary separation distance between CGC and RNSS	20 km	11 km

Considering the case of a CGC transmitter and an aeronautical RNSS receiver, to meet compatibility in the RNSS passband with no further filtering, some separation distance is required. Using a simple assumption of free-space loss this distance would be between 700 m and 311 km, depending on the CGC carrier frequency considered and on the type of RNSS system (GPS or GLONASS).

Considering the case of a CGC transmitter and a non-aeronautical RNSS receiver, the above distance would be reduced to 370 m in the best case but could still reach 167 km.

5.3 Analysis of the results

5.3.1 CGC/TDMA

In the case of user equipments, a minimum separation distance between the CGC terminal and the RNSS receiver is necessary. This distance depends on the CGC modulation and duplex technique.

- In the case of general purpose receivers, the distance varies from 370 m to 11 km if the CGC carrier is at 1626 MHz. For smaller frequency offset, the necessary separation distance will increase up to 167 km if the CGC carrier is at 1611 MHz
- In the case of aeronautical purpose receivers, the distance varies from 700 m to 20 km if the CGC carrier is at 1626 MHz. For smaller frequency offset, the necessary separation distance will increase up to 311km if the CGC carrier is at 1611 MHz.

These distances are not compatible with a mobile usage of mobile RNSS receiver (i.e. RNSS receiver in smart phones). Indeed, it is highly possible that a CGC handset and a mobile phone could be very close from each other (especially if it is an integrated system). Moreover, GNSS signals are used by many terminals to collect the UTC reference time, and applications can be found everywhere. Finally, it is important to note that interference come from both the proposed CGC unwanted emissions and carrier levels.

In the case of base stations, since both the e.i.r.p and the out-of-band emissions are similar to the one considered for user equipments, the necessary minimum separation distance are similar to the ones given above.

5.3.2 CGC/CDMA

Only user equipment transmitters are envisaged in the 1.6GHz band if the CDMA technique is considered.

- In the case of general purpose receivers, the distance is between 370 m and 2.4 km if the CGC carrier is at 1626 MHz. For smaller frequency offset, the necessary separation distance will increase up to 133 km if the CGC carrier is at 1611 MHz
- In the case of aeronautical purpose receivers, the distance is between 700 m and 4.4 km if the CGC carrier is at 1626 MHz. For smaller frequency offset, the necessary separation distance will increase up to 247 km if the CGC carrier is at 1611 MHz.

Again, these distances are not compatible with a mobile usage of mobile RNSS receiver (i.e. RNSS receiver in smart phones). Indeed, it is highly possible that a CGC handset and a mobile phone could be very close from each other (especially if it is an integrated system). Moreover, GNSS signals are used by many terminals to collect the UTC reference time, and applications can be found everywhere. Finally, it is important to note that interference come from both the proposed CGC unwanted emissions and carrier levels.

5.3.3 Sensitivity Analysis

In some practical scenarios, much smaller distances may be necessary, since other factors such as shielding or antenna isolation would further reduce the required separation. For instance, a much lower separation distance would be necessary with general purpose receivers in an urban environment due to non-line-of-sight propagation paths (e.g. models such as ITU-R M.1225 predict propagation in urban environments).

A 12dB increase in isolation (or a 12dB reduction in unwanted emission power density) would reduce these separation distances by a factor of 4. An other example is the consideration of the antenna isolation between an RNSS equipment mounted above an aircraft and a CGC user terminal or base station located on the ground. However, this will not have any impact for scenarios with low elevation angles. In addition, additional filtering may be specified to further reduce these distances.

The analyses applied a static 10dB apportionment of the interference allowance to the aggregated MSS CGC signals. In the aeronautical case, this may be appropriate due to line-of-sight interference paths. However, in the general case a simple apportionment of this kind may over-estimate the interference probability since non-line-of-sight propagation will significantly increase isolation. In these cases, the approach would be to conduct a Monte Carlo analysis first, and then determine if multiple-entry interference is a realistic probability. If, for example, the Monte Carlo analysis estimates a minimum separation distance of only a few metres for the general case, it would be unlikely that multiple CGC transmitters would be impacting on a single RNSS receiver. However, in some scnearios, noting the large distances that have been determined in the simulations (tens of kilometers), they may not be reduced to a manageable proportion.

It should also be noted that these emissions masks define a maximum envelope which unwanted emissions may not breach in terms of average power. Given the narrow-band nature of the wanted CGC/TDMA signals, any unwanted emissions below 1610 MHz will be very narrow-band and spurious in character. The assumption that continuum unwanted emissions may be created across the RNSS band could overestimate the potential for interference. The US/FCC has overcome this problem by specifying a narrow-band limit to be applied to spurious emissions in the RNSS band (-80dBW/700Hz). A similar approach could be envisaged in CEPT, with a narrow band limit to be defined.

Important note: These attenuations are the minimum requirements since section 6.2 gives the impact of a single CGC interferer on a RNSS receiver while the above criterion is for all CGC transmitters (the aggregate impact of all CGC transmitters). An additional apportionment is thus needed to be consistent.

5.4 Conclusion

Based on the assumptions for RNSS and CGC operations, the compatibility between a CGC terminal and RNSS receiver around 1.6 GHz may require large separation distances between CGC transmitters and RNSS receivers to ensure the protection of RNSS equipment. The aggregate impact of CGC devices was not studied, but would give rise to increased separation distances in some cases such as multiple line-of-sight paths. However, in urban environments the aggregate impact may be mitigated by significantly increased propagation losses compared to free-space.

6 FIXED SERVICE IN THE BAND 2483.5-2500 MHz

The band 2483.5-500 MHz and bands either side are also allocated to fixed services on a primary basis.

Although FS is mentioned for that band in Radio Regulations and ECA, In Europe, the commonly used applications in this band do not include fixed service since the general long standing CEPT policy of requiring relocation of all FS to bands above 3 GHz (see ECC Report 003) and much more the withdrawal of ERC/DEC/(99)08 for fixed links in the frequency range 2.1 to 2.6 GHz.

7 RADIO ASTRONOMY SERVICE IN THE BAND 1610.6-1613.8 MHz

The band 1610.6-1613.8 MHz is allocated to radio astronomy.

Generic case

The threshold levels detrimental to radioastronomy are given in Recommendation ITU-R RA.769 as a received power level of -220 dBW in 20 kHz not to be exceeded more than 2% of the time.

The generic e.i.r.p. limit required for the protection of radio-astronomy stations operating in the band 1610.6-1613.8 MHz from interference from CGC base stations that may operate in the 1610-1626.5 MHz is given by the following curve, assuming a flat terrain, 50 m for the RAS antenna height and 10 m for the CGC base station antenna height, and taking into account Recommendation ITU-R P.452-13.

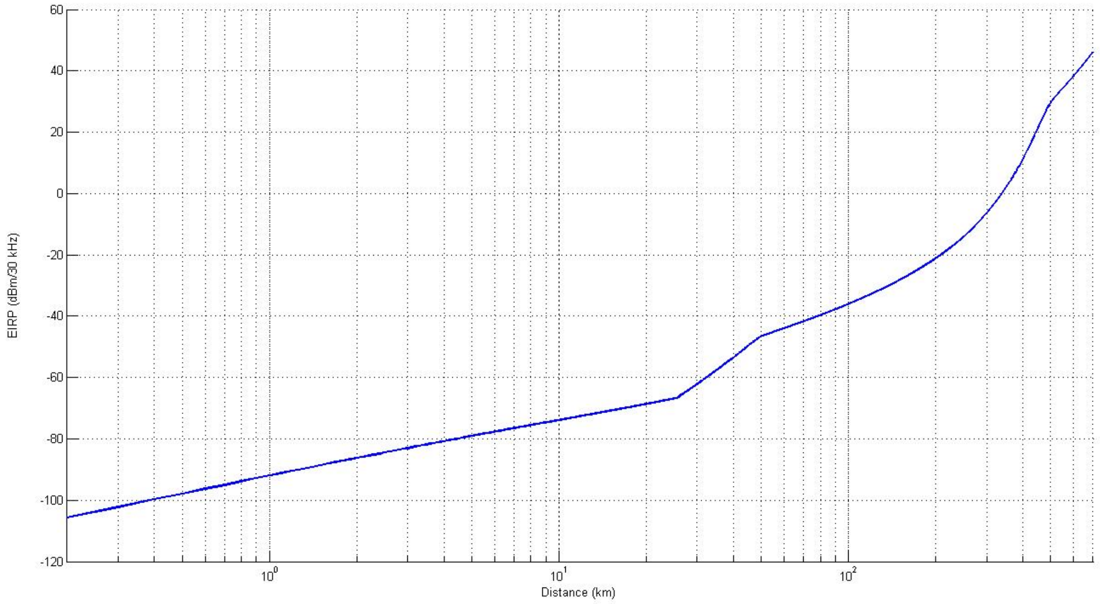

Figure 5: E.i.r.p. limit for CGC base stations function of the separation distance from the RAS

The separation distance for CGC base stations operating in the same band as the RAS, with an emission power from 26 to 43 dBm in 30 kHz and a maximum antenna gain of 18 dBi should be greater than 400 km. In view of the number of RAS stations performing (or trying to perform) observations in CEPT in this frequency range, the band 1610.6-1613.8 MHz should be avoided for the deployment of CGC.

The actual separation distance should be determined on a case by case basis taking into account in particular the terrain model.

Specific cases: Effelsberg and Westerbork

In order to determine the impact of terrain in the interference level experienced by RAS sites, evaluations were conducted for Effelsberg (Germany) and Westerbork (Netherlands).

The specific calculations were performed with a software tool, which is used for field strength predictions applying topological and morphological data. The calculations are based on the Propagation model Recommendation ITU-R P.452. The following assumptions for the calculations were used:

Table 14: Input parameters for the calculation

Assumptions	**Level**	**Unit**
Frequency	1612	MHz
Protection criterion RAS (According to Recommendation ITU-R RA.769)	-169 (35s integration time)*	dBW/MHz/m^2
Antenna height RAS Effelsberg	50	m
Antenna gain RAS Effelsberg	(see Figure 6)	dBi
Antenna height RAS Westerbork	20	M
Antenna gain RAS Westerbork	0	DBi
Unwanted emission power CGC BS **(e.i.r.p.)**	According to EN 301 441	dBW/30 kHz
Antenna Height CGC	10 / 40	m

*spfd correction for 35s integration time:

$$Gcorr := 5 \cdot \log\left(\frac{2000s}{35s}\right)$$

$$Gcorr = 8.785$$

Hence the Recommendation ITU-R RA.769 protection level of -238 dBW/m^2/Hz was adapted to -229 dBW/m^2/Hz = -169 dBW/m^2/MHz.

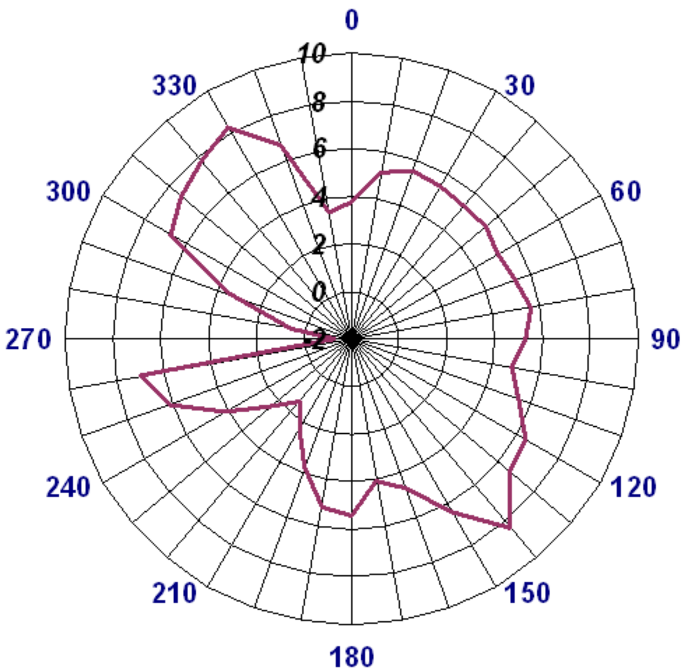

Figure 6: Effelsberg antenna gain as a function of the azimuth

The terrain corrected sidelobe gain of the Effelsberg antenna was used in the calculations.

Annex 1 shows the results of the simulations for the RAS station Effelsberg, Germany, and for Westerbork,

<u>Conclusions</u>

It seems to be appropriate to coordinate CGC base stations in the 1.6 GHz band on a case by case basis due to the differences in the terrain models around the affected radio telescopes. The RAS band 1610.6-1613.8 MHz should be avoided for the deployment of CGCs, because this would lead to separation distances of several hundred of kilometres. Simulations which are based on the propagation model Recommendation ITU-R P.452, using topological and morphological data, leading to the conclusion, that a minimum separation distance between a single CGC BS and the RAS station Effelsberg of about 30 km and to the RAS station Westerbork of about 50 km should be appropriate, under the assumption that the maximum unwanted emission level of the CGC BS is -56 dBW/30 kHz (e.i.r.p.) in the RAS frequency band and the CGC maximum antenna height is 10 m. It should be noted that the Recommendation ITU-R. RA.769 protection level for short integration times (35s) was applied. This means that the protection level of -238 dBW/m^2/Hz for spectroscopy was relaxed to -229 dBW/m^2/Hz in these simulations.

Aggregate effect of multiple CGC base stations

Simulations were conducted using the SEAMCAT software tool. The following assumptions were made:

Table 15: RAS victim receiver

Reception bandwidth	20	kHz
Tsys	22	K
Boltzmann constant	$1.38*10^{-23}$	J/K
Resulting Noise floor	-142	dBm
Protection level according to Recommendation ITU-R RA.769	-190	dBm/20kHz
Interference criterion (I/N)	-48	dB
Antenna gain	0	dBi
Antenna height	20 - 50	m (uniform distribution)
Operating frequency	1613.79	MHz

Table 16: Interfering transmitter

Operating frequencies	1616,3 – 1624.0	MHz (uniform distribution)
Channel spacing	5	MHz
Antenna height	10 – 40	m (uniform distribution)
Conducted power	20	dBm (constant)
Antenna gain	18	dBi (omni)
Emission mask	According to 3GPP TS 25.105 v9.1.0, Table 6.5	
Number of active transmitters	5	
Simulation radius	30 – 150 km scenario 1 100 km scenario 2	
Propagation model	Recommendation ITU-R P.1546 suburban (2%)	

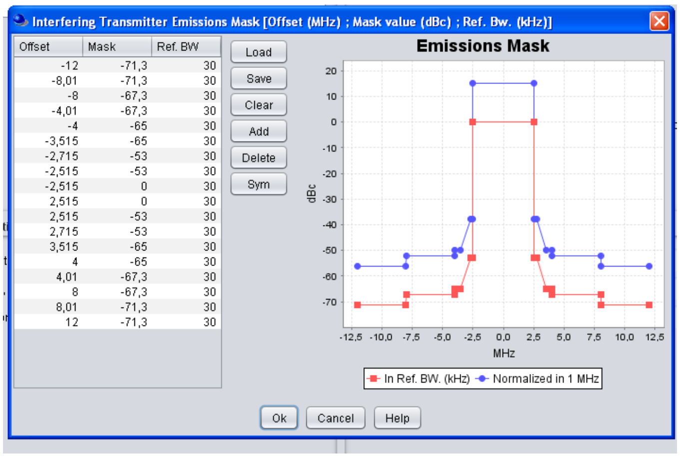

Figure 7: Unwanted emission mask for the transmitter from 3GPP TS 25.105 v9.1.0

The emission mask values of the technical specification 3GPP TS 25.105 v9.1.0, Table 15, and Table 16 were used in the simulations. According to this specification the values are valid for BS with an output power 31 ≤ P < 39 dBm. The levels between 4 and 12 MHz frequency offset were adapted to a reference bandwidth of 30 kHz.

Results

The corresponding figures are given in Annex 2.

Conclusions regarding the aggregate effect of multiple CGC base stations

Statistical simulations in relation to the aggregate effect of multiple interfering CGC stations using the SEAMCAT software tool were performed. Assuming an output power of 38 dBm e.i.r.p. of the CGC base stations and an emission mask according to the technical specification 3GPP TS 25.105 v9.1.0, there is an interference probability of nearly 60%, if five CGC base stations are located around the Earth station with a uniform distribution radius between 30 and 150 km. Expanding the protection zone to 100 km leads to a probability of still about 30% that the interference criterion will be exceeded.

A frequency separation between the RAS band and the frequency band used by CGCs and a reduction of the CGC base station power seems helpful to improve this situation. Alternatively, out-of-band filtering which improves upon the specification used in 3GPP TS 25.105 v9.1.0 might also improve the compatibility.

8 MOBILE SATELLITE SERVICE IN THE BANDS 1610-1626.5 AND 1626.5-1660 MHZ

The band above 1626.5 MHz is allocated on a primary basis to MSS (Earth to space). The services operating in this band might also use CGC this is the subject of studies within CEPT. It was established that compatibility issues of CGC between the adjacent use of NGSO and GSO MSS operators should generally be dealt with by means of coordination discussions between those operators.

However, CEPT has yet to consider the general studies relating to the possible effects of increased handset deployment on adjacent band MSS systems that might be necessary, before these discussions can take place. It was considered that since the actual density of MSS terminals was much lower than expected before the development of the unwanted emission masks for MSS terminals, no change to these masks would be necessary to accommodate the increase of terminals due to the operation of CGCs.

9 MOBILE (SAB/SAP AND ENG/OB) IN THE BAND 2483.5-2500 MHz

Broadcasters in several countries use the band 2483.5-2500 MHz for Services Ancillary to Broadcasting (SAB), Services Ancillary to Programme-making (SAP), Electronic News Gathering (ENG) and Outside Broadcasting (OB)[5]. This document looks at the issues raised by this application.

[5] According to EFIS, the band 2483.5 – 2500 MHz is used for SAB/SAP in Belgium, Cyprus, Italy, Lithuania, Netherlands, Portugal, Slovenia and the UK (EFIS contains the allocation status, whereas the mentioned ECC Report 002 on SAP/SAB looked into actual use through questionnaires, and concluded that this sub-band is not among typical uses for SAP/SAB).

9.1 Interference scenarios

The band 2483.5-2500 MHz is used for MSS downlink (space to Earth). In a CGC implementation, therefore, the band would normally be used by base-station transmitters. Typical SAP/SAB broadcast scenarios are given in ERC Report 038. These generally involve wireless cameras which can be hand-held, mounted on a vehicle or in some cases airborne. The signals from these cameras are received by a suitable receiver mounted on a tripod, vehicle, mast or other structure. In this study we will consider interference from CGC base stations to a multi-purpose receiver. Various types of receiving antenna are used. For this study we will consider scenarios involving four typical antennas specified in ERC Report 038:

- A handheld helix with a gain of 12 dB
- A disc yagi with a gain of 16 dB
- A 0.6 metre dish with a gain of 21 dB
- A 1.2 metre dish with a gain of 27 dB.

Recent discussions with operators of SAB/SAP equipment suggest that currently extensive use is made of omni-directional dipole receiving antennas. The analysis is, therefore, also performed for such a receiving antenna with a gain of 3 dBi.

Regarding the CGC base stations, two categories will be considered. The first of these is a higher power station typically used in rural and some urban environments. Such stations generally have an e.i.r.p of around 30 dBW[6] and serve an area with a radius in the order of 4 km, often referred to as a macro cell. The second category is a lower power station typically used in dense urban areas. Such stations generally have an e.i.r.p of around 13 dBW and serve an area with a radius in the order of 0.5 km, often referred to as a micro cell.

9.2 Interference analysis

Table 17 and Table 18 show calculations of the required protection distance between a CGC transmitting base station and a multi-purpose receiver. The calculation is based on an I/N ratio of -10dB and has been performed for the four antenna types above for two conditions:

a) The CGC base station in the direction of the main beam of the receiving antenna

b) The CGC base station in the direction of the deepest null of the receiving antenna

The SAB/SAP receiver noise is based on the characteristics given in ERC Report 038, but assuming a bandwidth of 8 MHz in line with a standard DVB-T channel. Table 17 is based on the parameters of a CGC base station configured as a typical Macro-cell base station and Table 18 is based on the parameters of a typical CGC Micro-cell base station.

[6] one MSS operator specifies a maximum E.I.R.P. of 32 dBW.

Table 17: Calculation of interference into SAB/SAP from CGC macro cell base station

Antenna type	Omni Antenna	Hand-held helix	Disk yagi	0.6 metre dish	1.2 metre dish
Peak Gain (dBi)	3	12	16	21	27
Front-to-null ratio (dB)[7]	0	-30	-30	-30	-35
Minimum absolute gain (dB)	3	-18	-14	-9	-8
Frequency (MHz)	2500				
Boltzmanns Constant (dB)	-228.6				
Receiver noise temp (dBk)	32.0				
Bandwidth (dB Hz)	69.0 (8 MHz)				
Receiver noise (dBW)	-127.6				
I/N (dB)	-10.0				
Maximum interference (dBW)	-137.6				
CGC transmit power (dBW)	13				
CGC antenna gain (dB)	17				
CGC e.i.r.p. (dBW)	30				
Base station antenna height (m)	20				
Min Path Loss for base station on boresight (dB)	**170.6**	**179.6**	**183.6**	**188.6**	**194.6**
Path Length (Rec. M.1225) (km)	3.1	5.2	6.6	8.7	12.3
Path Length (Rec P.1546) (km)	20.9	30.4	36.0	44.6	58.5
Min Path Loss for base station on null(dB)	**170.6**	**149.6**	**153.6**	**158.6**	**159.6**
Path Length (Rec M.1225) (km)	3.1	0.93	1.17	1.55	1.65
Path Length (Rec P.1546) (km)	20.9	8.70	10.30	12.70	13.20

Table 18: Calculation of interference into SAB/SAP from CGC micro base station

Antenna type	Omni Antenna	Hand-held helix	Disk yagi	0.6 metre dish	1.2 metre dish
Peak Gain (dBi)	3	12	16	21	27
Front-to-null (dB)	0	-30	-30	-30	-35
Minimum absolute gain (dB)	3	-18	-14	-9	-8
Frequency (MHz)	2500				
Boltzmanns Constant (dB)	-228.6 (8MHz)				
Receiver noise temp (dBk)	32.0				
Bandwidth (dBHz)	69.0				
Receiver noise (dBW)	-127.6				
I/N (dB)	-10.0				
Maximum interference (dBW)	-137.6				
CGC transmit power (dBW)	8				
CGC antenna gain (dB)	5				
CGC e.i.r.p. (dBW)	13				
Base station antenna height (m)	10				
Min Path Loss for base station on antenna boresight (dB)	**153.6**	**162.6**	**166.6**	**171.6**	**177.6**
Path Length (Rec M.1225) (km)	1.2	2.0	2.5	3.3	4.6
Path Length (Rec P.1546) (km)	7.7	11.2	13.2	16.2	20.9
Min Path Loss for base station in null(dB)	**153.6**	**132.6**	**136.6**	**141.6**	**142.6**
Path Length (Rec M.1225) (km)	1.2	0.35	0.44	0.58	0.62
Path Length (Rec P.1546) (km)	7.7	3.00	3.70	4.60	4.80

[7] This represents the deepest null in the antenna pattern.

Generally, the interference path is from a CGC transmitting antenna at a nominal height of 10 - 20 metres to a SAB/SAP receiving antenna which could be at a typical height of 10 metres. This is within the range of applicability of Recommendation ITU-R P.1546 which we believe to be a realistic model in most. Since we assume a receiving antenna height of 10 metres it can be used without any height gain correction. In some situations, however, where deployment is in dense urban areas and the SAB/SAP antenna is at a low height (e.g. a manually tracked tripod mounted antenna) Recommendation ITU-R M.1225 may be appropriate. If an I/N ratio of –6dB is used instead of –10 dB, then the separation distances would reduce slightly.

The distance to protect SAP SAB against a CGC Macro and Micro cell base stations generally exceeds the typical cell radius for all SAB/SAP receiving antenna types for both macro and micro cell CGC base stations. In situations where Recommendation ITU-R P.1546 is applicable, the protection radius is large. It is considered most unlikely that even the most careful positioning of the receiver could avoid a nearby CGC base station; given the need for the receiver to track the motion of the transmitting camera and that, it would be in the main beam for some of the time. Moreover, the use of omni-directional antenna would further limit the ability to avoid interference from the base stations.

9.3 Conclusions

From the above analysis, it appears that the presence of CGC base stations operating in the band 2483.5-2500 MHz could significantly restrict its usability for Services Ancillary to Broadcasting (SAB), Services Ancillary to Programme-making (SAP), Electronic News Gathering (ENG) and Outside Broadcasting (OB).

The introduction of CGC into this band in countries using it for SAP/SAB would severely limit the use of the band for these broadcasting applications in those countries (4 of the 48 CEPT countries). It is likely that the operation of CGC base stations would permanently remove the ability of SAB/SAP systems to operate in the area concerned. These SAP/SAB systems are deployed on an ad-hoc basis, and their locations are largely unknown. Consequently, it would not be possible for CGC operators to coordinate with SAB/SAP in such cases.

10 RADIO DETERMINATION SATELLITE SERVICE IN THE BAND 2483.5-2500 MHz

10.1 Interference analysis

The band 2483.5-2500 MHz is allocated for MSS downlink (space to Earth). In a CGC implementation, therefore, CGC base-stations would normally transmit in this band. The base stations considered assume a typical antenna height of 30 metres for a macro cell and 10 metres for a micro cell. e.i.r.p. values are 30 and 13 dBW respectively. The CGC transmissions are assumed to occupy a bandwidth of 1.25 MHz.

The interference analysis considers interference to a general purpose RNSS receiver in a mobile or handheld application at a height of about 1.5 metres above ground level. The maximum interference value will be in accordance with the figure for a General Purpose GNSS receiver given in the developing ITU-R recommendations. Strictly this value is only appropriate for the band 1559-1610 MHz. However, in the absence of information relating to systems operating in the band under consideration, we have used the value given in this document.

The analysis is based on propagation model Recommendation ITU-R P.1546-3. This model provides path loss predictions to a height of 10 metres above ground level. It then provides a correction factor for the assumed RDSS receiver height of 1.5 metres.

Table 19 presents the calculation of the separation distance required to protect the RDSS receiver from typical CGC Macro and Micro base stations.

Table 19: Calculation of protection distances CGC base stations to general purpose RNSS receivers in the 2.4 GHz band

Technical parameter	CGC Macro base station	CGC Micro base station
Frequency (MHz)	2500	2500
Antenna height (m)	30	10
CGC e.i.r.p. (dBW/1.25MHz)	30.0	13.0
Maximum RNSS interference at antenna output (dBW/1MHz)	-146.0	-146.0
RNSS antenna gain (dB)	0.0	0.0
Maximum isotropic RNSS interference (dBW/1MHz)	-146.0	-146.0
Bandwidth Correction (dB)	1.0	1.0
Propagation loss (dB)	175.0	158.0
Recommendation ITU-R P.1546 height correction 10 - 1.5 metres	-20.0	-20.0
Path loss to 10 metres	155.0	138.0
Separation distance – Recommendation ITU-R P.1546 (km)	**13.0**	**3.9**

10.2 Conclusions

From the results, it is clear that the distance needed to protect RNSS receivers from interference from CGC base stations exceeds the typical cell radius[8] in the case of both macro and micro cell base stations. It is likely; therefore, that operation of RNSS receivers in the RDSS band 2483.5-2500 MHz would not be compatible with CGC networks deployed as part of an MSS.

11 IMT ABOVE 2500 MHz

In this chapter, only the scenario of interference from CGC BS to IMT FDD BS is considered, which is considered as the worst case scenario. The other scenarios between CGC BS/terminals and IMT TDD BS/UE are not analyzed. With the unwanted emission characteristics assumed in section 3.2.1, it is considered that the limiting factor of interference from CGC BS to IMT BS is the IMT BS receiver selectivity. The following interference analysis is focused on the IMT BS desensitisation due to CGC in-band transmissions.

FDD CGC are described in section 3 with CGC BS Tx power 32 dBW and antenna gain 19 dBi. However, in the following analyses, a 17 dBi antenna gain is used for CGC base stations.

The CGC network deployment is defined in section 3.2.1 and is assumed to be similar to that used for PCS and broadband wireless systems, coverage will be provided by macro base stations whereas traffic hotspots may be served by micro and/or pico cells. For the co-existence study between CGC (BS emission) operating in 2483.5-2500 MHz and IMT operating above 2500 MHz , two different scenarios are considered in the interference analysis between CGC BS and IMT BS:

1) CGC is deployed as macro cellular network with multiple CGC base stations in the same geographical area with IMT
2) Co-existence between an individuel CGC base station and a single IMT BS

11.1 Interference analysis between IMT and CGC BS in macrocellular deployment scenario

The BEM defined in CEPT Report 19 to ensure compatibility between ECN BS has an out-of-block (baseline) e.i.r.p. level of -45 dBm/MHz over all frequencies of the 2.6 GHz band except frequencies allocated to FDD down link and ± 5 MHz outside the range of frequency blocks allocated to FDD down link. In addition, there is a 5 MHz transition (‘restricted’) block between one TDD operator and another TDD or FDD operator. This transition block is supposed to be taken from the TDD blocks.

Adjacent CGC operator must complies with certain baseline levels over the IMT BS receiver frequencies. A guard band could also be introduced (taken within the CGC spectrum below 2500 MHz) if the CGC spectrum emission mask is not able to reach

[8] Typical base station cell radii from ETSI Report TR 125 942 are 4km for a macro cell in a rural area, 1.5 km for a macro cell in an urban area and 0.5 km for a micro cell.

the baseline level without guard band. It would be difficult to share the guard band between MSS and IMT. The frequency band 2483.5-2500 MHz is allocated to MSS. CGC is a new concept developed as a terrestrial network component for improving the MSS indoor coverage. The utilisation of the frequency band 2483.5-2500 MHz band by CGC should ensure that CGC base stations will not cause degradation in performance to the networks which would be deployed above 2500 MHz. The band plan of the 2500-2690 MHz band allocated to IMT systems has been defined by ECC in ECC/DEC/ (05)05 and by the EC in EC Decision 2008/477/EC and does not include a guard band.

As stated in CEPT Report 19, the BEM baseline provides a minimum protection of IMT BS reception against the out of band emission from CGC for a separation distance between CGC and IMT BS more than 100 m. the cell sizes of IMT and CGC operating around 2.5 GHz will be typically several hundreds of meters, and the deployment between IMT and CGC operators may or may not be coordinated. Therefore, there is probability that some CGC and IMT BS separation distances will be less than 100 m, in this case, the BEM baseline level of -45 dBm/MHz might not be sufficient, additional isolation is needed for the protection of IMT BS uplink reception, this additional requirement must be taken into account in the deployment of CGC which comes after the initial deployment of IMT network in 2500-2690 MHz and would be for the national administrations, to take into account knowing their use of the bands.

The protection of IMT BS reception by considering the receiver ACS and in-band blocking characteristics needs also to be taken into account.

The LTE wide area BS ACS and In-band blocking characteristics defined in 3GPP TS36.104[4] are summarized in Table 20.

Table 20: LTE BS ACS and In-band blocking levels

Interferer frequency range	ACS/in-band Blocking (dBm)	BS Rx Desense (dB)
2495-2500 MHz	-52	6
2480-2495 MHz	-43	6
Below 2480 MHz	-15	6

Below 2480 MHz, the ACS/in-band Blocking value is of -15 dBm. Therefore, the in-band blocking can be expected to increase from -43 to -15 dBm when the frequency decreases from 2495 MHz to 2480 MHz. The 6 dB Rx desense levels are however used only for laboratory tests. For actual IMT deployment, 1 dB desense levels should be considered.

For 1 dB BS receiver desensitisation, the required protection levels for IMT macro cellular BS (wide area) are:

Over the frequency range 2495-2500 MHz: -62.5 dBm

Over the frequency range 2480-2495 MHz: -53.5 dBm.

Under the assumption of 100 meters separation between CGC BS and IMT BS, the MCL (Minimum Coupling Loss) is MCL = (3 -17) +32.4+20*log10(2500)+20*log10(100/1000)+(3-17) =52 dB.

This consideration leads to the conclusion that the LTE BS specified blocking level would be exceeded if the CGC BS transmit more than:

-62.5 dBm+52 = -10.5 dBm over the frequency range of 2495-2500 MHz

-53.5 dBm+52 =-1.5 dBm over the frequency range of 2480-2495 MHz.

A restriction of CGC operations to the band 2483.5-2495 MHz would improve the compatibility situation between CGC base stations and IMT base stations. However, the above analysis suggests that the transmit e.i.r.p. of the CGC base stations in the 2480 to 2495 MHz band should be limited to 15.5 dBm (-1.5 dBm + 17 dB), which would effectively preclude the implementation of a CGC network.

In the above analysis, only CGC macro cellular deployment scenario is considered, based on the co-existence condition used in CEPT Report 19 (100 m separation distance between CGC transmitter and IMT BS).

11.2 Interference analysis between an individual IMT BS and a single CGC micro BS

CGC macro BS e.i.r.p. was assumed as 32 dBW with 19 dBi BS antenna gain (BS antenna height at 30 m) in section 3 and 30 dBW in this section, CGC micro BS e.i.r.p. was assumed as 13 dBW in this section (BS antenna height at 10 m).

The ACS and blocking levels are dependent on the BS classes (Wide Area BS for macro cellular deployment, Local area BS for micro/pico cellular deployment, Home BS for femtocellular deployment). The 1 dB desense ACS requirements are shown in Table 21 below.

Table 21: ACS Requirements with 1 dB desense level

Interferer frequency range	ACS/in-band Blocking (dBm) (Adjacent Wide area BS Receiver)	ACS/in-band Blocking (dBm) (Adjacent Local BS Receiver)	ACS/in-band Blocking (dBm) (Adjacent Home BS Receiver)	BS Rx Desense (dB)
2495-2500 MHz	-62.5	-54.5	-55.8	1
2480-2495 MHz	-53.5	-45.5	-46.6	1

The analyses presented in Figure 8 and Figure 9 below are based on the full Recommendation ITU-R F.1336 antenna model and assume a 5 deg vertical beamwidth and 17 dBi antenna gain. Also, using the microcellular e.i.r.p. as macrocellular deployment assumptions, the analyses in Figure 8 and Figure 9 below are based on a CGC base station e.i.r.p. of 13 dBW. On this basis the minimum coupling loss requirements are shown in Table 22 below.

Table 22: Minimum coupling loss required from CGC transmitter with 13 dBW e.i.r.p.

Interferer frequency range and Tx e.i.r.p. = 13 dBW	Minimum Coupling loss to meet ACS reqt in Table 21 (Adjacent Wide area BS Receiver)	Minimum Coupling loss to meet ACS reqt in Table 21 (Adjacent Local BS Receiver)	Minimum Coupling loss to meet ACS reqt in Table 21 (Adjacent Home BS Receiver)	BS Rx Desense (dB)
2495-2500 MHz	88.5	80.5	81.8	1
2480-2495 MHz	79.5	71.5	72.6	1

The analysis presented in the section 11.1 assumes 100 m separation between the CGC and IMT base stations, whereas the analyses presented in Figure 8 and Figure 9 below consider separation distances of up to 1 km and up to 5° or more antenna down tilt as assumption. The analyses in Figure 8 and Figure 9 below illustrate the effect of these differences. For example, for a CGC and IMT antenna tilt of 2.5 degrees, it is necessary to have 1000 m horizontal and 87 m vertical separation to an IMT wide area base station, and 300 m plus 29 m vertical separation to an IMT local area base station.

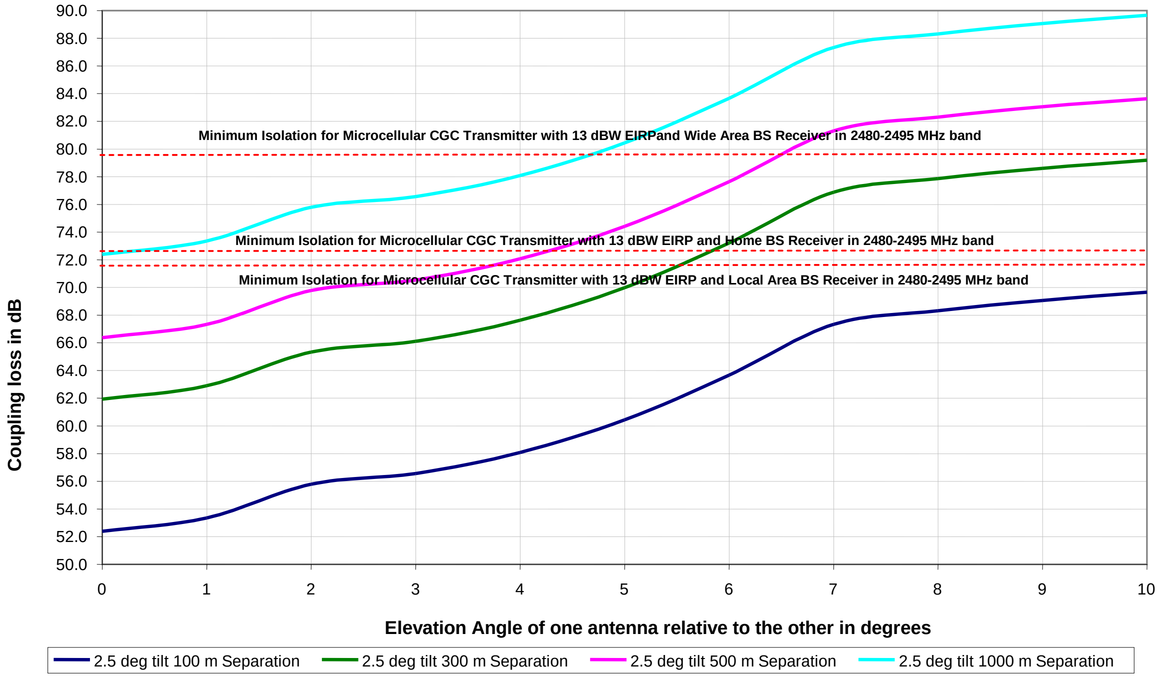

Figure 8: Coupling loss between CGC and IMT receiver as a function of antenna down tilt (2.5 deg), antenna separation and angle of elevation relative to each other

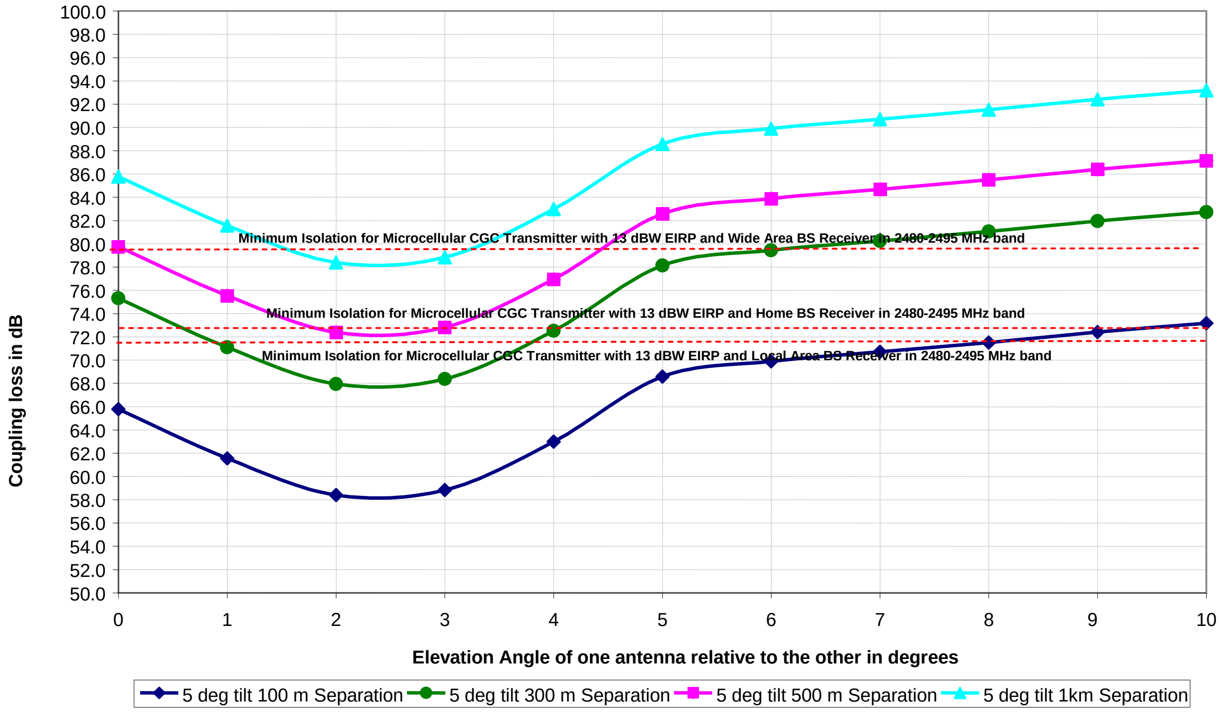

Figure 9: Coupling loss between CGC and IMT receiver as a function of antenna down tilt (5 deg), antenna separation and angle of elevation relative to each other

The combination of antenna down tilt angle and separation distance could improve the situation in some circumstances between a single victim IMT BS and CGC BS.

One of the factors identified in the analysis for enhancing the MCL is the angular separation between the CGC and IMT base station antennas. It is recognised that on a flat terrain, in particular in an urban environment, it is difficult to achieve the necessary height difference between antennas to create the larger angular separations identified in the analysis.

However, this situation could be enhanced by natural features of the terrain, e.g. steep slopes, and may be more easily achievable in sub-urban and rural areas. It is therefore a factor that might be deployable in certain specific circumstances. However, the calculation in Figure 8 and Figure 9 take into account only one single CGC base station with the assumption of CGC micro BS e.i.r.p. of 13 dBW for macro cellular deployment and one single IMT base station. It was also supposed IMT local area BS and Home BS are using 17 dBi antennas which is a worst case assumption.

If we now assumed a IMT network in a cellular grid using different site-site distances, 200 m, 400 m and 2 km. We also assume that all IMT base stations have same antenna height and place one CGC BS in the middle of the cellular grid so that a maximum separation distance is achieved with the closest IMT BS. Figure 9, Figure 10, Figure 11 and Figure 12 shows the MCL situation for the 3 different IMT networks. The x-axis value has been changed to difference in antenna height instead of elevation angle difference because different IMT base stations will experience different elevation angles due to the different distance to the CGC node.

When comparing the three figures is it clear that for large IMT cells (rural scenario) is it sufficient to coordinate a CGC base station with the closest IMT base station while for smaller IMT cell sizes (urban scenario) might any of the four studied IMT base stations be the one that needs to be coordinated. As an example for the 200 m IMT grid; an antenna height difference between 0-12 m and >39 m is the closest IMT BS most affected, for a height difference between 12-19 m is the second closest IMT BS most affected, for a height difference between 19-25 m is the third closest IMT BS most affected and between 25-39 m height difference is the fourth closest IMT BS the one that needs to be coordinated with.

This leads to a very complex coordination situation. If also the real network situation, with difference in IMT BS antenna heights, difference in site to site distance and the differently used antenna tilts, were to be included will the situation be extremely difficult to handle. E.g. a re-trimming of a single IMT BS node may totally change the coordination conditions. A CGC network with several nodes would further complicate the situation.

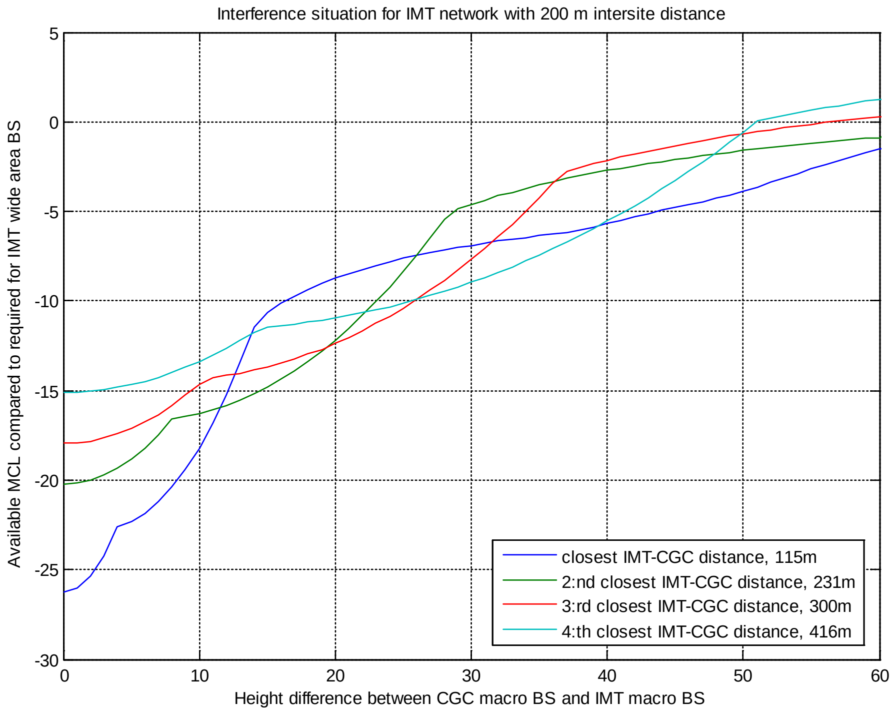

Figure 10: IMT network with 200 m site to site distance

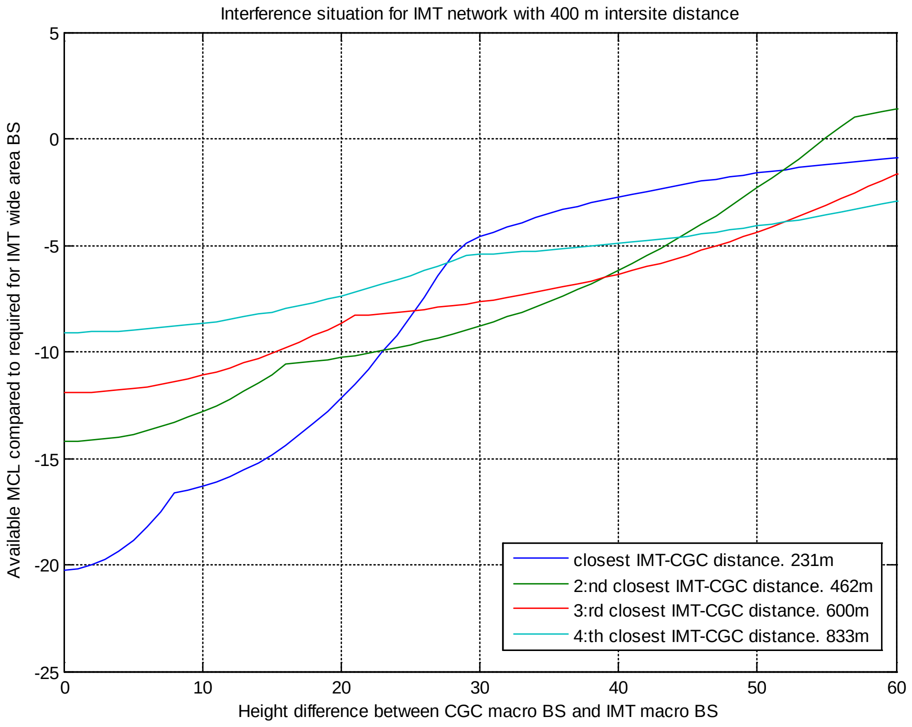

Figure 11: IMT network with 400 m site to site distance

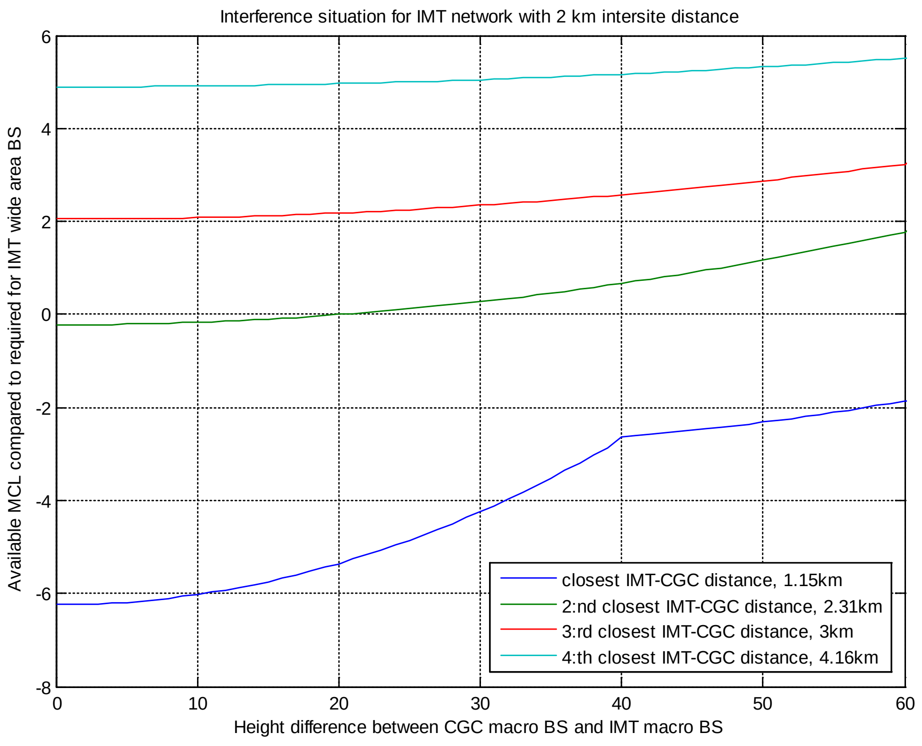

Figure 12: IMT network with 2 km site to site distance

There are other factors or situations that could reduce the interference levels in some specific cases:

Base Station Receive Antenna Gain

The analysis above is based on the IMT macro cellular base station configuration employing a receive antenna gain of 17 dBi. In those cases where medium range or local area base stations are deployed as microcells or picocells, i.e. no IMT base stations deployed above rooftop, the receive antenna gain may be down to as low as 5 dB as illustrated in Table 23 below. This could increase the MCL by up to 12 dB or even more for local or Home BS configurations. To create local coverage for these scenarios small intersite distances of IMT base stations is required. This will to some extend reduce the mitigation from antenna gain due to shorter distance between CGC and IMT. It should also be highlighted that an IMT network will never be limited to only microcells or picocells configurations.

Table 23: Antenna gain assumptions for various deployment configurations

Cell type	Cell radius	Typical position of base station antenna	Base Station Receive Gain
Micro-cell (LTE Medium Area BS)	0.05 to 0.5 km	Outdoor; mounted below average roof-top level	5 dBi[9]
Pico-cell (LTE Local Area BS)[10]	Up to 50 m	Indoor or outdoor (mounted below roof-top level)	5 dBi or less
Femto-cell(LTE Home BS) [11]	Up to 50 m	Indoor (mounted below roof-top level)	0 dBi [3]

It is however noted that Base Stations with smaller Rx antenna gain as given in the above table will exhibit different antenna patterns that may lead to different results, and will benefit from limited angular discrimination from a CGC interfering station.

Frequency separation

The analysis above is based on a guard band separation of 5 MHz, between 2495 MHz and 2500 MHz. The CGC base stations will be deployed within the range of 2483.5 MHz and 2495 MHz. Therefore, there is the potential for actual frequency separation to be greater than the 5 MHz "guard band" used in the analysis.

As stated earlier in this section, the in-band blocking level for Wide Area BS receivers can be expected to increase from -43 dBm to -15 dBm when the frequency decreases from 2495 MHz to 2480 MHz. The MCL requirement decreases accordingly. However it is not known in detail how this inband blocking level will increase and the above values should be used with caution.

Propagation Loss

The analysis above assumes free space loss which represents the case between macro cellular CGC BS and macro cellular IMT BS where both antennas are installed above the rooftop in urban area and on mast in rural area where they are in line of sight. For the case between CGC macro cellular BS and IMT micro/pico BS in urban areas, for separation distances of more than about 100 meters there will inevitably be obstructions which will reduce the coupling factor between the CGC and IMT base stations. While the incidence of obstructions may be less for sub-urban and rural environments, the greater separation distances facilitate the opportunity for obstructions to be present in the transmission path. Such situations can only be identified with certainty and accuracy at the time of developing a definitive deployment plan, but it is also likely that the IMT network including those micro/pico BS may also include macro BS in line of sight for which free space loss will apply.

As an example, Recommendation ITU-R M.2146 [9] discusses the recommendation on the propagation model for a base station to base station urban environment in § 2.1 of Annex 1 based on Recommendation ITU-R P.1411-5 [10].

12 CONCLUSIONS

The compatibility between CGC (MSS Complementary Ground Component) is operating in the bands 1610-1626.5 MHz and 2483.5-2500 MHz and systems operating in the same bands and in adjacent bands have been studied.

The band 1610-1626.5 MHz is used by MSS/CGC associated with CDMA MSS systems for uplink (the terminal transmits, the satellite or CGC base station receives): the potential interference to victim systems comes mainly from MSS/CGC terminal emissions and out of band emissions. However, part of this band can also be used by CGC associated with TDMA MSS systems for downlink. In this case, the potential interference to victim systems could also come from CGC base stations.

[9] § 2 in [12] and Cell configurations described in [13]
[10] Local Area Base Stations are characterised by requirements derived from Pico Cell scenarios as described in §4.2 [11].
[11] Home Base Stations are characterised by requirements derived from Femto Cell scenarios as described in §4.2 [11].

The band 2483.5-2500 MHz is used by MSS/CGC associated with CDMA MSS systems only for downlink: the satellite or CGC BS transmits and the terminal receives. The potential interference is from CGC BS emission and out of band emission to IMT reception above 2500 MHz.

Interference simulations and analysis lead to the following conclusions:

For the band 1610-1626.5 MHz:

1) Based on the assumptions for RNSS and CGC operations, the compatibility between a CGC terminal and RNSS receiver around 1.6 GHz may require large separation distances between CGC transmitters and RNSS receivers to ensure the protection of RNSS equipment. The aggregate impact of CGC devices was not studied, but would give rise to increased separation distances in some cases such as multiple line-of-sight paths. However, in urban environments the aggregate impact may be mitigated by significantly increased propagation losses compared to free-space.

2) The band 1610.6-1613.8 MHz is allocated to radio astronomy service (RAS), the interference analysis with prediction and statistical simulations between CGC and RAS as indicated in Section 8 above show that because of the differences in the terrain models around the affected radio telescopes, CGC base stations in the 1.6 GHz band should be coordinated on a case by case basis with RAS Earth stations (including across borders). Deployment of CGCs in the RAS band 1610.6-1613.8 MHz would lead to the need for separation distances of several hundred of kilometres and should be avoided. Frequency separation between the RAS and CGCs and a possible reduction in the CGC base station power might be helpful for the protection of the RAS in some cases. Alternatively, reduction of unwanted emission with appropriate filtering can also improve the compatibility.

3) It was considered that since the actual density of MSS terminals was much lower than expected before the development of the unwanted emission masks for MSS terminals, no change to these masks would be necessary to accommodate the increase of terminals due to the operation of CGCs.

For the frequency band 2483.5-2500 MHz:

4) Compatibility between CGC BS operating in the band 2483.5-2500 MHz and IMT above 2500 MHz is difficult, deploying CGC BS as cellular network layout is not possible based on the co-existence conditions from CEPT Report 19:

   - The main interference mechanism is the IMT BS adjacent band selectivity and blocking, in order to protect IMT uplink reception above 2500 MHz, CGC BS transmit power at the BS output should be limited to -10.5 dBm in the frequency range 2495-2500 MHz with a 100 m separation distance, in a macrocellular environment. Since this is not feasible, a restriction of CGC operations to the band 2483.5-2495 MHz is therefore required.
   - The analysis shows that in the general case, the transmit EIRP of the CGC base stations in the 2480 to 2495 MHz band should be limited to 15.5 dBm, which would effectively preclude the implementation of a CGC macro cellular network in areas with macro cellular IMT networks.
   - In some circumstances (e.g. between a single CGC BS with an EIRP of 13 dBW and a single IMT BS), it may be possible to mitigate the interference by leveraging on several factors: space/angle isolation between the CGC BS antenna and IMT BS antenna (provided that the physical separation, horizontally and vertically, is sufficient), frequency separation between closely located CGC BS and IMT, increased propagation losses and lower IMT BS gains in certain environments. However, considering that IMT network is deployed as cellular layout, the coordination would remain difficult.

5) Some administrations already deploy terrestrial services operating in the band 2483.5-2500 MHz, for example, hand-held radio cameras and the associated broadcast auxiliary services used for video programme making and video transmission (SAB/SAP), and these services have successfully operated in this band for many years without interference from MSS downlink signals. However, if CGC base stations are deployed within the countries that deploy SAB/SAP in these bands (4 of the 48 CEPT countries), then as described in Section 10 this will place significant constraints on the SAB/SAP to the extent that they may become unusable, even though such systems are generally deployed on an occasional basis with a very low deployment density. This situation will not exist in the majority of CEPT countries where these SAB/SAP services are not deployed in this band.

6) Interference analysis between CGC base stations and RDSS show that the distance needed to protect RNSS receivers used under the RDSS allocation against interference from CGC base stations exceeds the typical cell radius in the case of both macro and micro cell base stations. It is concluded therefore, that RDSS systems and CGC networks will not be compatible in the band 2483.5-2500 MHz.

As a general conclusion, and according to the above results, the introduction of CGC in the MSS bands of 1610-1626.5 MHz and 2483.5-2500 MHz is not compatible with the systems in the same band such as RDSS or SAP/SAB where these systems are deployed, and would be very difficult with some systems deployed in adjacent band such as RNSS or IMT. In addition, the deployment of CGC shall be avoided in the RAS band 1610.6-1613.8 MHz.

ANNEX 1 : RESULTS OF SIMULATIONS FOR PARTICULAR RAS STATIONS

Figure **13** to Figure 18 show the results of the simulations for the RAS station Effelsberg, Germany, for different unwanted emission levels and 40 m and 10 m antenna height of the CGC Base station.

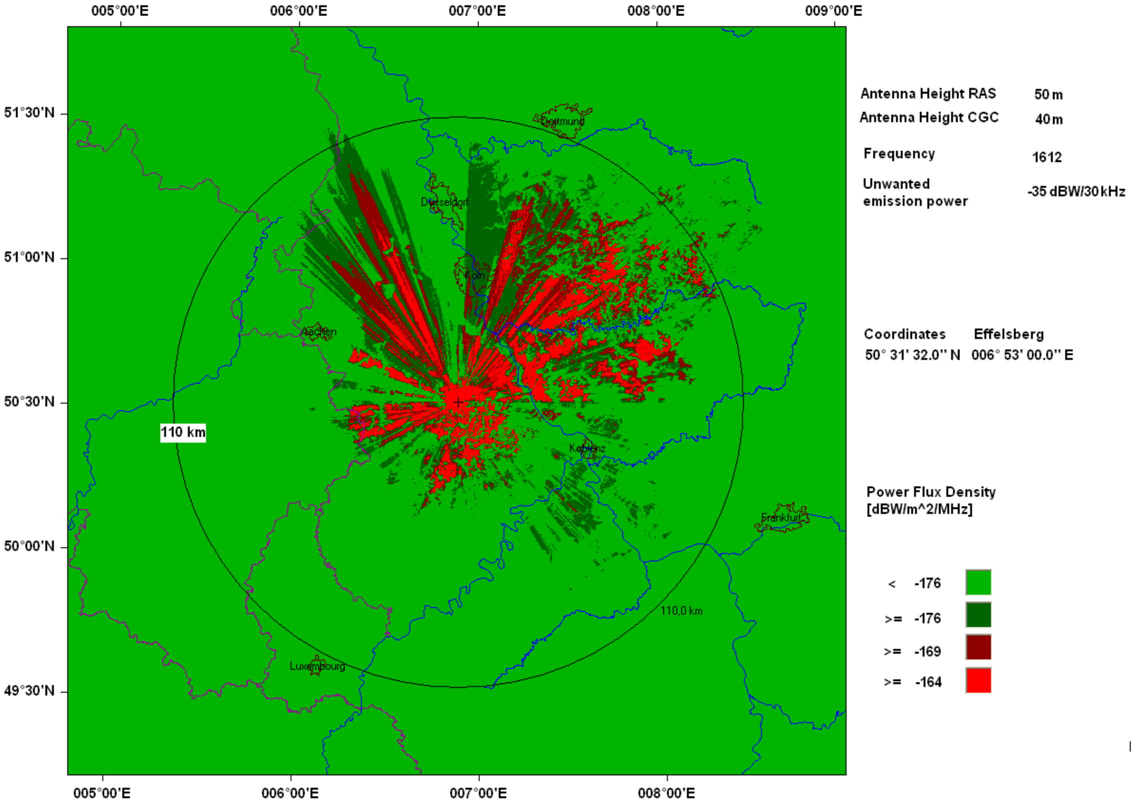

Figure 13: CGC antenna height 40 m, -35 dBW/30 kHz (e.i.r.p.) unwanted emission power

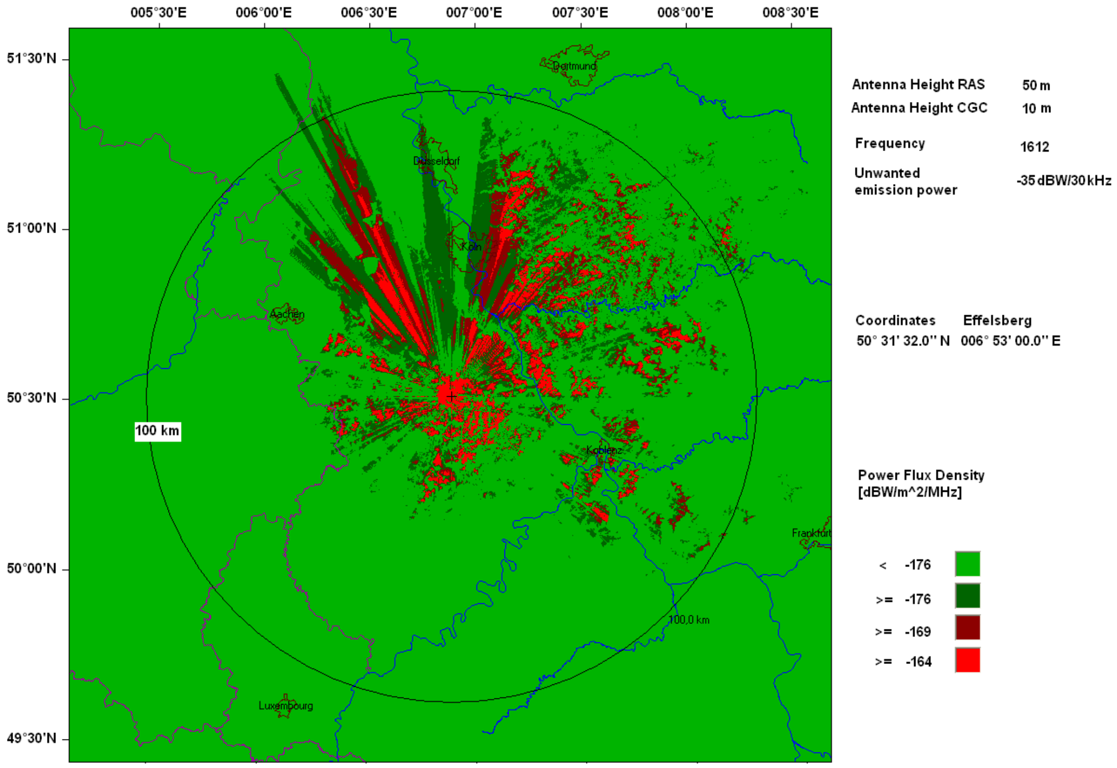

Figure 14: CGC antenna height 10 m, -35 dBW/30 kHz (e.i.r.p.) unwanted emission power

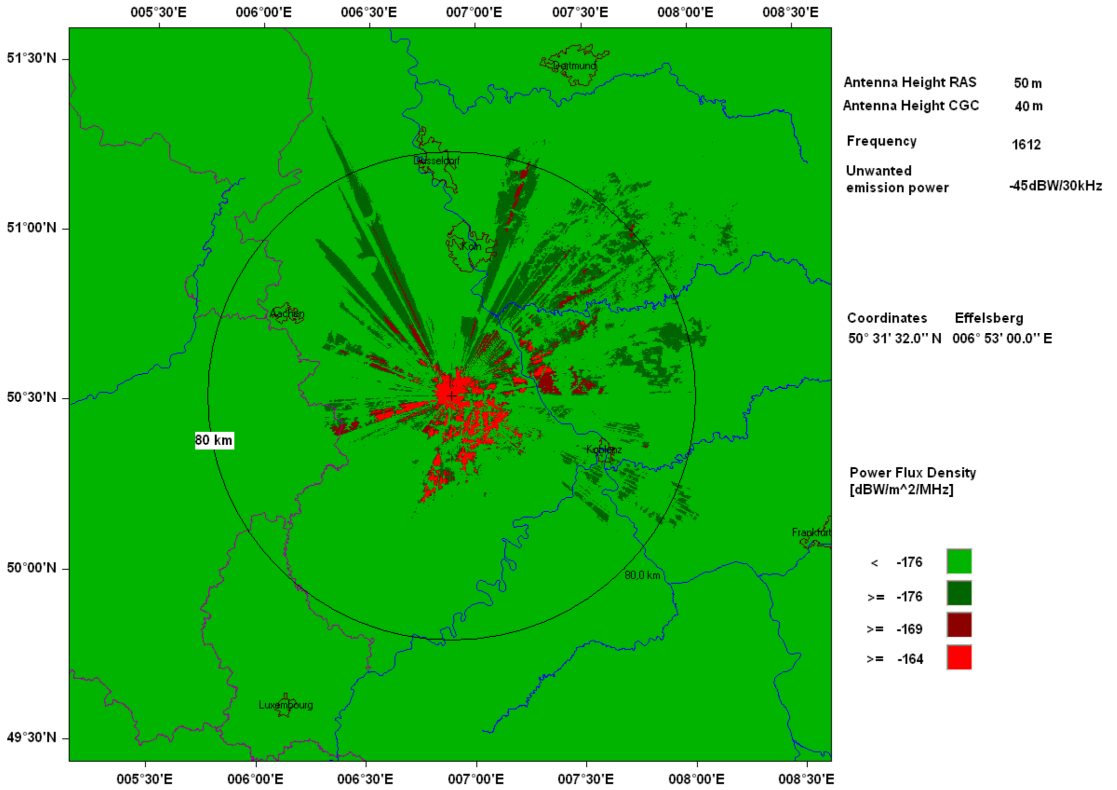

Figure 15: CGC antenna height 40 m, -45 dBW/30 kHz (e.i.r.p.) unwanted emission power

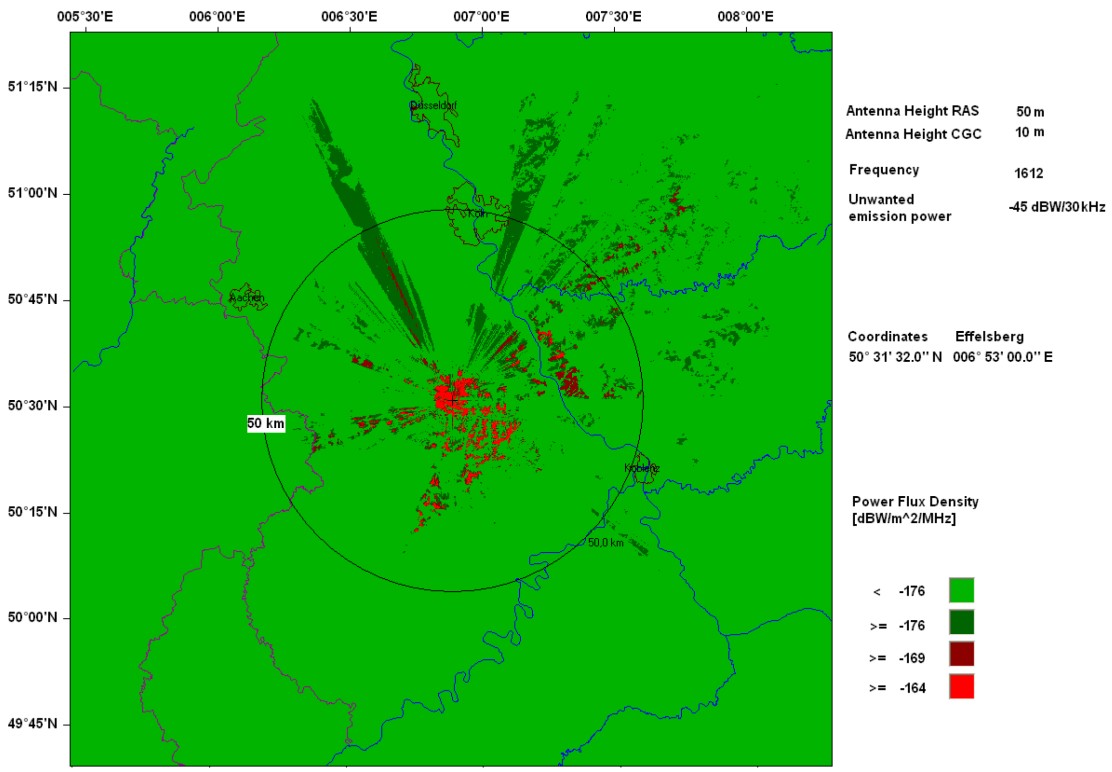

Figure 16: CGC antenna height 10 m, -45 dBW/30 kHz (e.i.r.p.) unwanted emission power

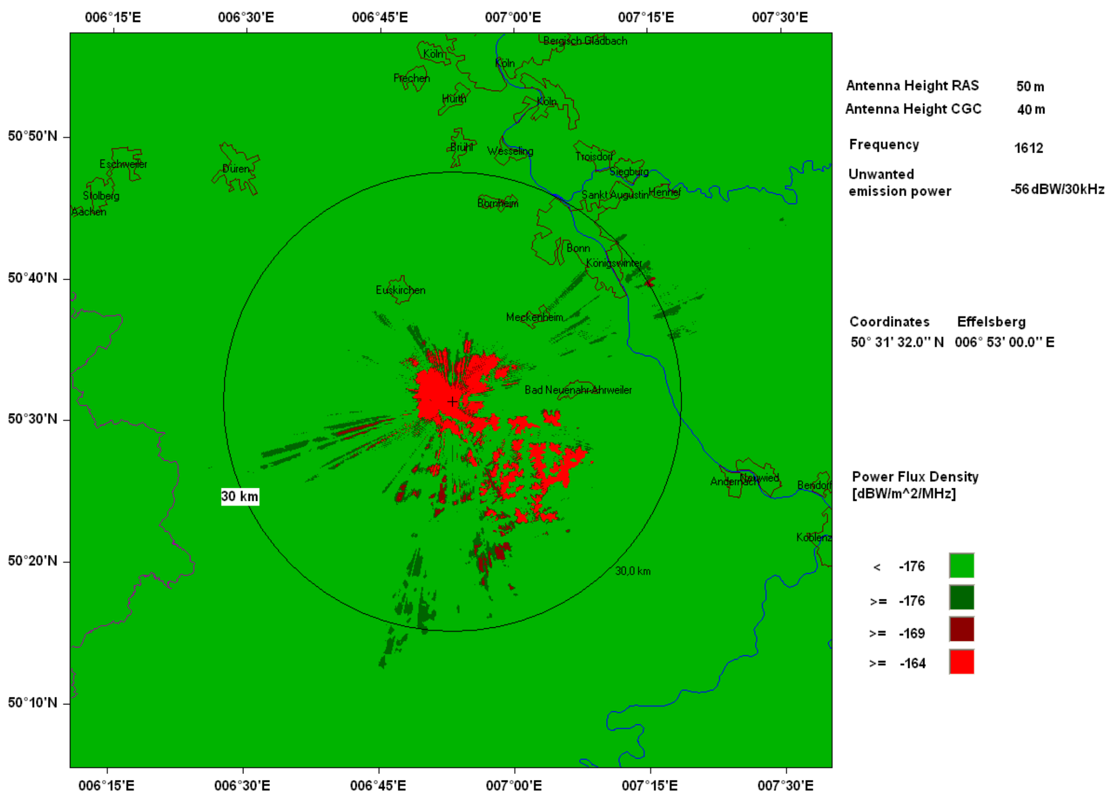

Figure 17: CGC antenna height 40 m, -56 dBW/30 kHz (e.i.r.p.) unwanted emission power

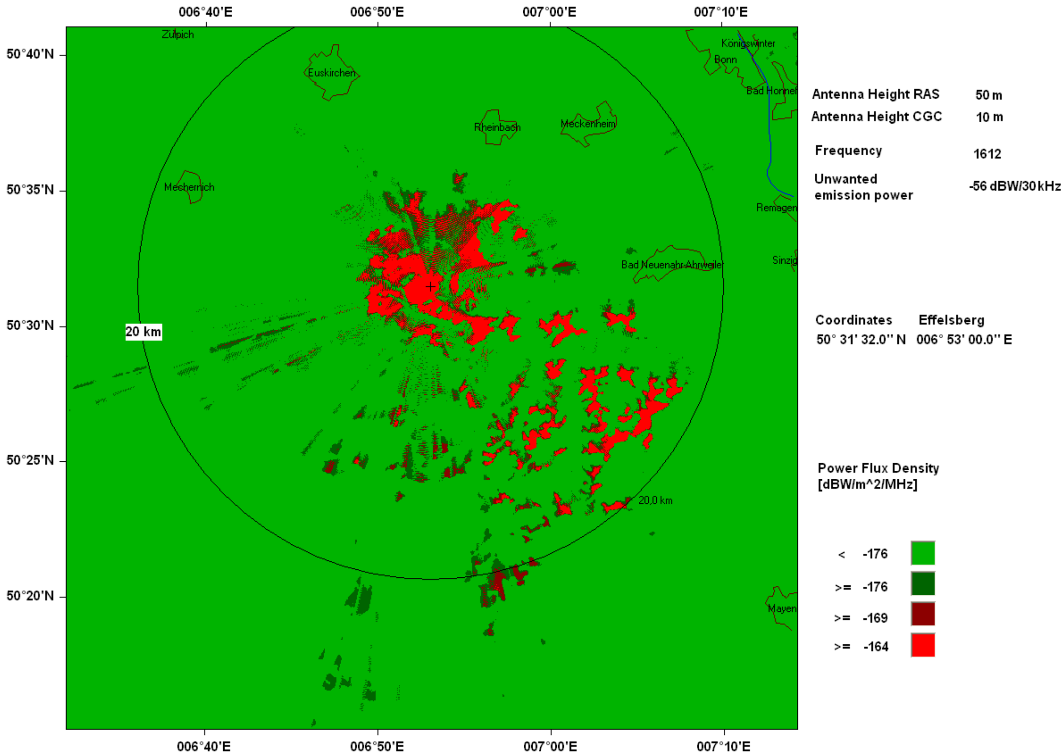

Figure 18: CGC antenna height 10 m, -56 dBW/30 kHz (e.i.r.p.) unwanted emission power

Figure 19 to Figure 24 show the results of the simulations for the RAS station Westerbork, The Netherlands, for different unwanted emission levels and 40 m and 10 m antenna height of the CGC Base station. The antenna height of the Westerbork station was set to 20 m.

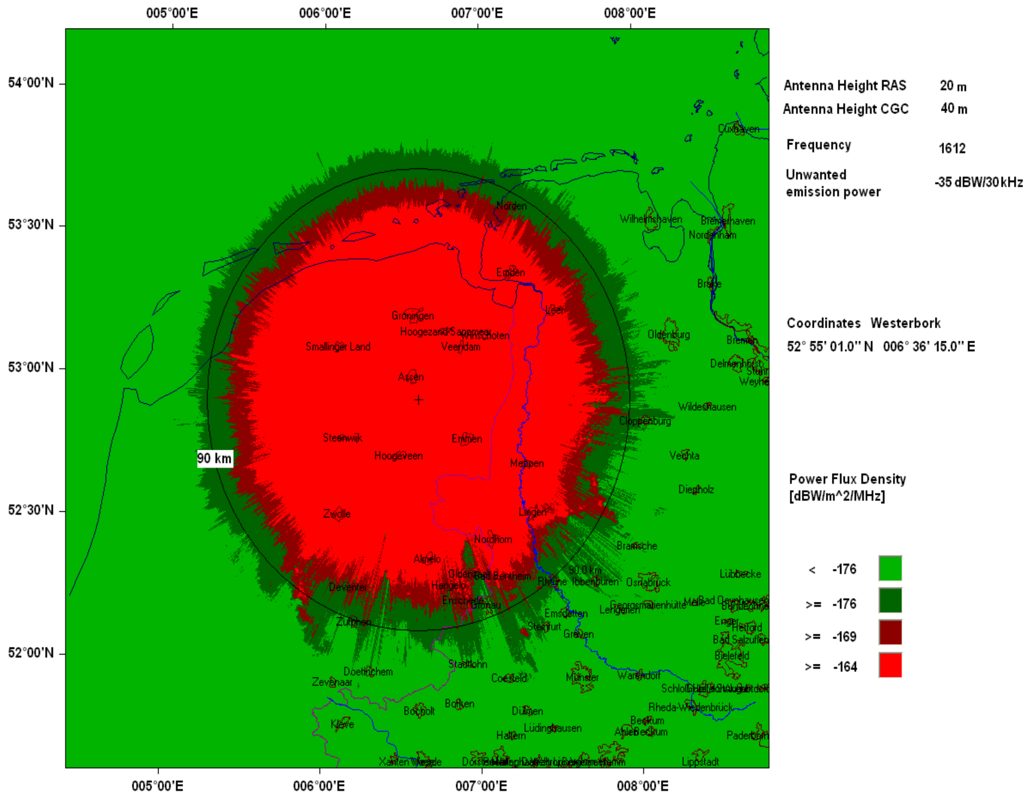

Figure 19: CGC antenna height 40 m, -35 dBW/30 kHz (e.i.r.p.) unwanted emission power

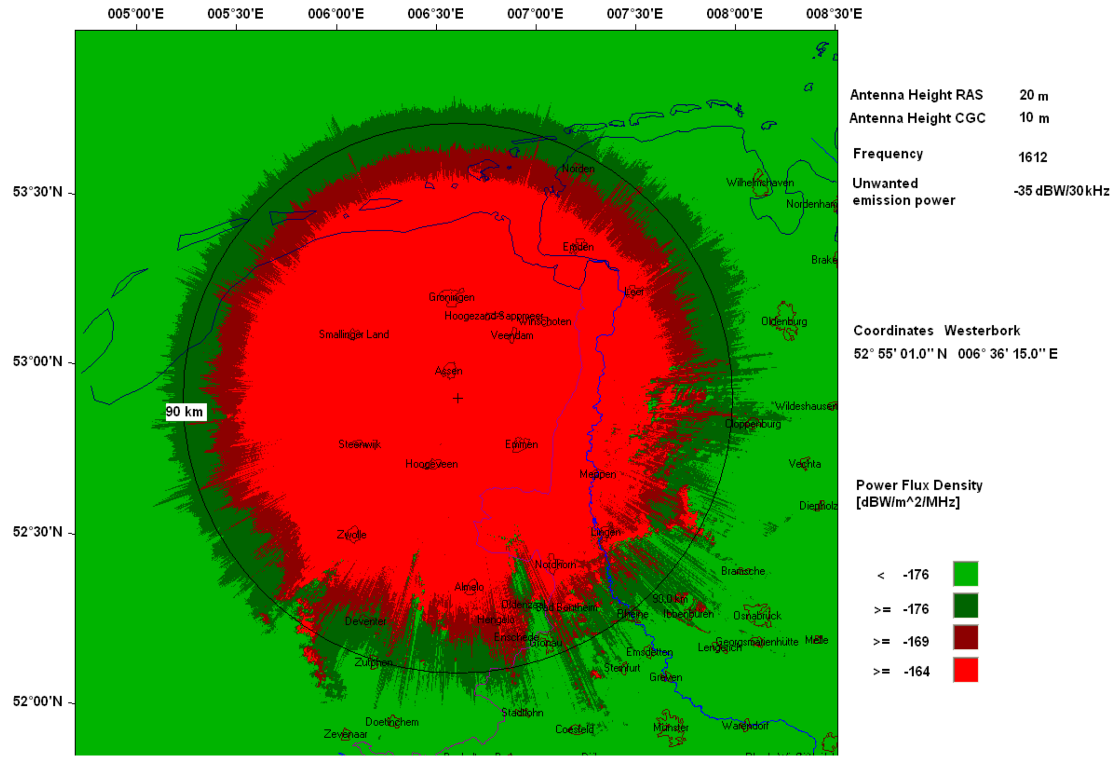

Figure 20: CGC antenna height 10 m, -35 dBW/30 kHz (e.i.r.p.) unwanted emission power

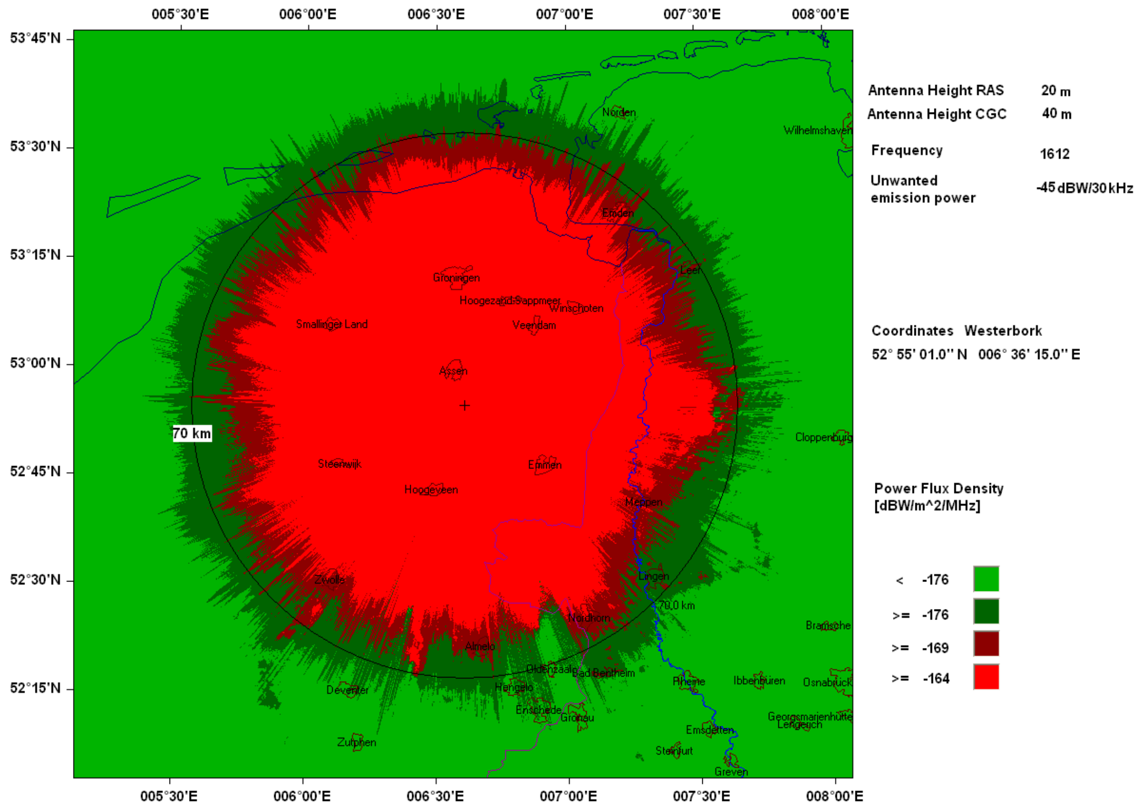

Figure 21: CGC antenna height 40 m, -45 dBW/30 kHz (e.i.r.p.) unwanted emission power

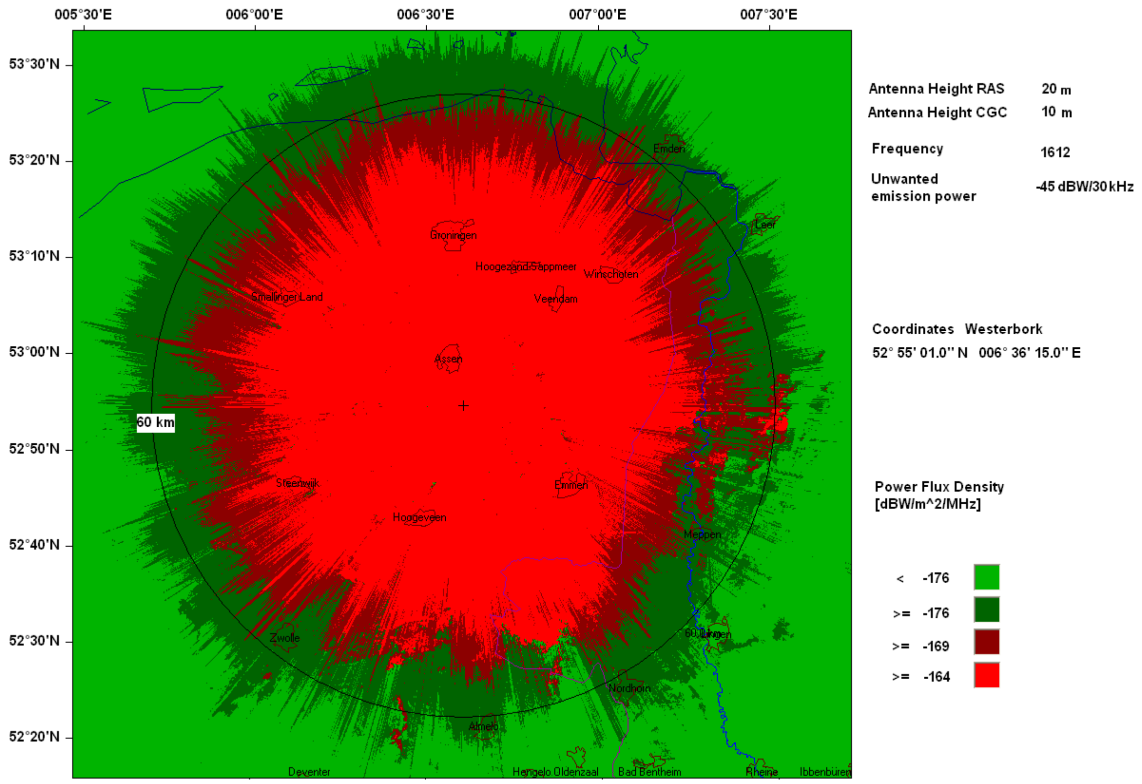

Figure 22: CGC antenna height 10 m, -45 dBW/30 kHz (e.i.r.p.) unwanted emission power

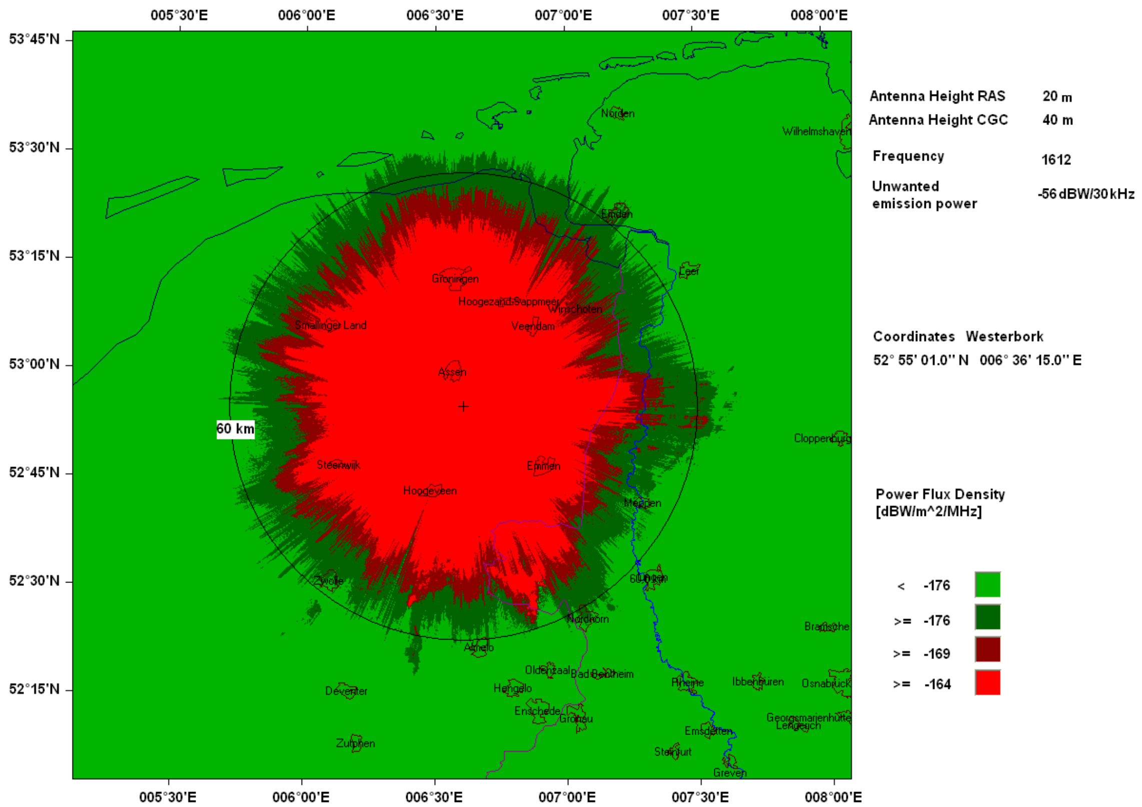

Figure 23: CGC antenna height 40 m, -56 dBW/30 kHz (e.i.r.p.) unwanted emission power

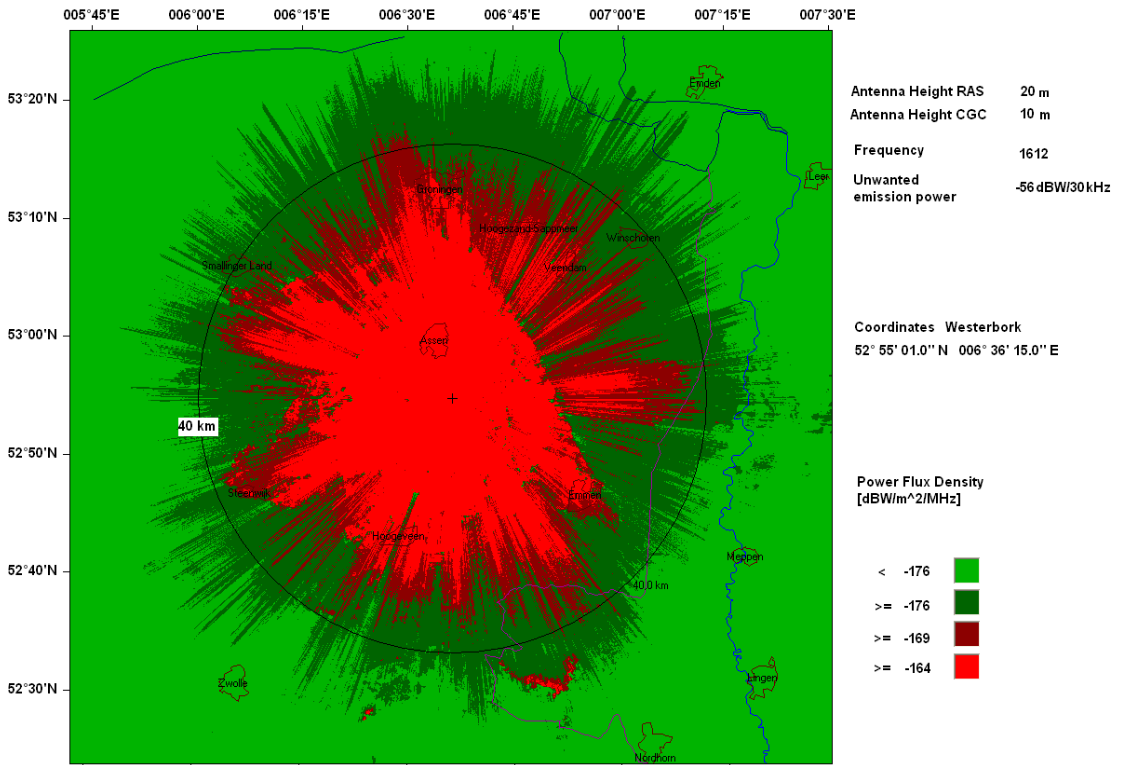

Figure 24: CGC antenna height 10 m, -56 dBW/30 kHz (e.i.r.p.) unwanted emission power

ANNEX 2 : RESULTS OF SIMULATIONS FOR PARTICULAR RAS STATIONS

Scenario 1: Five CGC Base stations are distributed at a distance from 30 – 150 km from the RAS receiver.

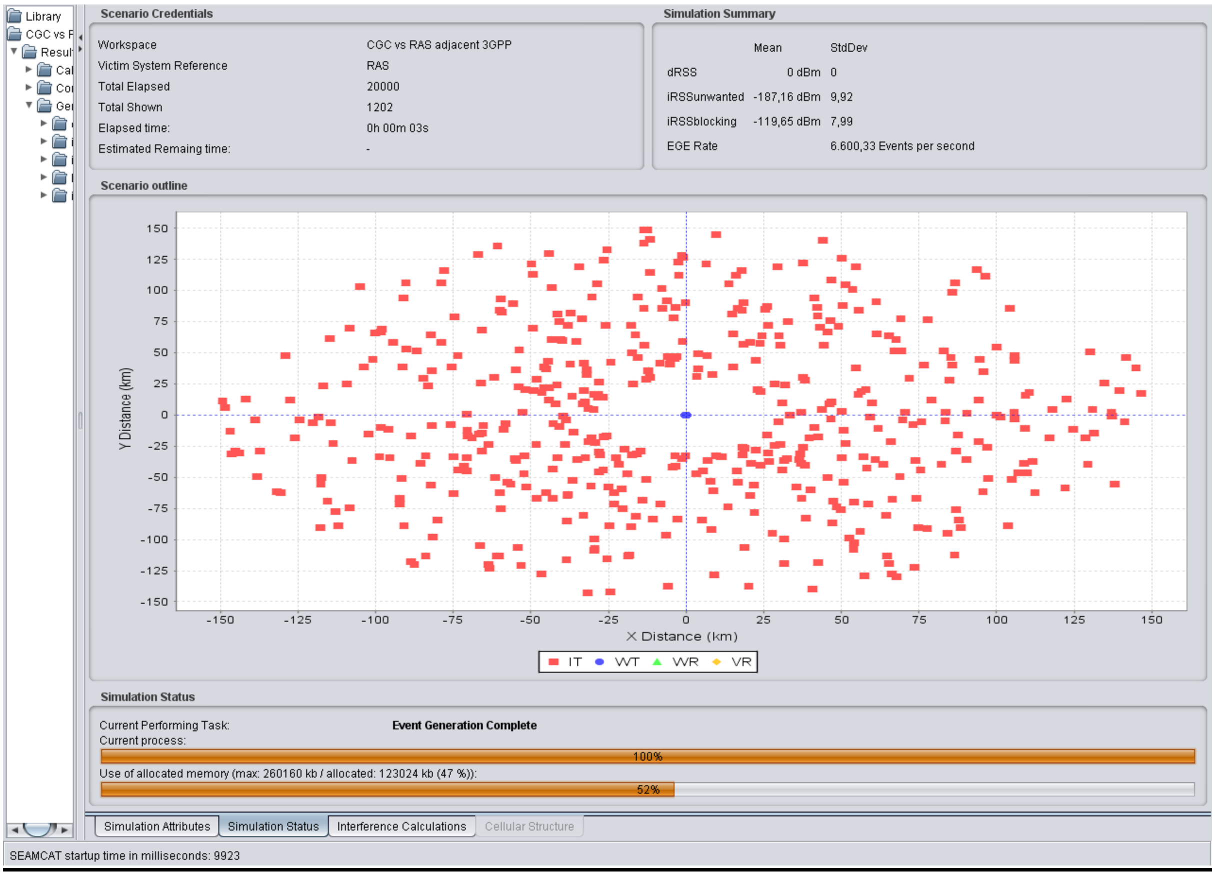

Figure 25: Simulation summary 30 – 150 km

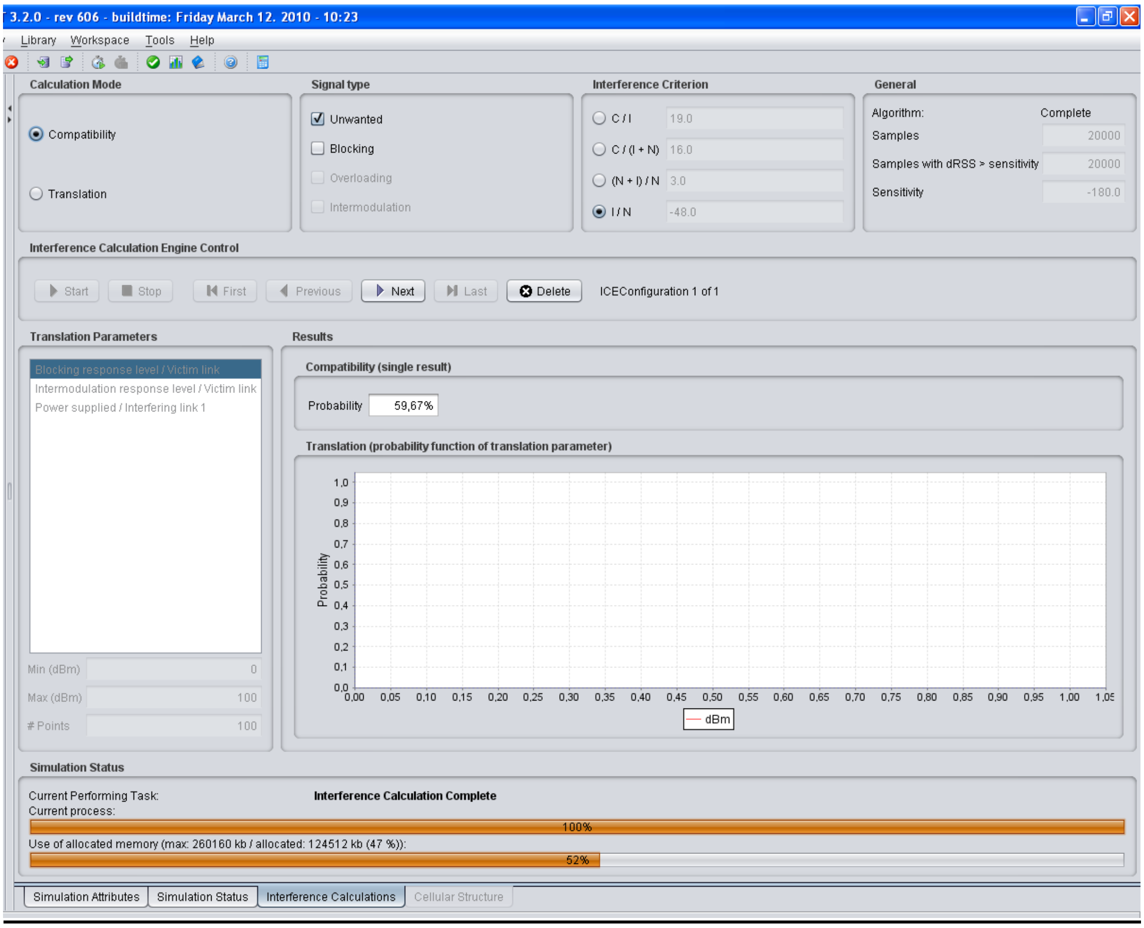

Figure 26: Interference probability calculation

The interference calculation shows a probability of nearly 60% that the interference criterion will be exceeded.

<u>Scenario 2: </u>Five CGC base stations are distributed at a distance of 100 km from the RAS receiver.

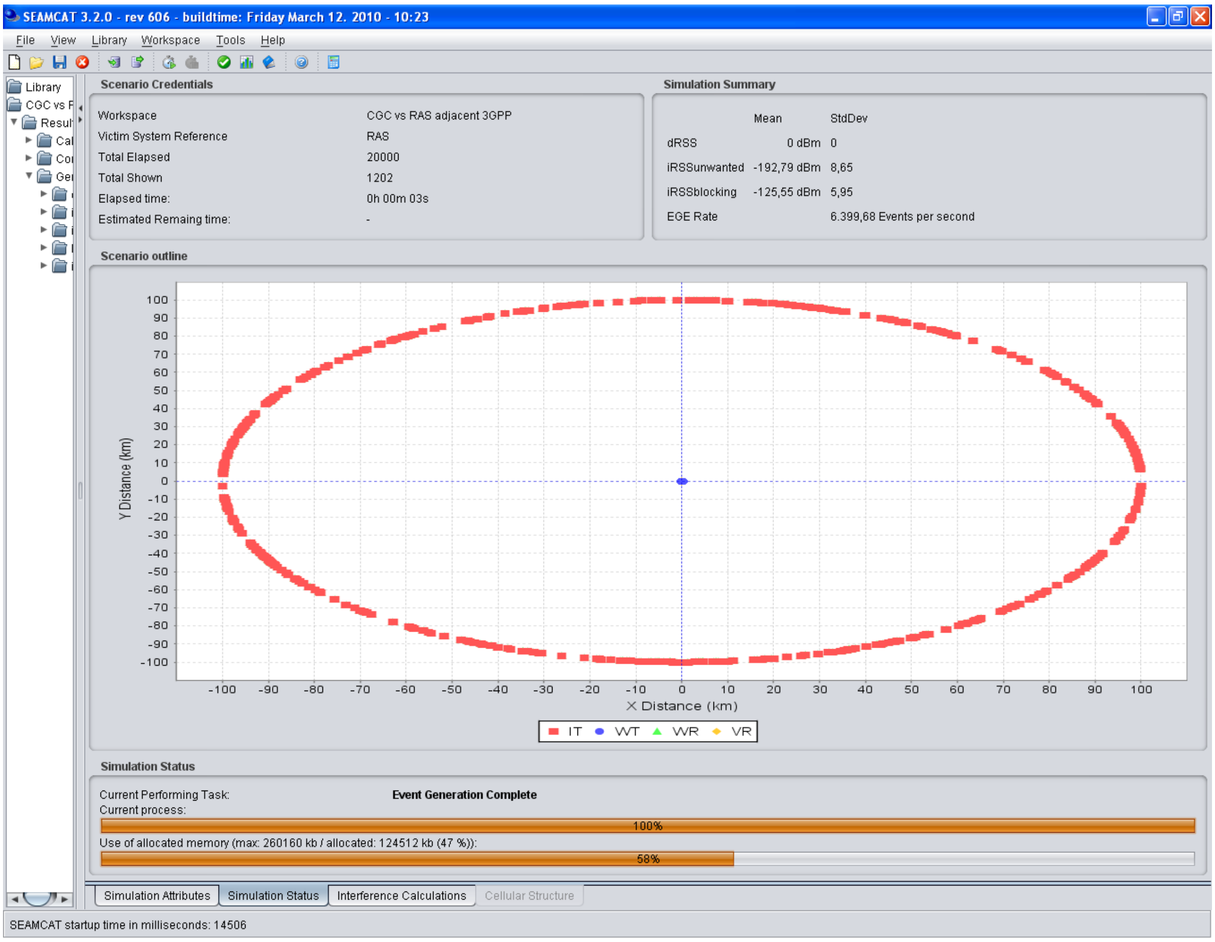

Figure 27: Simulation summary 100km protection zone, five interfering base stations

Expanding the protection zone to 100 km from the RAS station, the simulation shows a probability of still more than 30% (see Figure 28**Error! Reference source not found.** below) that the interference criterion will be exceeded.

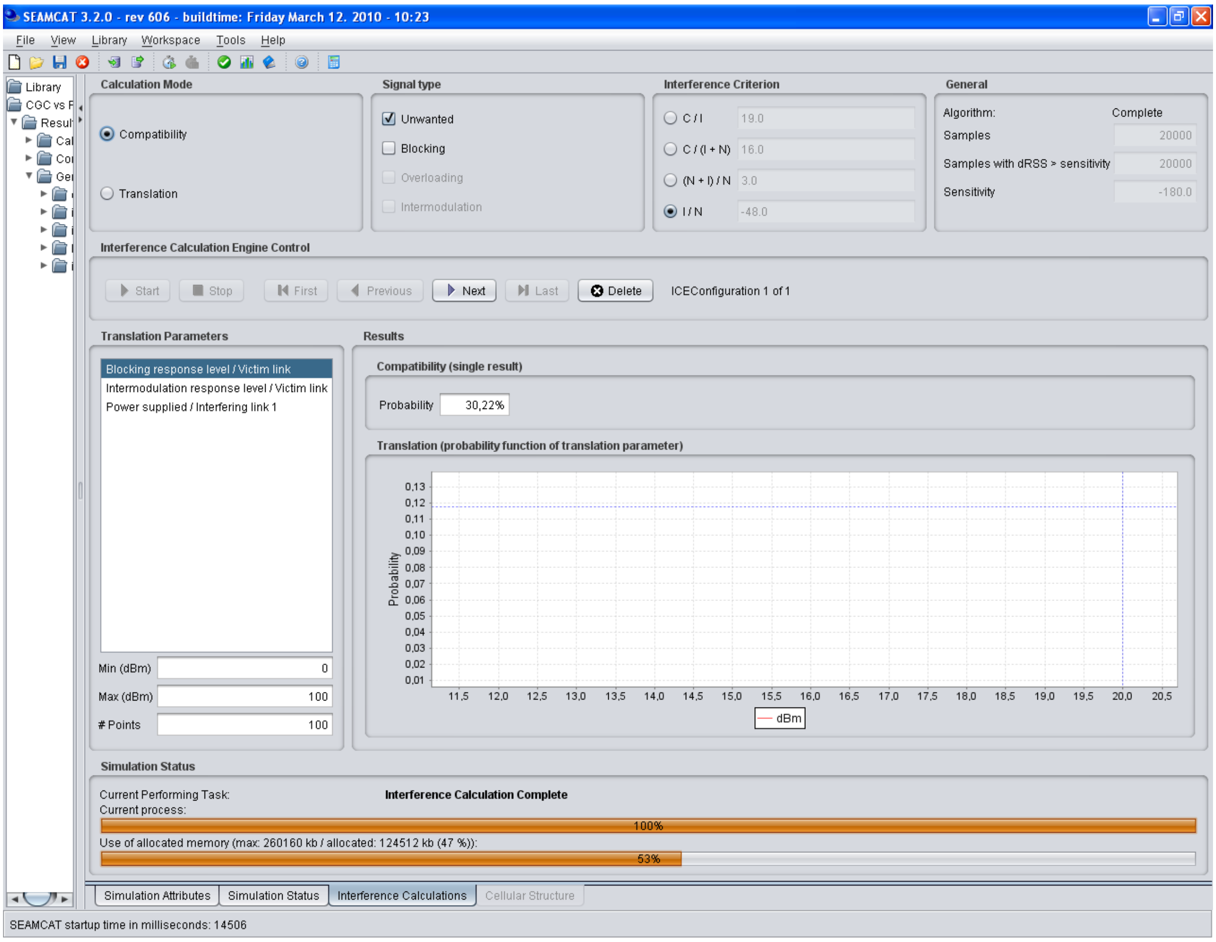

Figure 28: Interference probability calculation

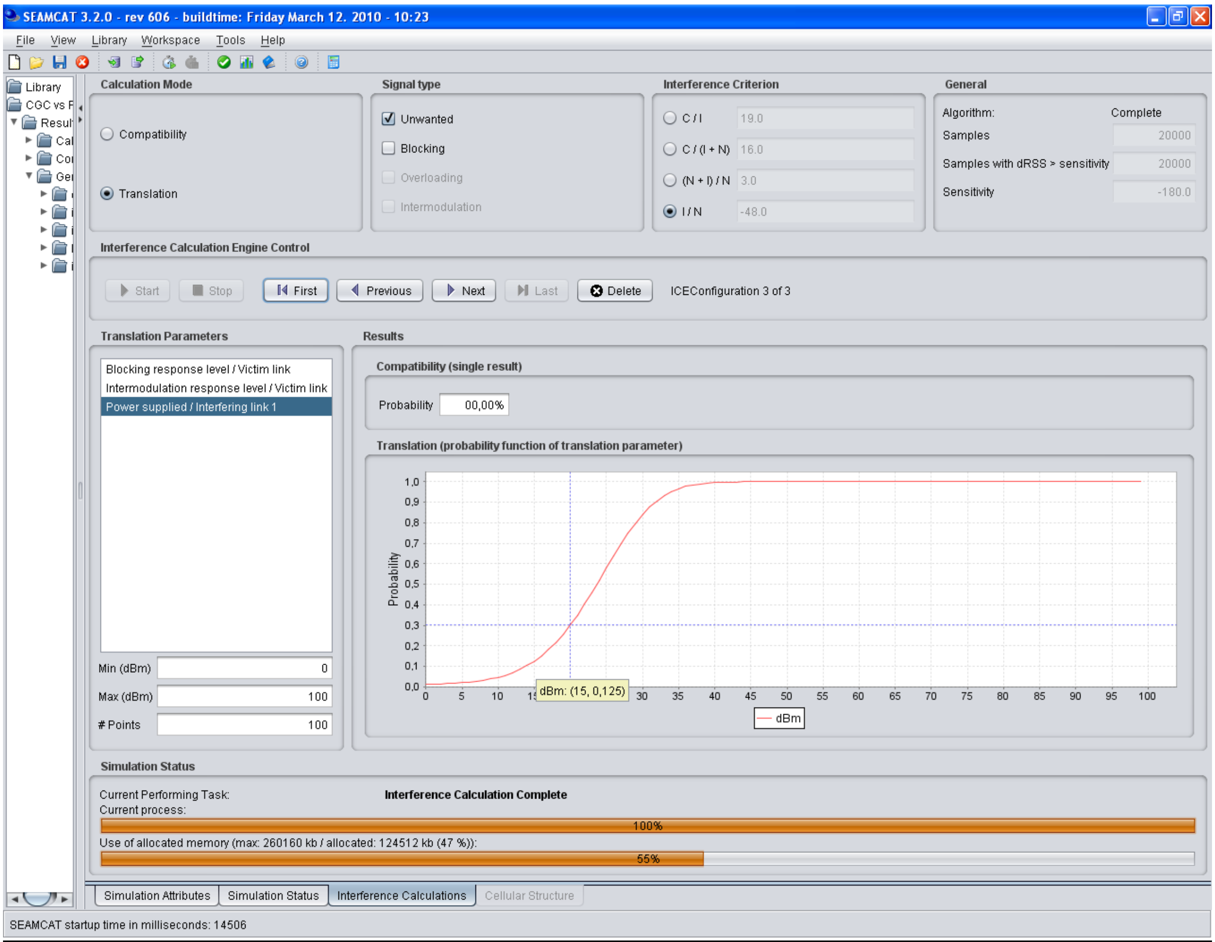

Figure 29: Interference Probability as function of the transmitted power

From the curve in Figure 29**Error! Reference source not found.** it can be found the dependence of the output power of the base stations and the corresponding probability of exceeding the interference criterion. Relaxing the output power of the CGC BS by 5 dB will still lead to a probability of about 12.5% that the interference criterion will be exceeded.

ANNEX 3 : LIST OF REFERENCES

[1] FCC, "Technical evaluation of big LEO ATC proposals" Appendix C3 of FCC Document 03-15A4

[2] ECC Report 005, Adjacent Band Compatibility Between GSM And Tetra Mobile Services At 915 MHz, June 2002

[3] ECC Report 038, The Technical Impact Of Introducing CDMA-PAMR On The UIC DMO & GSM-R Radio Systems In The 900 MHz Band, February 2004

[4] ECC Report 041, Adjacent Band Compatibility Between GSM And CDMA-PAMR At 915 MHz, February 2004

[5] 3GPP TS 25.102, Technical Specification Group Radio Access Network: User Equipment (UE) radio transmission and reception (TDD), May 2008

[6] 3GPP TS 25.105, Technical Specification Group Radio Access Network: Base station (BS) radio transmission and reception (TDD), September 2008

[7] 3GPP TS 45.102, Technical Specification Group GSM/EDGE Radio Access Network: Radio transmission and reception, August 2008

[8] Recommendation ITU-R Report M.2146, "Coexistence between IMT-2000 CDMA-DS and IMT-2000 OFDMA-TDD-WMAN in the 2500-2690 MHz band operating in adjacent bands in the same area"

[9] Recommendation ITU-R P.1411-5, "Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz"

[10] 3GPP TS 36.104 V9.2.0 (2009-12), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (Release 9)

[11] ETSI EN 302 574 "Satellite Earth Stations and Systems (SES); Harmonized Standard for satellite earth stations for MSS operating in the 1980 MHz to 2010 MHz (earth-to-space) and 2170 MHz to 2200 MHz (space-to-earth) frequency bands; Part 1: Complementary Ground Component (CGC) for wideband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive"

[12] CEPT Report 19 Report from CEPT to the European Commission in response to EC Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS.

[13] Recommendation ITU-R RA.769 "Protection criteria used for radio astronomical measurements"

[14] Recommendation ITU-R P.452 "Prediction procedure for the evaluation of microwave interference between stations on the surface of the Earth at frequencies above about 0.7 GHz"

[15] Recommendation ITU-R P.1546 "Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3000 MHz"