



CEPT Report 28

Report from CEPT to the European Commission  
in response to the Mandate

**“Mobile Communication Services on Vessels (MCV)”**

Final Report on 26 June 2009 by the



Electronic Communications Committee (ECC)  
within the European Conference of Postal and Telecommunications Administrations (CEPT)

## 0 EXECUTIVE SUMMARY

This Report provides a summary of the studies contained in ECC Report 122 “The compatibility between GSM use onboard vessels and land-based networks” [2] in response to the EC Mandate on MCV (Mobile Communication Services on Vessels) see Annex 1.

The study also includes the co-existence with RSBN systems used by some CEPT countries for aeronautical radionavigation.

Note that the following issues are beyond the scope of this Report:

- possibility of operation of the MCV system in internal waters, harbours and ports;
- operation within territorial seas of backhaul connection (e.g. satellite link) from MCV to its serving land-based network node.

The Report establishes different interference scenarios and considers the results of MCL and SEAMCAT simulations for these various scenarios. The results show compatibility between MCV operating in territorial seas and land-based systems can be achieved provided the following conditions are met:

- the System shall not be used closer than 2 NM from the baseline;
- only indoor v-BS antenna(s) shall be used;
- DTX<sup>1</sup> has to be activated on the MCV uplink;
- the timing advance<sup>2</sup> value of v-BS must be set to minimum;
- all v-MS shall be controlled to use the minimum output power (5 dBm in 900 MHz and 0 dBm in 1800 MHz bands);
- Within 2-3 NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN<sup>3</sup> & min RXLEV<sup>4</sup> level) shall be  $\geq -70$  dBm/200 kHz;
- Within 3-12<sup>12</sup> NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN & min RXLEV level) shall be  $\geq -75$  dBm/200 kHz;
- the v-BS emissions measured anywhere external to the vessel (i.e. at ship perimeter or on its open deck areas) shall not exceed -80 dBm/200 kHz (referenced to a 0 dBi measurement antenna gain);

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<sup>1</sup> DTX (discontinuous transmission, as described in GSM standard ETSI TS 148 008 [7])

<sup>2</sup> Timing advance (as described in GSM standard ETSI TS 144 018 [8])

<sup>3</sup> ACCMIN (RX\_LEV\_ACCESS\_MIN, as described in GSM standard ETSI TS 144 018 [8])

<sup>4</sup> RXLEV (RXLEV-FULL-SERVING-CELL, as described in GSM standard ETSI TS 148 008 [7])

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**LIST OF ABBREVIATIONS**

<b>Abbreviation</b>	<b>Explanation</b>
ACCMIN	Minimum received signal level for accessing the network
ARNS	Aeronautical Radionavigation Service
BS	Base Station
BSC	Base Station Controller
BTS	Base Transceiver Station
BCCH	GSM carrier which contains the Broadcast Control Channel
C	Carrier
CEPT	European Conference of Postal and Telecommunications Administrations
DAS	Distributed Antenna System
DEC	Decision
DTX	Discontinuous Transmission
GPS	Global Positioning System
EC	European Commission
ECC	Electronic Communications Committee
ERC	European Radiocommunications Committee
EU	European Union
GSM	Global System for Mobile communications
GSMOBV	GSM onboard vessel (system)
HLR	Home Location Register
I	Interference
l-	land-based- (prefix)
l-BS	GSM Base Station located on the ground
l-MS	GSM Mobile Station located on the ground
l-Node B	UMTS base station located on the ground
l-UE	UMTS User Equipment located on the ground
ITU-R	International Telecommunication Union - Radiocommunication Sector
MCL	Minimum Coupling Loss
MCV	Mobile Communication Services on Vessels
MEAS REP	MEASurement REPort
MS	Mobile Station
MSC	Mobile Switching Centre
N	Noise
NA	Not Applicable
NM	Nautical Mile (=1.852 km)
PLMN	Public Land Mobile Network
PRMG	radio beacon system for landing (in use in some CEPT countries according RR No 5.323)
RSBN	Short-range aeronautical radionavigation system
RXLEV	Received Signal Level
SEAMCAT	Spectrum Engineering Advanced Monte-Carlo Analysis Tool (free software tool available from <a href="http://www.ero.dk/seamcat">www.ero.dk/seamcat</a> ), the version used in simulations of this Report is v. 3.1.42
UE	User Equipment
v-	vessel- (prefix)
v-BS	GSM base station located onboard vessel
v-MS	GSM mobile station located onboard vessel
v-UE	UMTS User Equipment located onboard vessel
UMTS	Universal Mobile Telecommunications System
UNCLOS	United Nations Convention on the Law Of the Sea
VLR	Visitor Location Register
3GPP	Third Generation Partnership Project

## Mobile Communication services on Vessels (MCV)

### 1 INTRODUCTION

The GSM system onboard vessels (e.g. cruise liners, ferries, cargo ships), hereinafter referred to as “the System” or MCVsystem<sup>5</sup>, enables onboard use of GSM mobile terminals beyond the reach of coastal coverage of land-based GSM networks [1]. The operation of the System in internal waters, harbours and ports is beyond the scope of this Report.

The System is to be operated on a secondary basis, i.e. not to cause interferences to other authorised systems and not to claim protection from these other systems.

This Report provides a summary of the compatibility studies contained in ECC Report 122 [2] between the System and land-based networks with the intention to find technical requirements for the System, so that:

1. it will not cause harmful interference to land-based networks and
2. land-based mobile terminals are not connected to the System, when the System is in use in territorial seas.

The study considered co-existence between MCV systems and land-based GSM/UMTS networks in the 900 and 1800 MHz bands. Additionally, the co-existence between MCV and RSBN systems (short-range aeronautical radionavigation system), which operate in the 862 – 960 MHz band under No 5.323 of the ITU Radio Regulations [4], was considered. The operation of the backhaul link (e.g. satellite link) is outside the scope of this Report.

The operation of the System should not cause harmful interference to land-based GSM and UMTS networks operating in the frequency bands:

- 880-915 MHz (uplink)/ 925-960 MHz (downlink)
- 1710-1785 MHz (uplink)/ 1805-1880 MHz (downlink).

Protection of other land-based systems (networks operating in other frequency bands) has not been considered because the System itself will not use any bands other than the GSM-900 and GSM-1800 band, and any transmissions from onboard user terminals of those other systems would only happen in the presence of the signal from the relevant land-based network, i.e. within service coverage of those networks.

RSBN and PRMG (radio beacon system for landing) are in operation in some CEPT countries in the frequency band 862 – 960 MHz under the additional allocation to the aeronautical radionavigation service (ARNS) on a primary basis under RR No 5.323.

ERC Report 81 [3] covers the basic principle of sharing between the GSM-900 and RSBN systems at the 900 MHz band. It includes necessary geographical separation distances between GSM BS and the RSBN receiver for the different RSBN operating modes. Based on the conclusions in the ERC Report 81, it was assumed that MCV is not expected to interfere with RSBN systems.

This report has been developed within CEPT with contributions from Administrations and industry. The associated ECC report (ECC Report 122) was approved in September 2008.

### 2 BACKGROUND

This report covers the technical aspects of operation of mobile communication systems on board vessels (MCV) in the “territorial sea”, as defined in the UN Convention on the Law of the Sea (UNCLOS, 1982), excluding internal waters, harbours, and ports.

The territorial sea is understood as being on the waterway side of the geographic baseline, as illustrated below in Fig. 1<sup>6</sup>.

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<sup>5</sup> For the purpose of this report, MCV is understood to be seaborne GSM 900/1800 systems

<sup>6</sup> The breadth of the territorial sea of a state may vary and be less than 12 NM.

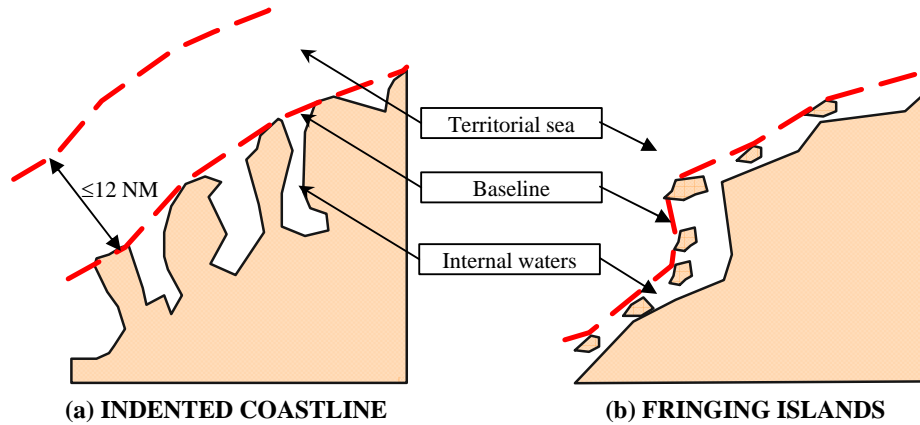


Figure 1: Illustration of baseline between internal waters and territorial sea (NM – nautical miles)

Maritime safety aspects (both technical and human factors related) are out of the scope of this report and fall under the responsibilities of the relevant maritime authorities.

The system under consideration in this report, (i.e. the equipment necessary to establish a GSM-900 and/or GSM-1800 MHz pico-cell<sup>7</sup> system on board a vessel, “the System”), is intended to provide an interface to on board GSM terminals providing the full range of services normally provided on a GSM network. The link between the System and other networks is out of the scope of this report.

### 3 MCV SYSTEM DESCRIPTION

The GSM base station located onboard vessel (v-BS) of MCV serves roaming GSM mobile stations located onboard vessels (v-MS) carried by ship passengers or crew by providing connectivity in the GSM-900 and/or GSM-1800 frequency band.

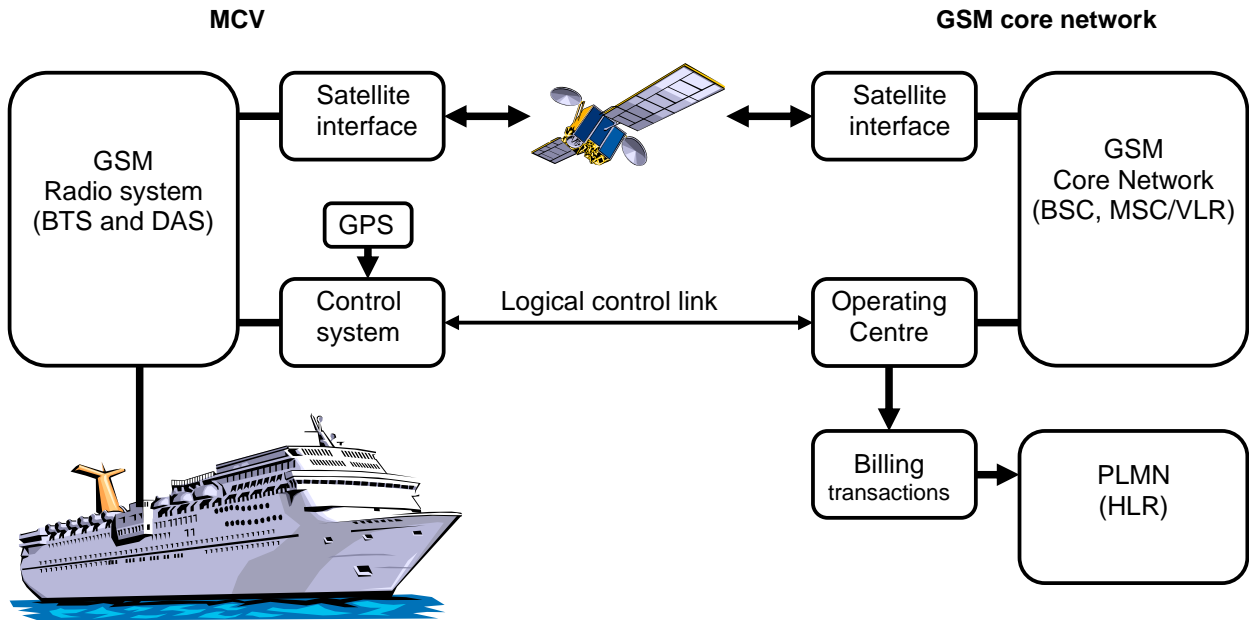


Figure 2: MCV system

<sup>7</sup> Pico cells are cells, predominantly used indoors and in this case on the vessel.

The GSM related equipment installed on a ship consists of the following main parts:

**Cabinet with main equipment for:**

- Control system
- Interface to satellite
- GSM base transceiver stations (BTS)
- GPS receiver

**Antenna System**

- Cabling and antenna(s)

**Equipment Cabinet**

The GSM related equipment is installed in a suitable cabinet located in the data/satellite communications room onboard and connected to the distributed antenna system.

**Satellite Interface onboard**

The interface with the satellite system onboard the ship is done with a standard multiplexer.

**Distributed Antenna System (DAS)**

On a ship requiring a larger coverage area for MCV, a DAS may be used to distribute the GSM radio signal, from one or several transceivers, throughout the ship with a number of low power antenna points ensuring required coverage onboard. The DAS architecture offers the possibility to control disabling and enabling of the outside antennas (e.g. those located on the sundeck). In addition, attenuators are connected on the coaxial antenna feeder cables in the situation where further power reduction is required. It was assumed that a leaky cable system was not a typical installation in a MCV system.

**DAS Components:**

- **Main unit:** located in the cellular cabinet
- **Extended units:** located in various locations onboard
- **Remote units:** located near antenna ends, will normally feed multiple antennas
- **Coaxial cables:** between remote units and antennas
- **Various attenuators:** to reduce power fed to antenna
- **Antennas:** typically omni-directional, ceiling mounted antennas

**Control System**

The onboard GSM network is operated by the control system via the service provider operations centre.

The control system contains a detailed set of rules of operation for all the regions where vessels sail. This entails automatic:

- system switch-off/on when crossing defined boundaries
- where the MCV system is authorized to operate in territorial seas, it must re-configure operation of the MCV as required by authorization conditions, such as:
  - tune frequency(ies);
  - disable outside antenna points;
  - activate any necessary mitigation mechanisms, as provided for in the authorization.

Input from the GPS unit, included in the system, is used to continuously keep track of the vessel's location.

This implies that the crew onboard has no means of controlling the operation of the GSM system with one exception: they can turn it off by a main switch. In order to turn the system back on, the operations centre will have to be contacted.

**Onboard GSM Base Stations**

GSM access onboard a vessel is to be provided by one or more pico-cell BTS (v-BS). The v-BS operates in the GSM-900 and/or GSM-1800 frequency band.

**4 TECHNICAL PARAMETERS AND PROTECTION CRITERIA FOR THE SYSTEMS**

The following input parameters were used for the compatibility study between MCV operating in GSM900/1800 bands and land-based systems: GSM900/1800 and UMTS900/1800. The parameters and their values are taken from ECC Report 122. These values were based on typical values of network equipment parameters (as provided by manufacturers and operators) where available. Otherwise, reference values extracted from the standards were used.

Parameter		GSM900		GSM1800		UMTS900 <sup>1</sup>		UMTS1800 <sup>1</sup>	
		MS	BS	MS	BS	UE	Node B	UE	Node B
Antenna input Power	dBm / channel	33	43	30	43	21/24 <sup>3</sup>	33 <sup>2</sup>	21/24 <sup>3</sup>	33 <sup>2</sup>
Antenna input Power, MCV	dBm / channel	5	-6 <sup>5</sup>	0	-6 <sup>5</sup>	NA	NA	NA	NA
Receiver bandwidth	kHz	200	200	200	200	3840	3840	3840	3840
Noise level	dBm / channel	-114	-117	-114	-117	-96	-103	-96	-103
Receiver Sensitivity	dBm / channel	-105	-108	-105	-108	-114	-121	-114	-121
Maximum antenna gain <sup>4</sup>	dBi	0	15	0	18	0	15	0	18
Maximum antenna gain MCV	dBi	0	2	0	2	NA	NA	NA	NA

**Table 1: Parameters used in the studies**

Notes:

<sup>1</sup> Assumed “typical” values given awaiting commercial product information.

<sup>2</sup> Typical operator power levels for the UMTS pilot channel = max Input power (43 dBm) –10 dB = 33 dBm as per UMTS defined testing procedures.

<sup>3</sup>Maximum UE transmit powers values quoted to be used for the following simulations:

- Maximum UE transmission power value for simulations on the impacts for the support of voice service = 21 dBm (assumes UE power class 4);
- Maximum UE transmission power value for simulations on impacts for the support of non voice service = 24 dBm

<sup>4</sup>The same maximum antenna gain is assumed for UMTS as for GSM.

<sup>5</sup>Typical antenna input power is –6 dBm for existing MCV systems, including the feeder loss, which can be significant for the v-BS since it contains long-distance cables.

The reference values taken from standards documentation are based on the 3GPP specifications.

**5 COMPATIBILITY STUDIES UNDERTAKEN**

**5.1 Methodology used for the compatibility study**

For the estimation of the effect on the land-based networks, two methods were used: the worst case methodology MCL (minimum coupling loss) and simulation using SEAMCAT.

Propagation models used for the studies were:

- Recommendation ITU-R P.525-2 free space path loss model [5];
- Recommendation ITU-R P.1546-2 propagation model [6];
- Hata model (also implemented in SEAMCAT).

**5.2 Scenarios studied**

**5.2.1 Scenario 0: Coverage of the land-based networks at sea and its effects**

This scenario is used to estimate the distance from the shore to the MS located on a vessel that is still able to connect to the land-based network. It should be noted that this is not an interference situation, but this scenario is used as a reference situation for some of the compatibility studies.



### 5.2.2 Scenario 1: Impact of the v-MS on the l-BS

This scenario is used to calculate the impact of the v-MS on the l-BS. Note that the affected land-based system might be either GSM or UMTS system operating in the same frequency band as the MCV.

### 5.2.3 Scenario 2: Impact of the v-BS on the l-MS

This scenario is used to calculate the impact of the v-BS on the l-MS/l-UE. Note that the affected land terminal might belong to either GSM or UMTS system operating in the same frequency band as the MCV.

### 5.2.4 Scenario 3: Possibility of the l-MS to connect unintentionally to the v-BS

This scenario is used to calculate the possibility of the l-MS to connect unintentionally to the MCV. This scenario can also be seen as an "unwanted roaming" situation.

### 5.2.5 Scenario 4: Impact of the v-BS (connected to v-MS) on the MS located onboard vessel but connected to l-BS

Scenario 4 is a special case of scenario 2. This scenario is used to calculate the impact of the v-BS on a MS, which is carried onboard vessel but still maintains connection to the land-based network. This situation is envisaged while ship is located in the areas of coastal coverage by land-based networks, as established by Scenario 0. Note that the affected MS/UE might be connected to either GSM or UMTS system operating in the same frequency band as the MCV.

## 5.3 Results for the different scenarios

### 5.3.1 Scenario 0: Coverage of the land-based networks at sea and its effects

The MCL calculations show that in the case of a single GSM BS on land, the coverage will extend beyond 12 NM from the shore for both GSM900 and GSM1800.

In a more realistic scenario, the inter-cell interferences should be taken into account. In accordance with assumption of rural area deployment, the distance between co-frequency cell was derived from considering two inter-cell distances of 10 km and 15 km and frequency re-use scheme 7/21, i.e. leading to assumption of the same frequency being deployed in every second cell, thus giving  $d_{ij}=20$  and 30 km.

Simulating this scenario in SEAMCAT returned the following results, as shown in Tables 2 and 3.

R, km	900 MHz			1800 MHz		
	Mean C, dBm	Mean I, dBm	C/I, dB	Mean C, dBm	Mean I, dBm	C/I, dB
3	-43.4	-55.4	12	-49.1	-61.1	12
4	<b>-45.9</b>	<b>-54.9</b>	<b>9</b>	<b>-51.6</b>	<b>-60.7</b>	<b>9.1</b>
5	-47.8	-54.6	6.8	-53.6	-60.3	6.7

Table 2: Results of SEAMCAT simulations for relative C and I strength at various R and  $d_{ij}=20$  km

R, km	900 MHz			1800 MHz		
	Mean C, dBm	Mean I, dBm	C/I, dB	Mean C, dBm	Mean I, dBm	C/I, dB
3	-43.4	-59.5	16.1	-49.1	-65.2	16.1
4	-45.9	-59.1	13.2	-51.6	-64.8	13.2
5	-47.8	-58.8	11	-53.6	-64.5	10.9
6	<b>-49.4</b>	<b>-58.5</b>	<b>9.1</b>	<b>-55.1</b>	<b>-64.2</b>	<b>9.1</b>
7	-50.8	-58.2	7.4	-56.5	-63.9	7.4

Table 3: Results of SEAMCAT simulations for relative C and I strength at various R and  $d_{ij}=30$  km

In conclusion, it may be noted that the coverage distance of land GSM networks with 5 to 7.5 km cell radius (depending on the height of the land base stations above the sea level) would be in the order of 4-6 km (2-3 NM) into coastal waters, at which distance the C/I criterion becomes equal to 9 dB due to effect of interference-limited network.

**5.3.2 Scenario 1: Impact of the v-MS on the I-BS**

In the MCL calculations, the distance at which the interference criterion is  $C/I = 9$  dB is given in Table 4. The propagation losses have been calculated with the Recommendation ITU-R P.1546-2 (sea path, 50% time). The v-MS has been placed on the sundeck ( $L_{hull} = 0$  dB) as well as inside the ship, assuming different attenuation for the hull (varying from 5 to 25 dB). Both the co-channel and the adjacent channel situations have been considered. However, only the co-channel results are relevant here if there is no means to avoid the co-channel situation.

Distances in NM depending on the $L_{hull}$ (Attenuation of the hull)												
GSM frequency (MHz)	900	1800	900	1800	900	1800	900	1800	900	1800	900	1800
$L_{hull}$ (Attenuation of the hull)	0 dB		5 dB		10 dB		15 dB		20 dB		25 dB	
d (NM), co-channel	15.12	12.42	15.6	9.72	12.9	8.10	9.18	4.32	8.09	2.81	5.94	1.51
d (NM), 1 <sup>st</sup> adj. channel	6.48	3.51	6.48	1.94	4.86	1.08	3.51	0.70	2.15	-	1.19	-
d (NM), 2 <sup>nd</sup> adj. channel	2.16	1.24	3.78	0.73	2.27	-	1.40	-	0.75	-	-	-

**Table 4: Results of MCL calculations for the distances (in NM) complying interference criterion ( $C/I=9$  dB)**

In the SEAMCAT simulations, the probability of interference is calculated in cases, where the MCV system is randomly located at different path segments. The results are given for different hull attenuation values in the cases, where the discontinuous transmission (DTX) feature is either off or on in the uplink of the MCV system. The DTX is a standard GSM feature, further explained in Section 6. The effects on the land-based GSM900 and GSM1800 base stations are given in Table 5 in terms of probability of interference, whereas, in the case land-based UMTS900 and UMTS1800 base stations, the effects are given in Table 6 as percentage of excess outage.

Distance from shore	Probability of Interference with $L_{hull} = 0$ dB			
	GSM 900MHz		GSM 1800MHz	
	No DTX	DTX	No DTX	DTX
0-1NM	54.8%	22.4%	51.4%	20.3%
1-2NM	28.9%	11.5%	24.6%	9.9%
2-3NM	19.1%	7.6%	15.5%	6.2%
3-4NM	13.5%	5.3%	10.5%	4.2%
4-5NM	10.0%	4.1%	7.5%	3.0%
Distance from shore	Probability of Interference with $L_{hull} = 5$ dB			
	GSM 900MHz		GSM 1800MHz	
	No DTX	DTX	No DTX	DTX
0-1NM	43.9%	17.9%	40.1%	16.1%
1-2NM	18.0%	7.0%	15.1%	5.9%
2-3NM	10.4%	4.0%	8.1%	3.2%
3-4NM	6.3%	2.5%	5.0%	2.0%
4-5NM	4.7%	1.8%	3.3%	1.2%
Distance from shore	Probability of Interference with $L_{hull} = 10$ dB			
	GSM 900MHz		GSM 1800MHz	
	No DTX	DTX	No DTX	DTX
0-1NM	33.5%	13.2%	29.8%	11.6%
1-2NM	9.7%	3.9%	7.7%	2.9%
2-3NM	4.8%	1.8%	3.7%	1.4%
3-4NM	2.7%	1.1%	2.0%	0.6%
4-5NM	1.8%	0.7%	1.2%	0.5%
Distance from shore	Probability of Interference with $L_{hull} = 20$ dB			
	GSM 900MHz		GSM 1800MHz	
	No DTX	DTX	No DTX	DTX
0-1NM	15.3%	6.0%	13.1%	5.0%
1-2NM	2.1%	0.7%	1.1%	0.5%
2-3NM	0.6%	0.3%	0.3%	0.1%
3-4NM	0.3%	0.1%	0.1%	0.08%
4-5NM	0.1%	0.04%	0.1%	0.02%

**Table 5: Probability of interference from v-MS to I-BS with different ship hull attenuation, when MCV ship is randomly located within restricted path segments near the coast**

Distance from shore	Excess outage with $L_{\text{hull}} = 0$ dB	
	UMTS 900MHz	UMTS 1800MHz
	No DTX	No DTX
0-1NM	14.5 %	12.0 %
1-2NM	14.3 %	3.7 %
2-3NM	14.0 %	1.6 %
3-4NM	10.8 %	1.0 %
4-5NM	6.9 %	0.6 %

**Table 6: Simulated excess outage in UMTS reference cell on land due to emissions from v-MS, when MCV ship is randomly located within restricted path segments near the coast**

It has to be noted that in the case of UMTS 900 MHz and UMTS 1800 MHz the excess outages are much smaller, when DTX is used and the ship hull attenuation of 5 or 10 dB is assumed.

The probability of interference can be reduced, when proper mitigation techniques are applied. Detailed explanations for the mitigation factors can be found in section 6.

### 5.3.3 Scenario 2: Impact of the v-BS on the l-MS

In the MCL calculations, the distance at which the interference criterion is  $C/I = 9$  dB is given in Table 7.

Frequency	MHz	900	1800	900	1800	900	1800	900	1800	900	1800	900	1800
Hull attenuation	dB	0		5		10		15		20		25	
Distance (free space model)	km	8.4	4.2	4.7	2.4	2.7	1.3	1.5	0.7	0.8	0.4	0.5	0.2
Distance (P.1546-2 model)	km	5.0	4.0	4.0	2.0	2.7	1.3	1.5	0.7	0.8	0.4	0.5	0.2

**Table 7: Calculated distances to comply with the interference criterion ( $C/I = 9$  dB) for Scenario 2**

In the SEAMCAT simulations, the probability of interference is calculated in cases, where the MCV system is randomly located at different path segments.

Distance from shore	900 MHz	1800 MHz
0-12 NM	0.02 %	0.04 %
0-1 NM	0.50 %	1.1 %
1-2 NM	0.05 %	0.1 %

**Table 8: Results of simulations for probability of interference from v-BS to l-MS (GSM)**

Distance from shore	Excess outage	
	UMTS-900	UMTS-1800
0-1 NM	0 %	0 %

**Table 9: Results of simulations for excess outage in UMTS downlink (l-UE) due to interference from v-BS**

It may be seen from the Tables 7-9 that the probability of interference will be reasonably low in all cases, especially if some minimum separation distance (e.g. 1 NM) may be assumed. Note that the calculations were done with 0 dB hull attenuation, therefore the real probability of interference may be further reduced due to significant ship hull attenuation that would be typical for most v-BS installations.

### 5.3.4 Scenario 3: Possibility of the l-MS to connect unintentionally to the v-BS

The MCL method is used to assess the possibility for a l-MS to connect unintentionally to the v-BS. Results are given in Table 10. The results show that in order to avoid any unwanted roaming of a l-MS onto a v-BS, e.g. a minimum separation distance of 0.3 km assuming a hull attenuation of 20 dB has to be respected at 900 MHz. Another mean to avoid unintentional roaming is to use a standard GSM feature called Timing Advance (see further details in Section 6), which could be used to limit the distance at which a MS is allowed to connect a v-BS.

Frequency	MHz	900	1800	900	1800	900	1800	900	1800	900	1800	900	1800
Hull attenuation	dB	0		5		10		15		20		25	
Distance (free space model)	km	3.0	1.5	1.7	0.8	0.9	0.5	0.5	0.3	0.3	0.1	0.2	0.1
Distance (P.1546-2 model)	km	3.0	1.5	1.7	0.8	0.9	0.5	0.5	0.3	0.3	0.1	0.2	0.1

**Table 10: Minimum separation distances to avoid unwanted roaming of a l-MS onto the v-BS**

**5.3.5 Scenario 4: Impact of the v-BS (connected to v-MS) on the MS located onboard vessel but connected to l-BS**

The MCL method is used to assess the interference from a v-BS to a mobile station situated on the vessel and connected to a land-based network. The propagation model used is the free space loss and the interference criterion is I/N = -6 dB. The results are given in Table 11.

Frequency	MHz	900	1800	900	1800	900	1800	900	1800	900	1800
Hull attenuation	dB	0		5		10		15		25	
Distance (free space model)	km	10.1	5.2	5.7	2.9	3.2	1.6	1.8	0.9	0.568	0.291

**Table 11: Minimum separation distances to avoid interference from v-BS to MS located onboard vessel but connected to l-BS**

Simulating this scenario in SEAMCAT, by assessing the interference probability using a C/(N+I)=9 dB criterion, leads to the results shown in Table 12. The ship is located along the straight line normal to shore, with the maximum distances of 4 km ( $d_{ij}=20$  km) and 6 km ( $d_{ij}=30$  km), which correspond to the maximum service area distances calculated in Scenario 0.

Ship hull attenuation (dB)	Distance (km)	900 MHz	1800 MHz
0	4	21.3 %	19.2 %
	6	28.13 %	25.87 %
5	4	12.1 %	11.1 %
	6	18.4 %	16.5 %
10	4	5.9 %	5.5 %
	6	10.0 %	8.8 %
15	4	2.5 %	2.1 %
	6	4.6 %	3.9 %
20	4	1.0 %	0.8 %
	6	1.7 %	1.6 %
25	4	0.3 %	0.2 %
	6	0.7 %	0.6 %

**Table 12: Probability of interference from v-BS to MS located onboard vessel but connected to l-BS**

When considering the results given in Table 12, it may be further noted that in reality, even if the case of co-frequency collision occurs, both GSM land and ship systems shall react in order to cure the situation:

- the MS would sense deterioration of signal quality and would either:
  - if it were in passive (listening mode) – it would camp on another BCCH if one is available (e.g. the one from neighbouring cell on land, that would use the different set of channels), or
  - if it were in active mode, i.e. with call taking place, the system would also hand the call over to a neighbouring cell (if one is available);
- the MCV and its served v-MS would receive even more interference from land GSM system than other way around - note that the above statistics also mean that in 70-80% of cases, the signal from l-BS will be more than 9 dB above the signal from v-BS, thus rendering the communication between v-BS and v-MS impossible.

It has to be noted that Tables 11 and 12 only apply to the interferences caused by the v-BS on a GSM MS located onboard the vessel but connected to a l-BS. The counterpart scenario for UMTS UE has not been assessed; however scenario 2 shows that the latter case is less critical than the GSM case.

## 6 MITIGATION FACTORS

The mitigation factors that were considered as viable for the MCV were:

- **Ship hull attenuation**

The interference signals from indoor v-BS and v-MS could be attenuated by the body structures of the vessel (hull, walls, doors, windows, etc.). Different hull attenuation values must be considered due to the different materials that might come in a way of MCV emissions emanating from inside the ship.

- **ACCMIN/RXLEV**

The feature called ACCMIN (or RXLEV\_ACCESS\_MIN) is used to control the sensitivity of v-MS during the initial attachment of v-MSs to v-BS. It allows setting a value of received power level so that a MS is not allowed to access a given cell if its received control channel power is below the ACCMIN value. The feature RXLEV (in full RXLEV-FULL-SERVING-CELL) is a part of the standard MS measurement reporting procedures needed in GSM system. RXLEV is reported by MS routinely during the call within the MEASUREMENT REPORT (MEAS REP) message (described in ETSI TS 148 008). Thus during the call, v-BS could monitor the RXLEV-FULL-SERVING-CELL value and if its mean drops below the level corresponding to the ACCMIN setting, this will mean that during the call v-MS was brought outside the allowed connectivity area and will be disconnected from v-BS immediately following the MS release procedure (detailed in ETSI TS 148 008).

By combining the external limit for v-BS emissions with ACCMIN/RXLEV setting, it will be possible to ensure that v-MS is only allowed to operate (to establish initial connection and maintain the call) if it is physically located within the indoor coverage area of MCV system.

- **DTX**

DTX (Discontinuous Transmission) function senses when a speaker makes a pause (e.g. listening to the other end of conversation or during natural conversational pauses) and stops the transmission during those pause periods.

- **Timing Advance**

The timing advance mechanism available in GSM BS (implementation might be system/vendor specific) may be used to limit the cell size, limiting the maximum possible distance from the v-BS, where a v-MS is able to be connected, to 500 m

These factors are standard GSM features and can be easily implemented in the case of MCV. Other mitigation factors than the ones listed above were considered but not found viable.

## 7 CONCLUSIONS

Based on the analyses and assumptions made in ECC Report 122,

if the System is to be operated in territorial seas, then the following technical and operational requirements are to be met to avoid harmful interferences:

- the System shall not be used closer than 2 NM from the baseline;
- only indoor v-BS antenna(s) shall be used;
- DTX<sup>8</sup> has to be activated on the MCV uplink;
- the timing advance<sup>9</sup> value of v-BS must be set to minimum;
- all v-MS shall be controlled to use the minimum output power (5 dBm in 900 MHz and 0 dBm in 1800 MHz bands);
- Within 2-3 NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN<sup>10</sup> & min RXLEV<sup>11</sup> level) shall be  $\geq -70$  dBm/200 kHz;
- Within 3-12<sup>12</sup> NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN & min RXLEV level) shall be  $\geq -75$  dBm/200 kHz;
- the v-BS emissions measured anywhere external to the vessel (i.e. at ship perimeter or on its open deck areas) shall not exceed -80 dBm/200 kHz (referenced to a 0 dBi measurement antenna gain).

Therefore, in territorial seas between 2 and 12<sup>12</sup> NM from the baseline the MCV system can only be operated between, if all the above requirements are met. Otherwise, it must be switched-off, when entering the territorial sea.

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<sup>8</sup> DTX (discontinuous transmission, as described in GSM standard ETSI TS 148 008)

<sup>9</sup> Timing advance (as described in GSM standard ETSI TS 144 018)

<sup>10</sup> ACCMIN (RX\_LEV\_ACCESS\_MIN, as described in GSM standard ETSI TS 144 018)

<sup>11</sup> RXLEV (RXLEV-FULL-SERVING-CELL, as described in GSM standard ETSI TS 148 008)

<sup>12</sup> The breadth of the territorial sea of a state may vary and be less than 12 NM.

## ANNEX 1: EC MANDATE TO CEPT ON MOBILECOMMUNICATION SERVICES ON VESSELS (MCV)

ANNEX:

### ADOPTED

#### MANDATE TO CEPT ON MOBILE COMMUNICATION SERVICES ON VESSELS (MCV)

##### Title

Mandate to CEPT to identify the technical and operational conditions required to ensure the avoidance of harmful interference to the operation of radiocommunication services together with GSM systems on vessels in the 900 MHz and 1800 MHz frequency ranges in the territorial seas of Member States. This should also include conditions required to avoid connections from land-based mobile terminals to GSM systems on vessels when this system is in use at territorial waters.

##### Purpose

Pursuant to Art. 4 of the Radio Spectrum Decision, CEPT is mandated to undertake the work required to identify the most appropriate technical criteria for the timely and harmonised introduction of MCV applications in the European Union.

This present mandate limits itself to the study of technical and operational conditions of mobile communication systems on vessels based on GSM-900 and GSM-1800 technology to ensure the avoidance of harmful interference to the operation of existing land-based mobile networks and to ensure that land-based mobile terminals are not connected to a MCV system when this system is in use at the territorial waters. The limitation in technology is justified by the expectation that MCV services will be implemented using the GSM technology at first, which therefore needs to be prioritised. Further EC mandates targeting other technologies may be prepared in the future.

Seaworthiness and safety of MCV equipment are addressed by entities at national, European and global level other than spectrum management administrations and are outside the scope of this Mandate. This Mandate addresses only the operation of MCV in territorial seas of the Member States. All other operation (on the high seas, in inland waterways, lakes, ports and harbours etc.), including operation of backhaul connections (e.g. satellite link) is outside the scope of this Mandate.

##### Justification

Allowing people to be connected everywhere at all time is a recurring theme of the policy on the Information Society and of the i2010 initiative. The development of additional means of communicating is likely to be beneficial for growth in the mobile telephony market. Seaborne connectivity applications have a pan-European dimension as a significant proportion of sea travel concerns journeys between European Union members. A coordinated approach to the regulation of such services would support the objectives of the EU Single Market.

##### Order and Schedule

CEPT is hereby mandated to undertake all required activities to assess the technical and operational parameters applicable to seaborne GSM-900 and GSM-1800 systems that

will ensure avoidance of harmful interference to the operation of all radio services in these bands and that will ensure that land-based mobile terminals are not connected to MCV systems when these systems are in use at the territorial waters.

CEPT is mandated to provide deliverables according to the following schedule:

Delivery date	Deliverable	Subject
16 <sup>th</sup> March 2009	Final Report from CEPT to the Commission - subject to public consultation	Description of work undertaken and final results (for public consultation) under this Mandate.
29 <sup>th</sup> June 2009	Final Report from CEPT to the Commission (including possible amendments resulting from public consultation)	Description of work undertaken and final results under this Mandate based on the outcome of the public consultation.

In addition, CEPT is requested to report on the progress of its work pursuant to this Mandate to all the meetings of the Radio Spectrum Committee taking place during the course of the Mandate.

The result of this Mandate can be made applicable in the European Community pursuant to Article 4 of the Radio Spectrum Decision<sup>2</sup>.

In implementing this Mandate, the CEPT shall take the utmost account of Community law applicable.

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<sup>2</sup> Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJ L 108 of 24.4.2002, p.1.



**ANNEX 2: LIST OF REFERENCES**

- [1] ECC/DEC/(08)08: ECC Decision of 31 October 2008 on the harmonised use of GSM system on board vessels in the frequency bands 880-915/925-960 MHz and 1710-1785/1805-1990 MHz <http://www.erodocdb.dk/>
- [2] ECC Report 122: The compatibility between GSM use onboard vessels and land-based networks. Vilnius, September 2008 (<http://www.erodocdb.dk/>)
- [3] ERC Report 81: Basic principles for spectrum sharing between the GSM and RSBN systems. Nicosia, January 1999 (<http://www.erodocdb.dk/>)
- [4] ITU Radio Regulations ([www.itu.int](http://www.itu.int))
- [5] Recommendation ITU-R P.525-2: Calculation of free-space attenuation ([www.itu.int](http://www.itu.int))
- [6] Recommendation ITU-R P.1546-2: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz ([www.itu.int](http://www.itu.int))
- [7] ETSI TS 148 008: Digital cellular telecommunications system (Phase 2+); Mobile Switching Centre - Base Station system (MSC-BSS) interface; Layer 3 specification
- [8] ETSI TS 144 018: Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification; Radio Resource Control (RRC) protocol