ECC Report 237

Compatibility study between wideband Mobile Communication services on board Vessels (MCV) and land-based MFCN networks

Approved 3 July 2015

0 EXECUTIVE SUMMARY

This Report studies the compatibility between Mobile Communications on board Vessels (MCV) systems and land-based MFCN networks, addressing three distinct issues:

- Suitability of the current MCV framework (ECC/DEC/(08)08 [1]) for the protection of land-based networks using LTE in the 900 MHz and 1800 MHz bands;
- Compatibility for scenarios introducing a new combination of technology and band on board vessels : introduction of LTE in the 1710-1785 / 1805-1880 MHz and 2500-2570 / 2620-2690 MHz bands (LTE MCV 1800 MHz and 2600 MHz); introduction of UMTS in the 1920-1980 / 2110-2170 MHz band (UMTS MCV 2 GHz); Lessons learnt from the current experience with ECC/DEC/(08)08 (GSM on board vessels in the bands 880-915 / 925-960 MHz and 1710-1785 / 1805-1880 MHz).

Analysing the results of the simulations, it appears that:

- The technical and operational conditions for GSM on board vessels from ECC/DEC/(08)08 are suitable for the protection of land-based LTE in networks in the 900 MHz and 1800 MHz band; In the 900MHz band, the simulation results show MCV GSM data traffic without DTX (i.e. GPRS/EDGE) could create more interferences to land LTE networks. As a consequence, the activation of GPRS/EDGE is not recommended in the 900MHz band. With the introduction of wideband technologies on board vessels, it is expected that data traffic will migrate to these new technologies.
- The protection of LTE and UMTS land networks requires to set some MCV system parameters to specific values, as summarized in Table 1.
- The maximum bandwidth to be used by the MCV system (LTE or UMTS) is 5 MHz (duplex) per frequency band (1800 MHz, 2100MHz or 2600 MHz bands);

The following MCV UMTS and LTE networks system parameters are also required to be set to specific values:

- RRC user inactivity timer is set to 2 seconds;
- LMPN network selection timer is set to 10 minutes in national waters;
- MCV carrier centre frequency shall not be aligned with land network carriers;
- The scrambling code of MCV UMTS network and the PCI of the LTE network shall be different from the PCI of land networks.

In order to avoid a harmful interference from LTE MCV systems in the international waters towards the LTE 1800 MHz and 2600 MHz terrestrial networks base stations, it is recommended to limit MCV LTE UE Tx power to the values given in Table 84 and Figure 14 between 12 and 41 NM from baseline. For simplification purpose the following formula could be used to define the MCV LTE1800 and LTE2600 UE Tx Power (dBm): 2+(D-12)*0.75, where D (NM) is the separation distance from baseline between 12 NM and 41 NM.

For MCV UMTS systems, no mitigation is required in international waters.

Table 1: MCV system specific values to protect land networks systems (GSM and LTE in the 1800 MHz band / UMTS and LTE in the 2100 MHz band / LTE in the 2600 MHz band)

System	On/off border (from baseline)	Outdoor antennas on/off (from baseline)	MCV UE max tx power	Quality criteria Qrxlevmin	Indoor MCV BS emission limit on deck	RRC inactivity release timer	Cell range for the DAS*
UMTS (2100 MHz)	2 NM	12 NM	0 dBm / 5 MHz	>= -87 dBm / 5 MHz between 2 and 12 NM	- 102 dBm / 5 MHz (CPICH)	2 seconds	600m
LTE (1800 MHz and 2600 MHz)	4 NM	12 NM	0 dBm (PcMax)	>= -105 dBm / 15 kHz (>= -83 dBm / 5 MHz) between 4 and 12 NM	-120 dBm / 15 kHz (-98 dBm / 5 MHz)	2 seconds	400m

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ACCMIN	Minimum received signal level for accessing the network
BCCH	Broadcast Control Channel
BP	Break Point
BS	Base Station
CPICH	Common Pilot Channel
DAS	Distributed Antenna System
DTX	Discontinuous Transmission
ECC	Electronic Communications Committee
EEZ	Exclusive Economic Zone
e.i.r.p.	equivalent isotropically radiated power
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
GSM	Global System for Mobile communications
GSMOBV	GSM on board vessels
LTE	Long Term Evolution
MCV	Mobile Communications on-board Vessels
MFCN	Mobile/Fixed Communications Networks
MSL	Mean Sea Level
NM	Nautical Mile
OMC	Operational Maintenance Centre
PCI	Physical layer Cell Identity
PLMN	Public Land Mobile Network
RR	Radio Regulation
RS	Reference Signal
RSRP	Reference Symbol Received Power
RXLEV	Received Signal Level
SDCCH	Standalone Dedicated Control Channel
SEAMCAT	Spectrum Engineering Advanced Monte Carlo Analysis Tool
SINR	Signal to Interference Noise Ratio
TCH	Transport Channel
TDD	Time Division Duplex
TS	Technical Specification
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UNCLOS	United Nations Convention on the Law of the Sea

1 INTRODUCTION

According to the current regulatory framework (ECC/DEC/(08)08 [1]), Mobile Communications on board Vessels systems are allowed in the 900 MHz and 1800 MHz bands using the GSM technology. The ECC/DEC/(08)08 “on the harmonised use of GSM system on board vessels in the frequency bands 880-915 / 925-960 MHz and 1710-785 / 1805-1880 MHz”, published on 31st of October 2008 was based on ECC Report 122 [2] “The compatibility between GSM use on board vessels and land-based networks”.

Since 2008, new technologies and new frequency bands have been made available to the Mobile/Fixed Communications Networks (MCFN). The present Report aims at studying the use of new technology/band combinations on board vessels while ensuring the compatibility with land-based networks. The new technology/band combinations envisaged for the MCV systems are: LTE in the 1800 MHz and 2600 MHz bands; and UMTS in the 2100 MHz band. Since LTE in the 900 MHz band benefits from an harmonisation at EU level[1] [4] and since this technology was not part of ECC Report 122, the present Report also studies the compatibility between GSM on board vessels complying to the technical and operational conditions from ECC/DEC/(08)08, with land-based network using LTE in the 900 MHz band.

The parameters used in the studies are given in section 2.2 and 2.3 for both the land-based networks and the MCV networks. Only the possible interferences from MCV networks on to land-based network are studied since MCV networks shall not cause harmful interference to, or claim protection from, any other authorised system. A total of 35 scenarios, as described in section 2.4, have been addressed to cover all the technology/band/network topology combinations.

An analysis of the SEAMCAT simulation results is given in section 3 for scenarios related to existing bands for MCV (900 MHz and 1800 MHz bands) and in section 4 for scenarios related to the possible new bands for MCV (2100 MHz and 2600 MHz). Mitigation techniques to protect the land-based networks are proposed in section 5.

This Report presents in section 6 studies on the suitability of the MCV framework for avoiding interferences and preventing unintended roaming. The conclusions are given in section 7.

[1] 2011/251/EU [4]

2 DEFINITIONS, PARAMETERS AND SCENARIOS FOR THE STUDIES

2.1 DEFINITIONS

2.1.1 Maritime zones, measured from baselines (typical values)

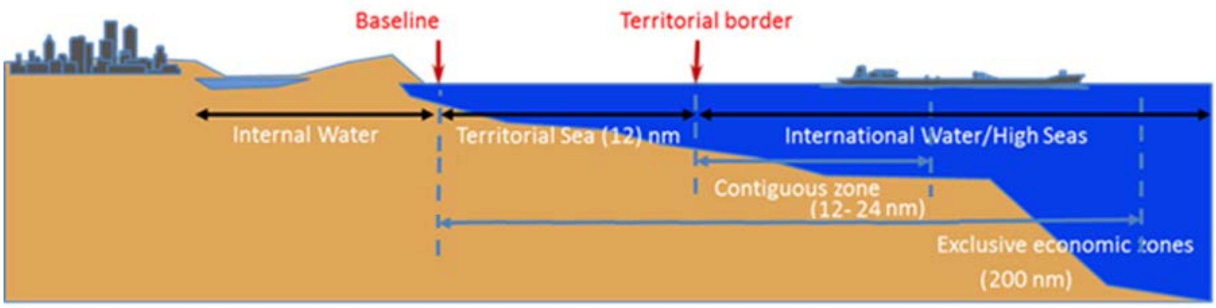

Figure 1: Maritime zones, measured from baselines (typical values)

Internal waters are defined as all waters shoreward of the baseline. In internal waters, vessels are subject to national/domestic jurisdiction.

Territorial Sea consists in the first 12 NM of ocean seaward of the baseline. In territorial sea, international law applies (for US and some other countries first 3 NM, domestic law applies).**Exclusive Economic Zone** is defined as the waters seaward of the territorial sea, extending to 200 NM from the baseline. The coastal nation has jurisdiction over foreign vessels for the purpose of management and conservation of the natural resources of the waters, seabed and subsoil of the zone.

High Seas/international waters are defined as all parts of the ocean seaward of any nation's including the Contiguous zone (which may not extend beyond 24 nautical miles from the baseline) and the Exclusive Economic Zone (EEZ). All "floating" vessels are subject to the exclusive jurisdiction of their flag nation. Systems are operated according to ITU RR5 and international laws in the area outside the territorial border.

The following methods are used to measure a baseline under United Nations Convention on the Law of the Sea 1982.

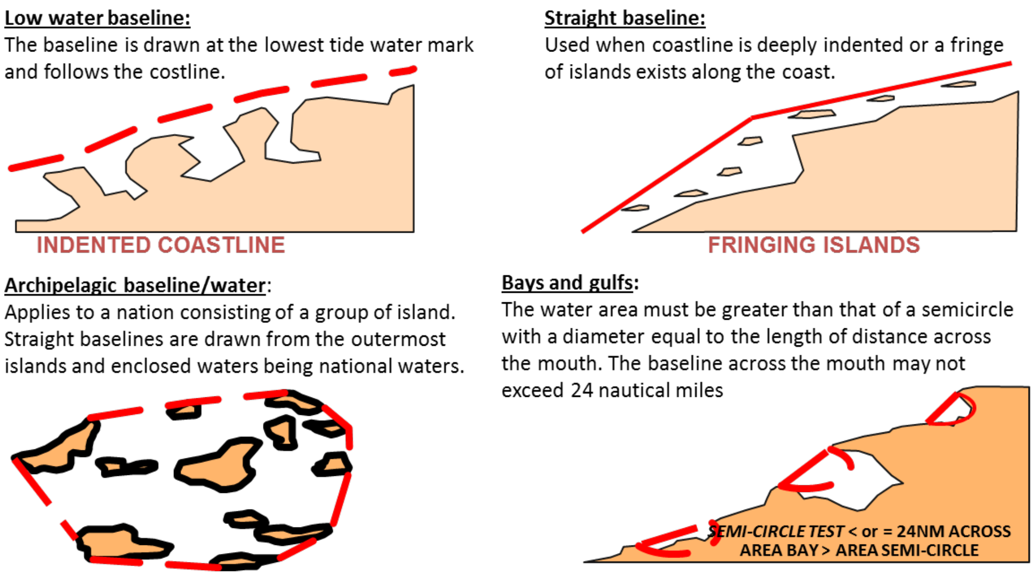

Figure 1: Definition of a baseline

The MCV system is using the baseline as reference for its operation. The baseline is defined in a map database. Modifications of the special areas may be defined to force the system to turn off in special areas (i.e. military zones, etc.).

2.2 LTE 900, LTE 1800, LTE 2600, UMTS 2100 PARAMETERS

2.2.1 Land based MFCN parameters

Given the technologies for the land based mobile service network currently used or planned in the frequency bands under consideration, the studies are conducted for LTE in the 1800 MHz and 2.6 GHz bands and for UMTS in the 2 GHz band. Since TDD systems are not envisaged to be used on board vessels in the duplex gap of the 2.6 GHz FDD band plan, only parameters for FDD systems are given in this section.

Table 2: Land BS MFCN parameters

Land MFCN base station		LTE 900	LTE 1800	LTE 2600	UMTS 2100
Channel bandwidth	MHz	5 MHz,10 MHz			5 MHz
Transmit Power	dBm	46 dBm / 10 MHz			43 dBm / 5 MHz, 10% for pilote
Antenna gain	dBi	18			
Antenna pattern		Sector (H = 65°, V = 8°)			
Antenna height above ground	m	30			
terrain height above sea (case 1)*	m	300			
Terrain height above see (case 2)	m	40			

Land MFCN base station		LTE 900	LTE 1800	LTE 2600	UMTS 2100
Minimum coupling loss (UE-BS)	dB	70			
Feeder loss**	dB	0			
Typical noise figure	dB	3			
Receiver thermal noise level	dBm/channel	-104.4 dBm / 4.5 MHz			-105.1 dBm / 3.84 MHz
Receiver sensitivity	dBm/channel	-103.5 dBm / 4.5 MHz			-123 dBm /3.84 MHz
Protection ratio		I/N = -6 dB 1% throughput loss			I/N = -6 dB 1% capacity loss
Cell range***	Km	125	55	43	156
Number of transmitting UE per cell (for LTE simulations)		5			

The table below shows the path losses and corresponding cell ranges for the land network for free space, and for Recommendation ITU-R P.1546 (sea model) and P452 models for BS height 330 m. P1546 cell range is estimated using the sea model charts of Recommendation ITU-R P.1546 (SEAMCAT only has land model). P452 cell range is estimated using SEAMCAT. In the simulations, the free space model is used for the path between the land UE and the land BS. As a consequence, the land cell range is independent of land network BS antenna height (simulations are done with 40m and 300m terrain height and an additional 30 m antenna height). The table below shows the land cell ranges used in the simulation (based on free space model) and the cell ranges using Recommendation ITU-R P.1546 sea model and P.452 with a land BS antenna height of 330 m [3].

Table 3: Cell ranges

Scenario	Path Loss (dB)	Free Space	ITU-R P1546 sea model (330 m I-BS antenna height)	P452 (330 m I-BS antenna height)
1. MCV GSM900 – Land LTE 900	133,5	125 km	60 km	41 km
2. MCV GSM1800 – Land LTE 1800	132,5	55 km	49 km	39 km
3. MCV LTE 1800 – Land GSM1800	134,5	70 km	52 km	42 km
4. MCV LTE 1800 – Land LTE 1800	133,5	55 km	49 km	39 km
5. MCV UMTS – Land UMTS	142,0	156 km	63 km	55 km
6. MCV UMTS – Land LTE 2100	132,5	48 km	43 km	39 km
7. MCV LTE 2600 – Land LTE 2600	133,5	43 km	42 km	39 km

The land MFCN parameters for the User Equipment are given in the table below.

Table 4: Land UE MFCN parameters

Land MFCN User Equipment (UE)		LTE 900	LTE 1800	LTE 2600	UMTS 2100
Channel bandwidth	MHz	5MHz, 10 MHz			5 MHz
UE Transmit Power	dBm/channel	23 (max.)			24 (max.)
UE Antenna Gain	dB	-3			
Antenna pattern		Omni			
Antenna height above ground	m	1.5			
Typical terrain height above sea	m	0			
Body loss	dB	4 or 1 (only considering handheld loss)			
Typical noise figure	dB	8			
Receiver thermal noise level	dBm/channel	-96.4 dBm / 9 MHz			-100.1 dBm / 3.84 MHz
Receiver sensitivity	dBm/channel	-94 dBm / 9 MHz	-95 dBm / 9 MHz	-96 dBm / 9 MHz	-118 dBm / 3.84 MHz
Protection ratio		I/N = 0 dB 1% throughput loss			I/N = 0 dB 1% capacity loss

The horisontal and vertical antenna patterns for the base stations of the land-based networks are as follow:

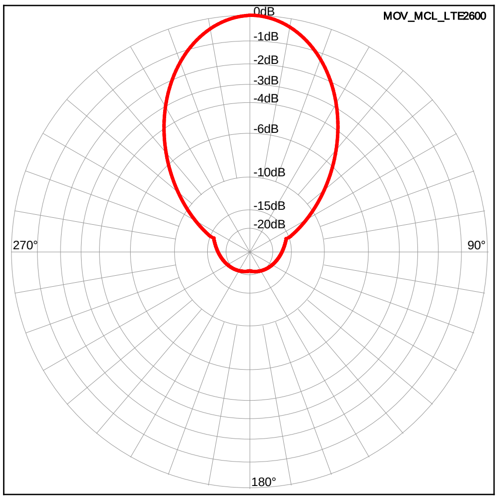

Figure 2: Land Base Station antenna horisontal pattern

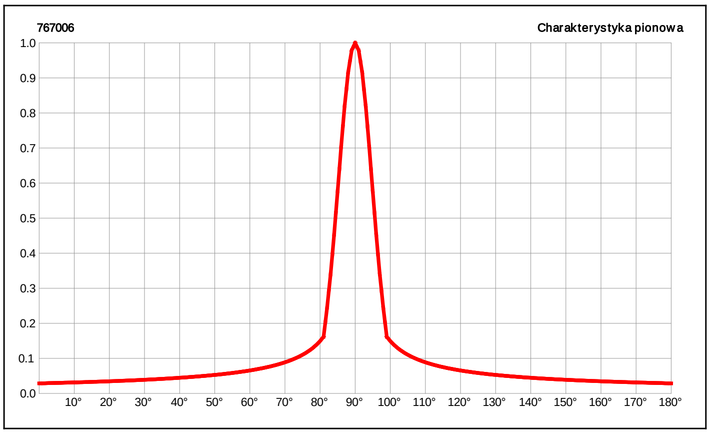

Figure 3: Land Base Station antenna vertical pattern

2.2.2 MCV system parameters

LTE is a technology candidate for being introduced in 1800 MHz and 2600 MHz bands on board vessels while for the 2GHz band, the candidate technology is UMTS.

Table 5: MCV base station parameters

MCV base station		LTE 1800	LTE 2600	UMTS 2100
Channel bandwidth	MHz	5 MHz, 10 MHz		5 MHz
Indoor Antenna Transmit power (per antenna)	dBm/channel	-5		
Typical number of antennas		50		
Indoor Antenna gain	dBi	2 3 (900 MHz band)	4	3
Outdoor antennas transmit power (considering four antennas of -5 dBm/antenna facing the land modeled as a single omni antenna for MCV)	dBm/channel	1		
Outdoor antennas (modeled as a single omni antenna for MCV) gain	dBi	3(900), 2 (1800), 3 (2100), 4(2600)		
Antenna pattern		Omni		
Antenna height above ground	m	3		
Typical terrain height above sea	m	12/27		
Minimum coupling loss (UE-BS)	dB	50		
Typical noise figure	dB	8		

MCV base station		LTE 1800	LTE 2600	UMTS 2100
Receiver thermal noise level	dBm/channel	-99.4 dBm / 4.5 MHz		-100,1 dBm / 3.84 MHz
Receiver sensitivity	dBm/channel	-98.5 dBm / 4.5 MHz		-118 dBm / 3.84 MHz
Cell radius	Km	0.05		
Number of transmitting UE per cell (for LTE simulations)		5 indoor / 1 outdoor*		

Table 6: MCV User Equipment (UE) parameters

MCV User Equipment (UE)		LTE 1800	LTE 2600	UMTS 2100
Channel bandwidth	MHz	10		5
UE Transmit Power	dBm/channel	23 (max.)		24 (max.)
UE Antenna Gain	dB	-3		
Antenna pattern		Omni		
Antenna height above ground	m	1.5		
Typical terrain height above sea	m	10		
Body loss	dB	4 or 1 (only considering handheld loss)		
Handheld loss	dB	1		
Typical noise figure	dB	8		
Receiver thermal noise level	dBm/channel	-96.4 dBm / 9 MHz		-100.1 dBm / 3.84 MHz
Receiver sensitivity	dBm/channel	-95 dBm / 9 MHz	-96 dBm / 9 MHz	-118 dBm / 3.84 MHz

2.3 GSM PARAMETERS (MCV SYSTEM)

The GSM parameters are taken from Table 2 of ECC Report 122 [2]. They only apply to GSM on board vessels since no scenario involving GSM on land is studied in this Report.

Table 7: GSM parameters

Parameter	Units	GSM900		GSM1800	
		MS	BS	MS	BS
Antenna input Power	dBm / channel	5	-6	0	-6
Receiver bandwidth	kHz	200	200	200	200
Reference System noise figure (taken from values quoted in standards)	dB	12	8	12	8
Typical System noise figure (operator quoted “typical” values)	dB	7	4	7	4
Reference Noise level (taken from values quoted in standards)	dBm / channel	-109	-113	-109	-113
Typical Noise level (“typical” operator values)	dBm / channel	-114	-117	-114	-117
Reference Receiver Sensitivity (taken from values quoted in standards)	dBm / channel	-102	-104	-102	-104
Typical; Receiver Sensitivity (“typical” operator values)	dBm / channel	-105	-108	-105	-108
Interference criterion I (C/(N+I))	dB	9	NA	9	9
Interference criterion II (I/N)	dB	-6	NA	-6	-6
Channel Spacing	kHz	200	200	200	200
Maximum antenna gain	dBi	0	2	0	2
Antenna heights (above mean sea level (MSL))	m	15/20/ 30	15/20/ 30	15/20/ 30	15/20/30
Body loss / Handheld loss	dB	4 or 1		4 or 1	

Notes:

- Typical antenna input power is –6 dBm for existing GSMOBV systems;
- The reference values taken from standards documentation are based on the 3GPP specifications;
- The bodyloss / handheld loss was not defined in ECC Report 122 [2].

In addition to these parameters used as baseline for the simulation, sensitivity analysis is performed using the technical conditions defined in ECC/DEC/(08)08 [1] which are:

- the System shall not be used closer than 2 NM from the baseline;
- only indoor v-BS antenna(s) shall be used between 2 and 12 NM from the baseline;

- DTX[2] has to be activated on the System uplink;
- the timing advance[3] 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 to 3 NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN[4] and min RXLEV[5] level) shall be -70 dBm/200 kHz;
- Within 3 to 12 NM from the baseline the v-MS receiver sensitivity and the disconnection threshold (ACCMIN and min RXLEV level) shall be -75 dBm/200 kHz;
- the v-BS emissions measured anywhere external to the vessel (i.e. at vessel perimeter or on its open deck areas) shall not exceed -80 dBm/200 kHz (assuming a 0 dBi measurement antenna gain).

2.4 SCENARIOS

The objective of this Report is to evaluate the possibility of introducing LTE on board vessels in the 1800 MHz and 2600 MHz bands, and UMTS in the band 2 GHz band. The following scenarios are studied to assess the potential of interferences on to land-based mobile network brought by the introduction of these new technologies. Since LTE will also be deployed in land-based networks in the 900 MHz band, impact of GSM on board vessel on to land mobile LTE network in the 900 MHz band is also studied.

For each band and for each technology considered for the interferer (the MCV system) and the victim (the land-based network), the scenario is subdivided into five sub-scenarios depending on the deployment configuration of the MCV system (indoor or outdoor).

Table 8: Scenarios studied

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
900	GSM	LTE	Outdoor v-BS	l-UE	1.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	1.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	1.3
			Indoor v-BS	l-UE	1.4
			Indoor v-UE	l-BS	1.5
1800	GSM	LTE	Outdoor v-BS	l-UE	2.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	2.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	2.3
			Indoor v-BS	l-UE	2.4
			Indoor v-UE	l-BS	2.5
	LTE	GSM	Outdoor v-BS	l-UE	3.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	3.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	3.3

[2] DTX (discontinuous transmission, as described in GSM standard 3GPP TS 148.008)
[3] Timing advance (as described in GSM standard 3GPP TS 144.018)
[4] ACCMIN (RX_LEV_ACCESS_MIN, as described in GSM standard 3GPP TS 144.018)
[5] RXLEV (RXLEV-FULL-SERVING-CELL, as described in GSM standard 3GPP TS 148.008)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
			Indoor v-BS	I-UE	3.4
			Indoor v-UE	I-BS	3.5
	LTE	LTE	Outdoor v-BS	I-UE	4.1
			Outdoor v-UE (connected to indoor v-BS antenna)	I-BS	4.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	I-BS	4.3
			Indoor v-BS	I-UE	4.4
			Indoor v-UE	I-BS	4.5
2 GHz	UMTS	UMTS	Outdoor v-BS	I-UE	5.1
			Outdoor v-UE (connected to indoor v-BS antenna)	I-BS	5.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	I-BS	5.3
			Indoor v-BS	I-UE	5.4
			Indoor v-UE	I-BS	5.5
	UMTS	LTE	Outdoor v-BS	I-UE	6.1
			Outdoor v-UE (connected to indoor v-BS antenna)	I-BS	6.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	I-BS	6.3
			Indoor v-BS	I-UE	6.4
			Indoor v-UE	I-BS	6.5
2.6 GHz FDD	LTE	LTE	Outdoor v-BS	I-UE	7.1
			Outdoor v-UE (connected to indoor v-BS antenna)	I-BS	7.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	I-BS	7.3
			Indoor v-BS	I-UE	7.4
			Indoor v-UE	I-BS	7.5

Simulation results for scenarios 1 to 4, dealing with bands where MCV systems are already allowed (900/1800), are given in section 3 while simulation results for scenarios 5 to 7, dealing with the possible new frequency bands for MCV, are given in section 4.

2.5 PROPAGATION MODELS

In order to address the scenarios mentioned in the section 2.3, the following propagation paths are identified.

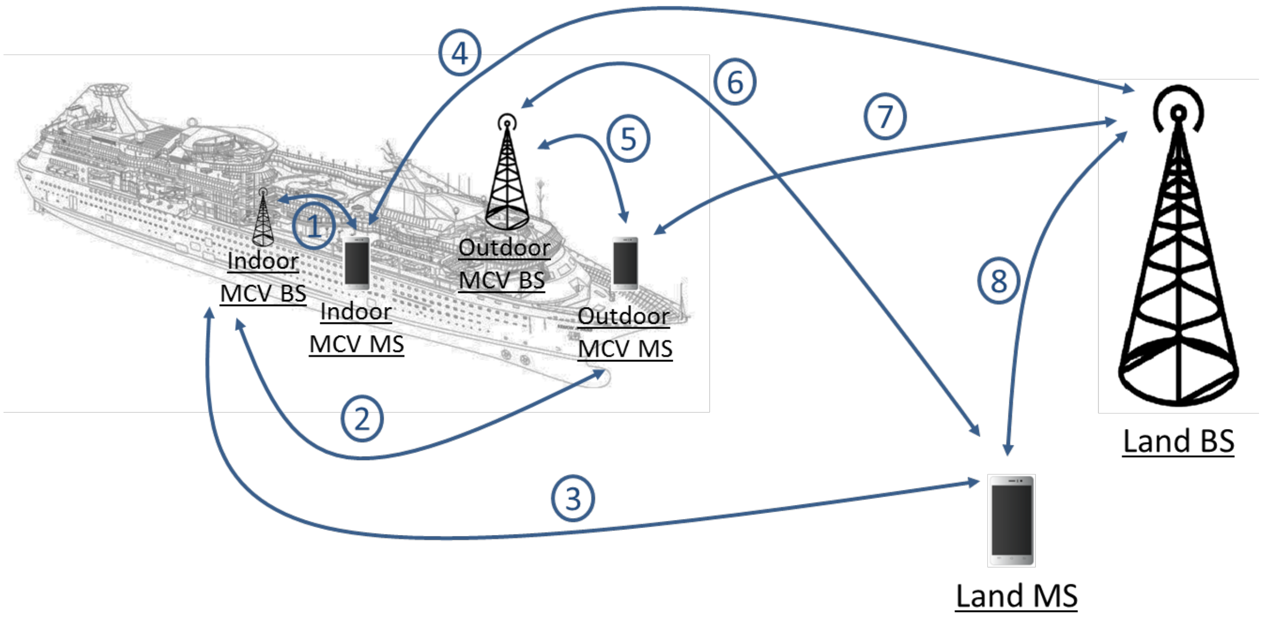

Figure 2: Propagation paths considered in the studies

The Table 9 describes for each of the above path the propagation model used in the studies.

Table 9: Propagation models

Path number	Path description	Propagation Model
1	Indoor MCV BS - Indoor MCV MS	IEEE C-Model (Break Point = 15m)
2	Indoor MCV BS - Outdoor MCV MS	Baseline: IEEE C-model (BP = 15 m) + 11 dB (σ = 6 dB) Sensitivity analysis: IEEE C-model (BP = 15 m) + 20 dB
3	Indoor MCV BS - Land MS	Baseline: ITU-R JTG 5-6 Sea model + 11 dB (σ = 6 dB) + 1 dB Sensitivity analysis: ITU-R JTG 5-6 Sea model +30 dB
4	Indoor MCV MS - Land BS	Baseline: ITU-R JTG 5-6 Sea model + 11 dB (σ = 6 dB) + 1 dB Sensitivity analysis: ITU JTG 5-6 Sea model +20 dB
5	Outdoor MCV BS - Outdoor MCV MS	IEEE C-model (Break Point = 15 m)
6	Outdoor MCV BS - Land MS	ITU-R JTG 5-6 Sea model + 1 dB
7	Outdoor MCV MS - Land BS	Baseline: ITU JTG 5-6 Sea model + 1 dB Sensitivity analysis: ITU JTG 5-6 Sea model + 30 dB
8	Land BS - Land MS	Free space with a 3.3 dB standard deviation

ITU JTG5-6 model is equivalent to Recommendation ITU P1546-2 for distances greater than 1km. The JTG5-6 model is a SEAMCAT plugin and can thus be modified to take into account the sea path whereas Recommendation ITU-R P.1546 model is implemented in SEAMCAT with land propagation curves only and can't be modified. The comparison between JTG56 sea model, ITU-R P1546 land model [3], and Free Space model is plotted in Figure 3.

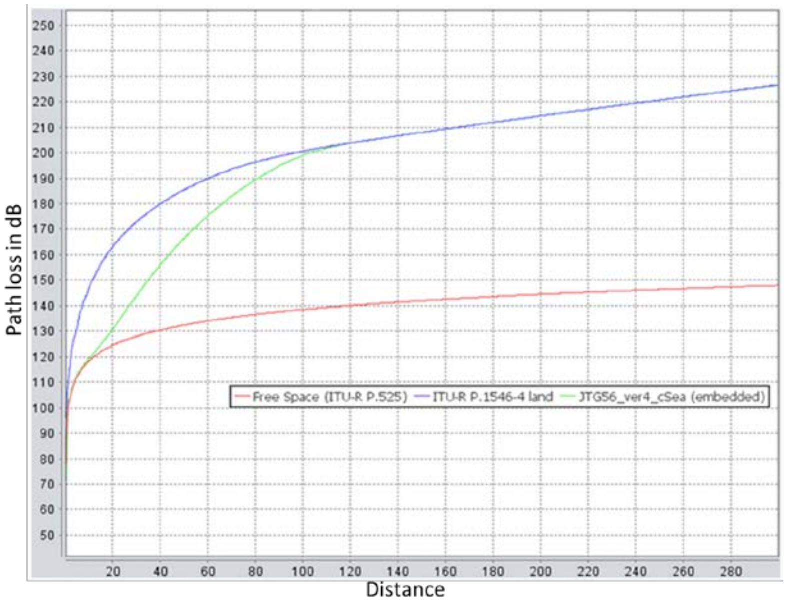

Figure 3: Propagation model comparison

For paths 2, 3, 4 and 7, several values for the additional attenuation factor are taken, accounting for all the attenuations of the body structures of the vessel (hull, walls, doors, windows, fences, etc.):

- As a baseline, the values are taken from existing ITU-R Recommendation P.1812 [15];
- For sensitivity analysis, values from actual measurements are taken. These measurements are presented in Estimation of the indoor-outdoor penetration loss on a ;
- Further information on the factor "+1 dB" added to the propagation losses for paths 3, 4 and 7 is given in Evaluation of the attenuation of the vessel's side;
- To take into account the specificity of the indoor environment inside vessels (presence of people across the propagation link in the corridors), the IEEE C-model is used with a breakpoint at 15m.

3 COMPATIBILITY STUDIES IN THE BANDS 900 AND 1800 MHZ

This section provides an analysis of the results of the simulations carried out. These simulations address two distinct issues:

- MCV systems are currently using the GSM technology in the 900 MHz and 1800 MHz bands according to the technical and operational conditions from ECC/DEC/(08)08 [1]. This decision was based on the ECC Report 122 published in 2008 [2] . Since 2008, the technologies used in those bands by land networks have changed or are changing. This section presents results to assess the suitability of technical and operational conditions from ECC/DEC/(08)08 to protect land network using LTE in those bands (scenario 1 for the 900 MHz band ; scenario 2 for the 1800 MHz band)

- The LTE technology is candidate for being used on board vessels in the 1800 MHz band. This section presents compatibility studies with land networks using either GSM (scenario 3) or LTE (scenario 4).

The simulations take into account the existing technical and operational requirements for GSM systems on board vessels from ECC/DEC/(08)08. The simulations have been done with SEAMCAT version 4.1.1.

3.1 SCENARIO 1: IMPACT OF GSM 900 ON VESSEL ON TO LTE 900 ON LAND

Taking into account ECC/DEC/(08)08 technical and operational conditions between 2 and 12 NM, the simulation results show a capacity loss for the land network above 1% for the most critical sub-scenario (scenario 1.5, impact of indoor MCV UE on to land BS). The propagation loss accounting for the vessel attenuation in this sub-scenario is 20 dB. An indoor MCV UE located at 2 NM from the land base station will cause a capacity loss of about 1.5%. It should be noted that in GPRS and Edge data service, the DTx is not used, and when considering 12 dB vessel attenuation (11 dB hull loss and 1 dB fense loss), the land network data capacity loss can be up to 12% when MCV GSM 900 MS transmits at 5 dBm. Nevertheless in the actual MCV framework, the activation of the DTx is mandatory.

For the other sub-scenarios, the capacity loss is below 1%.

The detailed simulation results for scenario 1 are given in ANNEX 1:.

3.2 SCENARIO 2: IMPACT OF GSM 1800 ON VESSEL ON TO LTE 1800 ON LAND

Taking into account ECC/DEC/(08)08 technical and operational conditions between 2 and 12 NM, none of the compatibility studies done for this scenario shows a high capacity loss on land network. The simulation results show that GSM on board vessel in the 1800MHz band with DTx on provide an appropriate protection to the land LTE1800 networks. The technical and operational conditions from ECC/DEC/(08)08 seem to be appropriated for protecting LTE 1800 land networks. The detailed simulation results for scenario 2 are given in ANNEX 2:.

3.3 SCENARIO 3: IMPACT OF LTE 1800 ON VESSEL ON TO GSM 1800 ON LAND

The studies assume that the outdoor antennas are supposed turned off in territorial waters (between 2 and 12 NM).

Under those assumptions, allowing LTE in the 1800 MHz band for MCV systems would not cause a high capacity loss on GSM1800 land network.

The detailed simulation results for scenario 3 are given in ANNEX 3:.

3.4 SCENARIO 4: IMPACT OF LTE 1800 ON VESSEL ON TO LTE 1800 ON LAND

This scenario has several challenging sub scenarios in terms of compatibility:

- Simulation results for scenario 4.2 show interferences from MCV outdoor UE connected to indoor MCV BS on to land BS. Without any mitigation techniques, land network data capacity loss is above 1% if the separation distance between MCV UE and land BS is below 80km. Within the territorial water, with the assumption that the MCV UE is located on the land side of the vessel (the vessel provides low attenuation between the MCV UE and the land BS), the capacity loss is between 95% (at 2 NM from baseline) and 48% (at 12 NM from baseline). As a consequence, simulations have been run with decreasing MCV UE maximum power until a capacity loss for the land network below 1% was reached. The MCV UE maximum power reaching that condition is 0 dBm at 12 NM from the baseline and -14 dBm at 2 NM from the baseline. Alternatively, rather than limiting the MCV UE maximum transmit power, having mandatory mechanisms preventing the MCV outdoor UE from connecting to indoor MCV antenna would solve the issue in the territorial waters.
- Simulation results for scenario 4.3 show interferences from MCV outdoor UE connected to outdoor MCV BS on to land BS. Compared to scenario 4.2, the MCV UE is connected to a MCV outdoor antenna rather than to a MCV indoor antenna. The separation distance to ensure a below 1% capacity loss for the land network is the same as for scenario 4.2 (80km). It could even be 90 km considering land BS at 600m above sea level. In the territorial waters, MCV UE maximum power should be -14 dBm for a UE at 2 NM from baseline and 0 dBm for a UE at 12 NM from baseline. Alternatively, if the outdoor antennas are requested to be turned off between 2 and 12 NM from shore, the issue is solved in territorial waters.
- Simulation results for scenario 4.5 show interferences from MCV indoor UE on to land BS. Simulations have been done with two values for the attenuation accounted for the vessel (wall loss, hull loss, fence loss)
  - For a 20 dB overall vessel attenuation, capacity loss on land network is below 1% if the separation distance is above 50km. At 2 NM, the capacity loss on the land network is about 23%. To decrease it below 1%, there is a need to reduce the MCV UE maximum transmit power to 3 dBm.
  - For a 12 dB overall vessel attenuation, capacity loss on land network is below 1% if the separation distance is above 70km. At 2 NM, the capacity loss on the land network is about 57%. To decrease it below 1%, there is a need to reduce the MCV UE maximum transmit power to -5 dBm. At 12 NM there is a need to limit the MCV UE transmit power to 0 dBm.

The other sub-scenarios (4.1 and 4.4) show limited risk of capacity loss for land networks.

The detailed simulation results for scenario 4 are given in ANNEX 4:.

4 COMPATIBILITY STUDIES IN NEW BANDS FOR MCV

4.1 SCENARIO 5: IMPACT OF UMTS 2100 ON VESSEL ON TO UMTS 2100 ON LAND

There is no interference issue if outdoor antennas are off between 2 and 12 NM and if outdoor MCV UEs are not allowed to connect to indoor MCV BS (if technically applicable; if not applicable the UE maximum transmit power will have to be limited).

The detailed simulation results for scenario 5 are given in ANNEX 5:.

4.2 SCENARIO 6: IMPACT OF UMTS 2100 ON VESSEL ON TO LTE 2100 ON LAND

Assuming that MCV outdoor antennas are off between 2 and 12 NM, there is no capacity loss on the land network above 1%.

The detailed simulation results for scenario 6 are given in ANNEX 6:.

4.3 SCENARIO 7: IMPACT OF LTE 2600 ON VESSEL ON TO LTE 2600 ON LAND

This scenario has several challenging sub scenarios in terms of compatibility:

- Simulation results for scenario 7.2 show interferences from MCV outdoor UE connected to indoor MCV BS on to land BS. Without any mitigation techniques, land network capacity loss is above 1% if the separation distance between MCV UE and land BS is below 80km. Within the territorial water, with the assumption that the MCV UE is located on the land side of the vessel (the vessel provides low attenuation between the MCV UE and the land BS), the capacity loss is between 91% (at 2 NM from baseline) and 38% (at 12 NM from baseline).

  As a consequence, simulations have been run with decreasing MCV UE maximum power until a capacity loss for the land network below 1% is reached. MCV UE maximum power reaching that condition is 0 dBm at 12 NM from the baseline and -12 dBm at 2 NM from the baseline. Alternatively, rather than limiting the MCV UE transmit power, having mandatory mechanisms preventing the MCV UE from connecting to indoor MCV antenna would solve the issue in the territorial waters.

- Simulation results for scenario 7.3 show interferences from MCV outdoor UE connected to outdoor MCV BS onto land BS. Compared to scenario 7.2, the MCV UE is connected to a MCV outdoor antenna rather than to a MCV indoor antenna. The separation distance to ensure a below 1% capacity loss for the land network is 70km. It could even be 80km considering land BS at 600m above sea level.

  In the territorial waters, the results are similar too: MCV UE maximum power should be -12 dBm for a UE at 2 NM from the baseline and 0 dBm for a UE at 12 NM from the baseline. Alternatively, if the outdoor antennas are requested to be turned off between 2 and 12 NM from shore, the issue is solved in territorial waters.

- Simulation results for scenario 7.5 show interferences from MCV indoor UE on to land BS. Simulations have been done with two values for the attenuation accounted for the vessel (wall loss, hull loss, fence loss)
  - For 20 dB attenuation, the capacity loss on land network is below 1% if the separation distance is above 30km. At 2 NM, the capacity loss on the land network is about 30% (land BS at 70 m above

sea level). To decrease it below 1%, there is a need to reduce the MCV UE maximum transmit power to 5 dBm.

- For 12 dB attenuation, the capacity loss on land network is below 1% if the separation distance is above 60km. At 2 NM, the capacity loss on the land network is about 57%. To decrease it below 1%, there is a need to reduce the MCV UE maximum transmit power to -3 dBm. At 12 NM there is a need to limit the MCV UE transmit power to 0 dBm.

The other sub-scenarios (7.1 and 7.4) show limited risk of capacity loss for land networks.

The detailed simulation results for scenario 7 are given in ANNEX 7:.

5 MITIGATION TECHNIQUES FOR UMTS AND LTE MCV SYSTEMS OPERATION

In this section several mitigation techniques are presented and analysed to assess their capability to reduce the risk of interference in the problematic scenarios to an acceptable level.

5.1 EXCLUSION ZONE FROM BASELINE

Based on simulation results, it is required to allow UMTS MCV systems only from 2 NM from the baseline.

Based on simulation results, it is required to allow LTE MCV systems only from 4 NM from the baseline.

5.2 MCV SYSTEM CHANNEL BANDWIDTH

The studies for UMTS in this Report are done for a 5 MHz channel bandwidth. As a consequence, since other sizes were not studied, MCV networks will only use a 5 MHz channel bandwidth for UMTS. LTE MCV networks will be limited to 5 MHz channel bandwidth as well.

5.3 LIMIT MAXIMUM UE TRANSMIT POWER

According to the scenarios done for UMTS where 5 indoor users are simulated, it is proposed to reduce the maximum power of indoor MCV UEs to 0 dBm in order to reduce the risk of interference to a minimum.

For LTE, the maximum power of indoor MCV UEs (PCMax parameter) shall also be set to 0 dBm.

5.4 OUTDOOR ANTENNA OFF

It is proposed to switch off the outdoor antennas inside the terrestrial waters (between 0 and 12 NM) since it is an efficient way (but not sufficient, see section 5.5) to prevent outdoor UE to connect to the MCV networks.

5.5 EMISSION LIMIT ON DECK

It is proposed to define a maximum emitted pilot power measured on deck -102 dBm / 5 MHz for UMTS.

It is proposed to define a maximum emitted pilot power measured on deck -98 dBm / 5 MHz for LTE.

5.6 PREVENT CONNECTION FROM OUTDOOR UE (ON THE VESSEL OR NEAR THE VESSEL) TO MCV INDOOR BS

Switching OFF the outdoor antennas is not enough to prevent an outdoor MCV UE from causing harmful interference to the land network and additional mitigations are required to prevent the outdoor UE to attach to the indoor MCV antenna. This relates to the scenarios 5.2 and 6.2 (Outdoor v-UE connected to indoor v-BS with l-BS as victim).

A UE out on the vessel deck shall not be able to connect to a MCV indoor BS and an indoor UE which is connected to an indoor antenna shall be disconnected when moving to the deck. The parameter Qrxlevmin will effectively prevent mobiles from connecting and disconnect mobiles in idle mode.

A UE in connected mode will be disconnected when:

- For voice calls, the user ends the connection manually;
- For data calls (Packet Switched), the user manually ends the connection or the UE periodically switches to idle mode for testing, measurements, etc. The behaviour on CS data call is not covered;
- Radiolink failure occurs (uplink or downlink signal too weak or quality too bad)

According to 3GPP TS 25.304 [10], (sections 5.4.3, 5.5.5, 5.2.3 and 5.2.6), the quality measurement Qrxlevmin can be used to disable the possibility for an outdoor v-UE to attach to and use the signal from the indoor antennas. This is achieved by requiring the v-UE to measure a signal level above what is specified as Qrxlevmin and broadcasted to all UE's in the SIB1 messages. If the measured signal (pilot signal power over the whole bandwith (RSRP)) is below the specified Qrxlevmin level, the UE will be forced to make a cell re-selection. As a consequence, the UE may select a signal from a terrestrial network and disconnect from the MCV network.

Qrxlevmin has to be 15 dB above the maximum power on the deck.

- For UMTS, the emission limit on deck of -102 dBm / 5 MHz (CPICH), leads to a Qrxlevmin equals to -87 dBm / 5 MHz;
- For LTE, the emission limit on deck of -98 dBm / 5 MHz (-120 dBm/15kHz), leads to a Qrxlevmin equals to -83 dBm / (-105 dBm / 15kHz).

ANNEX 15: and ANNEX 16: gives an illustration of the possibility of having an outdoor MCV UE connected to an indoor MCV BS being disconnected because of the signal from land networks. In addition to Qrxlevmin, this provides a possible mitigation of the interference caused by indoor MCV UE connected to an indoor antenna and moving outside to the deck.

The mitigation factors (maximum UE Tx-power, limitation of MCV BS signal strength on deck and Qrxlevmin) will ensure that a mobile located near the vessel is not able to connect to the MCV system. If a mobile on deck is prevented to connect, then all mobiles located further away from the vessel will be prevented from connecting to the MCV network. But for extra safety, it is proposed to limit the MCV cell range. In a vessel, there can be as much as 300-350m of cabling/fibres in the antenna network.

- For UMTS systems, the resolution of the cell range parameter is 3 chips (234m). The minimum value for the cell range should be 300-350 m (delay in cabling/fibres) + 50m (cell range) + 234m (resolution) that is 584-634m. As a consequence, the recommended value, set in the NodeB, is 600 m;
- For LTE systems, the minimum value for the cell range should be 300-350 m (delay in cabling/fibres) + 50 m (cell range) that is 400 m.

It is additionally proposed to set the RCC inactivity timer to 2 seconds to ensure that UEs connected to an indoor MCV antenna will have the opportunity to quickly disconnect from the MCV network when moving outside the vessel. Indeed, using this timer, the network can disconnect a UE if there is no user activity (no user plan packets are exchanged between the UE and the BS).

5.7 MINIMIZE PROBABILITY FOR INTERFERENCE

In order to further reduce the probability of interference, it is proposed to set the following parameters on the MCV system:

- LMPN network selection timer set to 10 minutes in national waters;
  - A shorter LMPN network timer ensures faster connection to land networks when there is one available. This will reduce the number of mobiles in the MCV network, and by that the traffic in the MCV system. This in turn will reduce the probability for interference;

- MCV carrier centre frequency not aligned with land network carriers;
  - A non-alignment of MCV carrier centre frequency with land network will reduce the interference level since only part of the MCV system emitted power will cause co-channel interference on a specific land cell;
- For UMTS, scrambling code of MCV systems shall be different from the scrambling code of land networks;
- For LTE, PCI code of MCV systems shall be different from the PCI of land networks.

5.8 SUMMARY THE PROPOSED MITIGATION FRAMEWORK AND VALUES

Table 10 summarizes the MCV systems parameters and values defined in sections 5.1 to protect land networks.

The following additional parameters are also needed:

- RRC user inactivity timer is set to 2 seconds;
- LMPN network selection timer is set to 10 minutes in national waters;
- MCV carrier centre frequency shall not be aligned with land network carriers (see ERC/REC/(01)01 [5], ECC/REC/(11)05 [6] and ECC/REC/(08)02 [7]);
- The scrambling code of MCV UMTS network and the PCI of the LTE network shall be different from the PCI of land networks (ERC/REC/(01)01[5], ECC/REC/(11)05 [6] and ECC/REC/(08)02 [7]))

Additional descriptions of the parameters are given in ANNEX 14:.

5.9 SOLUTIONS FOR MITIGATING HARMFUL INTERFERENCE TO LAND NETWORK FROM MCV LTE SYSTEM IN THE INTERNATIONAL WATERS

As described in ANNEX 13:, in order to avoid a harmful interference from LTE MCV system in the international waters towards the terrestrial networks base stations, it is recommended to limit LTE MCV UE Tx power to the values given in Table 84 and Figure 14 between 12 and 41 NM from baseline (the simulations have been done for a land BS antenna height of 330m).

For MCV UMTS systems, no mitigation is required in international waters.

Table 10: MCV system specific values to protect land networks systems (GSM and LTE in the 1800 MHz band / and UMTS and LTE in the 2100 MHz band / LTE in the 2600 MHz band)

System	on / off border	Outdoor antennas on/off	UE max tx power	Quality criteria Qrxlevmin	Indoor MCV BS Emission on deck	RRC inactivity release timer	Cell range for the DAS*
UMTS (2100 MHz)	2 NM	12 NM	0 dBm / 5 MHz	>= -87 dBm / 5 MHz between 2 and 12 NM	- 102 dBm / 5 MHz (CPICH)	2 seconds	600m
LTE (1800 MHz and 2600 MHz)	4 NM	12 NM	0 dBm (PcMax)	>= -105 dBm / 15 kHz (>= -83 dBm / 5 MHz) between 4 and 12 NM	-120 dBm / 15kHz (-98 dBm / 5 MHz)	2 seconds	400m

6 UNINTENDED ROAMING

6.1 THE CURRENT SITUATION

In 2012, a questionnaire was sent to CEPT administrations to analyse the need for an update of ECC/DEC/(08)08. ECO has received 24 responses. The responses to the question 3 of the questionnaire are given in Responses to the ECO questionnaire.

The summary of the question “Have interference issues with land-based mobile networks been reported?” is “A very few cases have been reported, some caused by GSM OBV being not switched off in ports.”

6.2 UNWANTED ROAMING

An l-UE not on board the vessel shall not be able to roam into the MCV network. This is done with a combination of different techniques, the timing advance, the outdoor antenna switched off inside national water, and the MCV system switched off between 0 and 2 or 4 NM.

6.3 UNINTENDED ROAMING

Unintended roaming is the case where the passenger does not know that they have roamed into a MCV network. The maritime roaming possibility was not commonly known and the passenger could roam into the network without noticing it and without knowing the cost related to the usage.

Today maritime roaming is commonly known, the network name is shown on the UE display and EU regulation 531/2012 specifies that the home operator should send a SMS to alert the passenger that they are roaming.

7 CONCLUSION

The simulations (scenario 1 and 2) show that the technical and operational conditions from ECC/DEC/(08)08 [1] are sufficient to ensure the protection of LTE systems recently introduced or foreseen to be introduced in the 900 MHz and 1800 MHz bands on land network under condition that the regulatory technical and operational parameters in ECC/DEC/(08)08 are fully implemented. In the 900MHz band, the simulation results show MCV GSM data traffic without DTX (i.e. GPRS/EDGE) could create more interferences to land LTE networks. As a consequence, the activation of GPRS/EDGE is not recommended in the 900MHz band. With the introduction of wideband technologies on board vessels, it is expected that data traffic will migrate to these new technologies.

The compatibility between LTE on board vessels in the 1800 MHz and 2600 MHz and land network systems (GSM and LTE for the 1800 MHz band and LTE for the 2600 MHz band) can be met, according to the simulations (scenario 3, 4 and 7), under the following conditions:

- The MCV system shall be OFF between 0 and 4 NM;
- The MCV system outdoor antennas shall be OFF between 4 and 12 NM;
- The maximum bandwidth used by the MCV system is 5 MHz (duplex) per frequency band (1800 MHz or 2600 MHz bands);
- The maximum UE transmission power is limited to 0 dBm (PcMax);
- The quality criteria Qrxlevmin is set to a value greater than or equals to -105 dBm / 15kHz (-83 dBm / 5 MHz) between 4 and 12 NM;
- The indoor MCV antenna emission on deck is limited to -120 dBm /15kHz (-98 dBm / 5 MHz);
- The RRC inactivity timer of the MCV system is set to 2 seconds;
- The timing advance value is set according to a cell range for the MCV distributed antenna system of 400m;
- The LMPN network selection timer is set to 10 minutes in the national water;
- The MCV carrier centre frequency shall not be aligned with land network carriers;
- The PCI of the MCV system shall be different from the land networks PCIs.

In order to avoid a harmful interference from MCV LTE system in the international waters towards the terrestrial networks base stations, it is recommended to limit MCV UE Tx power to the values given in Table 84 and Figure 14 between 12 and 41 NM from baseline. This limitation could be included in the license granted by the flag state and the established procedure contained in ITU RR and UNCLOS could be applied. For simplification purpose the following formula could be used to define the MCV LTE1800 and LTE2600 UE Tx Power (dBm): 2+(D-12)*0.75, where D (NM) is the separation distance from baseline between 12 NM and 41 NM.

The compatibility between UMTS on board vessels in the 2100 MHz and land network systems (UMTS or LTE) can be met under the following conditions (scenario 5 and 6):

- The MCV system shall be OFF between 0 and 2 NM;
- The MCV system outdoor antennas shall be OFF between 2 and 12 NM;
- The maximum bandwidth used by the MCV system is 5 MHz (duplex);
- The maximum UE transmission power is limited to 0 dBm / 5 MHz;
- The quality criteria Qrxlevmin is set to a value greater than or equals to -87 dBm / 5 MHz between 2 and 12 NM;
- The indoor MCV antenna emission on deck is limited to -102 dBm/ 5 MHz (CPICH);
- The RRC inactivity timer of the MCV system is set to 2 seconds;
- The timing advance value is set according to a cell range for the MCV distributed antenna system of 600m;
- The LMPN network selection timer is set to 10 minutes in the national water;
- The MCV carrier centre frequency shall not be aligned with land network carriers;
- The scrambling code of the MCV system shall be different from the land networks PCIs.

For MCV UMTS systems, no mitigation is required in international waters.

ANNEX 1: RESULTS FOR SCENARIO 1, GSM 900 ON BOARD VESSEL, LTE 900 ON LAND

Table 11: Overview of scenario 1 (GSM 900 on board vessel, LTE 900 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
900	GSM	LTE	Outdoor v-BS	l-UE	1.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	1.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	1.3
			Indoor v-BS	l-UE	1.4
			Indoor v-UE	l-BS	1.5

General Assumption

A theoretical LTE land cell range of 125km is used.

Scenario 1.1: Outdoor v-BS to land UE

Assumption: The simulation is made with 4 antennas, each with -5 dB input and which gives a composite power of 1 dBm

Table 12: Capacity loss for Scenario 1.1: Outdoor v-BS to land UE

GSM 900 to LTE 900 (land) Outdoor MCV-BS => Land UE (10 MHz land LTE network) 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22 (12)	30	50	100	150
330 m land ant. Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m land ant. Height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 1.2: Outdoor v-MS (connected to indoor antenna) to land BS

According to ECC/DEC/(08)08 the system shall be configured with AccMin $\geq$-70(75) dBm / 200 kHz to prevent a v-MS on deck from connecting to the indoor antennas below 12 NM.

Table 13: Capacity loss for Scenario 1.2: Outdoor v-MS (connected to indoor antenna) to land BS

GSM 900 to LTE 900 (land) Outdoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height, 1 user on deck (land side)	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height, DTX on, MS power 0 dBm	0.76	0.76	0.55	0.36	0.30	0.15	0.0	0.0
70 m antenna height, DTX on, MS power 0 dBm	0.92	0.78	0.51	0.38	0.41	0.02	0.0	0.0

Scenario 1.3: Outdoor v-MS (connected to outdoor antenna) to land BS
According to the technical and operational requirements from ECC/DEC/(08)08 MCV outdoor antenna are not allowed below 12 NM. As a consequence, simulations have been performed only for distances greater than 12 NM.

Table 14: Capacity loss for Scenario 1.3: Outdoor v-MS (connected to outdoor antenna) to land BS

GSM 900 to LTE 900 (land) Outdoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height 1 user on deck (land side)	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22.2 (12)	30	50	100	150
330 m antenna height, MS power control, DTX on	0.31	0.26	0.13	0.0	0.0
70 m antenna height, MS power control, DTX on	0.34	0.24	0.02	0.0	0.0

Scenario 1.4: Indoor v-BS to land MS
Assumption: -5 dBm input per antenna, 50 antennas give a composite power of 12 dBm. The composite wall loss is 30 dB.

Table 15: Capacity loss for Scenario 1.4: Indoor v-BS to land MS

GSM 900 to LTE 900 (land) Indoor MCV-BS => Land UE 10 MHz land LTE network 30 m MCV BS height	**Capacity loss (%) depending on the distance Km (NM) from the baseline**							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 1.5: Indoor v-MS to land BS

Assumptions: DTX used which corresponds to a case where the UE transmits 40% of the time for GSM voice service. Maximum MS power is 5 dBm. 5 full rate calls and full traffic on BCCH and SDCCH TCH channels is used. 1 GSM cell/frequency is used. To simulate 5 users and full traffic on BCCH and SDCCH, the power is transmitted 50 % of time for voice service when DTx is activated. The simulation is made with full traffic and signaling load.

Table 16: Capacity loss for Scenario 1.5: Indoor v-MS to land BS

GSM 900 to LTE 900 (land) Indoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height, DTX on, MS power = 5 dBm, 20 dB vessel attenuation	1.04	0.430	0.71	0.10	0.05	0.02	0.0	0.0
70 m, antenna height, DTX on, MS power = 5 dBm, 20 dB vessel attenuation	2.24	0.486	0.78	0.10	0.05	0.00	0.0	0.0
330 m antenna height, MS power = 5 dBm, DTx not used for data service, 12 dB vessel attenuation	7,938	6,371	2,705	1,379	0,799	0,304	-	-
70 m, antenna height, DTx not used for data service, MS power = 5 dBm, 12 dB vessel attenuation	12,10	6,789	2,757	1,391	0,816	0,040	-	-

ANNEX 2: RESULTS FOR SCENARIO 2, GSM 1800 ON BOARD VESSEL, LTE 1800 ON LAND

Table 17: Overview of scenario 2 (GSM 1800 on board vessel, LTE 1800 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
1800	GSM	LTE	Outdoor v-BS	l-UE	2.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	2.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	2.3
			Indoor v-BS	l-UE	2.4
			Indoor v-UE	l-BS	2.5

Scenario 2.1: Outdoor v-BS to land UE
Assumption: The simulation is made with 4 antennas, each with -5 dB input and which gives a composite power of 1 dBm

Table 18: Capacity loss for Scenario 2.1: Outdoor v-BS to land UE

GSM 1800 to LTE 1800 (land) Outdoor MCV-BS => Land UE (10 MHz land LTE network) 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22 (12)	30	50	100	150
330 m land ant. Height	0.0	0.0	0.0	0.00	0.00	0.00	0.0	0.0
70 m land ant. Height	0.0	0.0	0.0	0.00	0.00	0.01	0.0	0.0

Scenario 2.2: Outdoor v-MS (connected to indoor antenna) to land BS

Table 19: Capacity loss for Scenario 2.2: Outdoor v-MS (connected to indoor antenna) to land BS

GSM 1800 to LTE 1800 (land) Outdoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height, 1 user on deck (land side)	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height, DTX on, MS power 0 dBm	0.33	0.24	0.09	0.05	0.13	0.07	0.0	0.0
70 m antenna height, DTX on, MS power 0 dBm	0.58	0.27	0.09	0.05	0.13	0.01	0.0	0.0

Scenario 2.3: Outdoor v-MS (connected to outdoor antenna) to land BS
According to the technical and operational requirements from ECC/DEC/(08)08 MCV outdoor antenna are not allowed below 12 NM. As a consequence, simulations have been performed only for distances greater than 12 NM.

Table 20: Capacity loss for Scenario 2.3: Outdoor v-MS (connected to outdoor antenna) to land BS

GSM 1800 to LTE 1800 (land) Outdoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height 1 user on deck (land side)	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22	30	50	100	150
330 m antenna height, MS power control, DTX on	0.04	0.03	0.01	0.0	0.0
70 m antenna height, MS power control, DTX on	0.05	0.03	0.00	0.0	0.0

Scenario 2.4: Indoor v-BS to land MS
Assumptions: -5 dBm input per antenna, 50 antennas give a composite power of 12 dBm. The composite wall loss is 30 dB.

Table 21: Capacity loss for Scenario 2.4: Indoor v-BS to land MS

GSM 1800 to LTE 1800 (land) Indoor MCV-BS => Land UE 10 MHz land LTE network 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30 (15)	50 (26)	100	150
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 2.5: Indoor v-MS to land BS
Assumptions: DTX is used which corresponds to a case where the MS transmits 40% of the time. Maximum MS power is 0 dBm. 5 full rate calls and full traffic on BCCH and SDCCH TCH channels is used. 1 GSM cell/frequency is used. To simulate 5 users and full traffic on BCCH and SDCCH, power is transmitted 50 % of time.

Table 22: Capacity loss for Scenario 2.5: Indoor v-MS to land BS

GSM 1800 to LTE 1800 (land) Indoor MCV-MS => Land BS 10 MHz land LTE network 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height, DTX on, MS power = 0 dBm, 20 dB propagation loss accounting for the vessel attenuation	0.07	0.04	0.01	0.01	0.00	0.00	0.0	0.0
70 m, antenna height, DTX on, MS power = 0 dBm, 20 dB propagation loss accounting for the vessel attenuation	0.20	0.05	0.01	0.01	0.00	0.0	0.0	0.0

ANNEX 3: RESULTS FOR SCENARIO 3, LTE 1800 ON BOARD VESSEL, GSM 900 ON LAND

Table 23: Overview of scenario 3 (LTE 1800 on board vessel, GSM 900 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
1800	LTE	GSM	Outdoor v-BS	l-UE	3.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	3.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	3.3
			Indoor v-BS	l-UE	3.4
			Indoor v-UE	l-BS	3.5

General assumptions:
The interference criteria is C/I = 9 dB (as in ECC Report 122 [2]). The GSM cell range is set to 70km. The MCV LTE bandwidth is set to 5 MHz since it corresponds to the highest probability of interference. No frequency hopping is assumed on the land cell. The MCV LTE system uplink frequency is 1740 MHz while the downlink frequency is 1840 MHz.

Scenario 3.1: Outdoor v-BS to land MS
Assumptions: Similar technical and operational requirements as in ECC 08(08) [1] are assumed; the outdoor antennas are turned off while the vessel is in the territorial water. As a consequence, no simulations have been performed for separation distances below 12 NM. The outdoor MCV BS composite power is set to 1 dBm.

Table 24: Capacity loss Scenario 3.1: Outdoor v-BS to land MS

LTE 1800 to GSM 1800 (land) Outdoor MCV-BS => Land UE 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22	30	50	100	150
330 m antenna height	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0

Scenario 3.2: Outdoor v-UE (connected to indoor antenna) to land BS

Table 25: Capacity loss for Scenario 3.2: Outdoor v-UE (connected to indoor antenna) to land BS

LTE 1800 to GSM 1800 Outdoor MCV-UE => Land BS Probability for interference (%) 30 m MCV BS height 1 user on deck	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)
330 m antenna height, v-UE on the landside	0.63	0.0	0.0	0.0
70 m antenna height, v-UE on the landside	0.69	0.0	0.0	0.0

Scenario 3.3: Outdoor v-UE (connected to outdoor antenna) to land BS
Assumptions: Similar technical and operational requirements as in ECC 08(08) are assumed; the outdoor antennas are turned off while the vessel is in the territorial water. As a consequence, no simulations have been performed for separation distances below 12 NM.

Table 26: Capacity loss for Scenario 3.3: Outdoor v-UE (connected to outdoor antenna) to land BS

LTE 1800 to GSM 1800 (land) Outdoor MCV-UE => Land BS 30 m MCV BS height 1 user on deck outdoor antenna on	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22	30	50	100	150
330 m antenna height, UE on the land side of the vessel,	0.0	0.0	0.0	0.0	0.0
70 m antenna height, UE on the land side of the vessel,	0.0	0.0	0.0	0.0	0.0

Scenario 3.4: Indoor v-BS to land MS

Assumptions: Land network BS power is set to 43 dBm and MS sensitivity to -102 dBm. For the indoor BS simulation towards l-MS a wall loss at 30 dB used and 50 indoor antennas with -5 dB input give 12 dB composite power.

Table 27: Capacity loss for Scenario 3.4: Indoor v-BS to land MS

LTE 1800 to GSM 1800 Indoor MCV-BS => Land MS 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100	150
330 m antenna height and wall loss 30 dBm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height and wall loss 30 dBm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 3.5: Indoor v-UE to land BS

Table 28: Capacity loss for Scenario 3.5: Indoor v-UE to land BS

LTE 1800 to GSM 1800 Indoor MCV-UE => Land BS Probability for interference (%) 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)
330 m antenna height	0.0	0.0	0.0	0.0
70 antenna height	0.0	0.0	0.0	0.0

ANNEX 4: RESULTS FOR SCENARIO 4, LTE 1800 ON BOARD VESSEL, LTE 1800 ON LAND

Table 29: Overview of scenario 4 (LTE 1800 on board vessel, LTE 1800 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
1800	LTE	LTE	Outdoor v-BS	l-UE	4.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	4.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	4.3
			Indoor v-BS	l-UE	4.4
			Indoor v-UE	l-BS	4.5

General assumption: The cell range is calculated to 55km based on the free space model. The LTE channel bandwidth is set to 10 MHz for both land and on board vessels systems.

In the tables below, the cases for which no simulation has been run are marked as “NS” (not simulated).

Scenario 4.1: Outdoor v-BS to land UE
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 30: Capacity loss for Scenario 4.1: Outdoor v-BS to land UE

LTE 1800 to LTE 1800 (land) Outdoor MCV-BS => Land UE 30 m MCV BS antenna height	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22 (12)	30	50	100	150
330 m antenna height	0.00	0.00	0.01	0.0	0.0
70 m antenna height	0.00	0.00	0.00	0.0	0.0

Scenario 4.2: Outdoor v-UE (connected to indoor antenna) to land BS
Assumption: The simulations are made with the outdoor antennas OFF as the worst case. When the v-UE is located on the sea side of the vessel, an additional 30 dB attenuation is used for the path between the outdoor-UE and the land BS accounting for the loss through the vessel. When nothing is mentioned, the UE is on the land side of the vessel. For the path between the outdoor UE and the indoor MCV BS, using either 12 dB or 20 dB attenuation (accounting for the losses due to the vessel structure) does not have an impact on the simulation results.

Table 31: Capacity loss for Scenario 4.2: Outdoor v-UE (connected to indoor antenna) to land BS

LTE 1800 Outdoor MCV-UE => Land BS, 30 m MCV BS height outdoor ant OFF	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	70	80	100
330 m antenna height and the outdoor v-UE on the land side maxTxPowerUl = 23 dBm	87.29	82.57	62.45	47.71	36.22	2.26	0.56	0.06
70 m antenna height and the outdoor v-UE on the land side side of the vessel maxTxPowerUl = 23 dBm	95.06	83.80	63.22	48.50	36.55	0.06	0.01	0.00
70 m antenna height and the outdoor v-UE on the sea side of the vessel maxTxPowerUl = 23 dBm	5.94	1.47	0.35	0.17	0.09	0.0	0.0	0.0
70 m antenna height, maxTxPowerUl = 0 dBm	18.94	5.88	1.50	0.65	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 2 dBm	13.31	3.77	0.94	0.41	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 3 dBm	10.85	2.98	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 4 dBm	8.90	2.33	0.58	0.26	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 5 dBm	7.63	1.85	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 8 dBm	3.77	0.95	0.23	0.1	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 10 dBm	2.40	0.58	0.15	0.07	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 13 dBm	1.17	NS	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl - 14 dBm	0.93	NS	NS	NS	NS	NS	NS	NS

Scenario 4.3: Outdoor v-UE (connected on outdoor antenna) to land BS

Table 32: Capacity loss for Scenario 4.3: Outdoor v-UE (connected on outdoor antenna) to land BS

LTE 1800 Outdoor MCV-UE => Land BS 30 m MCV BS height 23 dBm maxTxPowerUl and the outdoor antenna ON	Capacity loss (%) depending on the distance Km (NM) from the baseline								
	3.7 (2)	22.2 (12)	30	50	60	70	80	90	100
330 m antenna height, UE on landside	87.26	47.97	36.39	19.88	8.23	2.14	0.53	NS	NS
70 m antenna height, UE on landside	NS	48.48	36.78	2.53	NS	0.06	0.01	NS	NS
630 m antenna height, UE on landside	56.87	46.13	NS	NS	14.91	NS	2.12	0.69	NS
70 m antenna height, UE on landside, UE Tx Power Max 23 dBm	94.96	48.26	NS	NS	0.36	NS	NS	NS	NS
70 m antenna height, UE on landside, UE Tx Power Max 0 dBm	18.56	0.66	NS	NS	NS	NS	NS	NS	NS
70 m antenna height, UE on landside, UE Tx Power Max - 10 dBm	2.34	NS	NS	NS	NS	NS	NS	NS	NS
70 m antenna height, UE on landside, UE Tx Power Max - 14 dBm	0.92	NS	NS	NS	NS	NS	NS	NS	NS

Table 33: Capacity loss for Scenario 4.3: Outdoor v-UE (connected on outdoor antenna) to land BS(Antenna height of 330m) at different MCV UE maximum transmit power

NM	12	17	22	27	33	38	40	41	42	43	49
Km	22,224	31,484	40,744	50,004	61,116	70,376	74,08	75,932	77,784	79,636	90,748
23 dBm	47,753	NS	NS	NS	NS	2,055	1,249	0,926	0,708	0,564	0,145
20 dBm	NS	NS	NS	NS	NS	1,073	NS	NS	NS	NS	NS
19 dBm	NS	NS	NS	NS	NS	0,879	NS	NS	NS	NS	NS
15 dBm	NS	NS	NS	NS	1,224	NS	NS	NS	NS	NS	NS
14 dBm	NS	NS	NS	NS	0,977	NS	NS	NS	NS	NS	NS
12 dBm	NS	NS	NS	NS	0,61	NS	NS	NS	NS	NS	NS
10 dBm	NS	NS	1,947	1,302	NS	NS	NS	NS	NS	NS	NS
9 dBm	NS	NS	NS	1,034	NS	NS	NS	NS	NS	NS	NS
8 dBm	NS	NS	1,238	0,803	NS	NS	NS	NS	NS	NS	NS
7 dBm	NS	NS	0,97	NS	NS	NS	NS	NS	NS	NS	NS
6 dBm	NS	NS	0,773	NS	NS	NS	NS	NS	NS	NS	NS
5 dBm	2,095	1,009	NS	NS	NS	NS	NS	NS	NS	NS	NS
3 dBm	1,3	NS	NS	NS	NS	N S	N S	N S	N S	N S	N S
2 dBm	1,034	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1 dBm	0,822	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
0 dBm	0,64	NS	NS	NS	N S	N S	N S	N S	N S	N S	N S

Table 34: Capacity loss for Scenario 4.3: MCV UE maximum transmit power for <1% land network uplink capacity loss at different separation distances from baseline

Distance (NM)	UE Max Tx power (dBm)
12	1
17	5
22	7
27	8
33	14
38	19
41	23

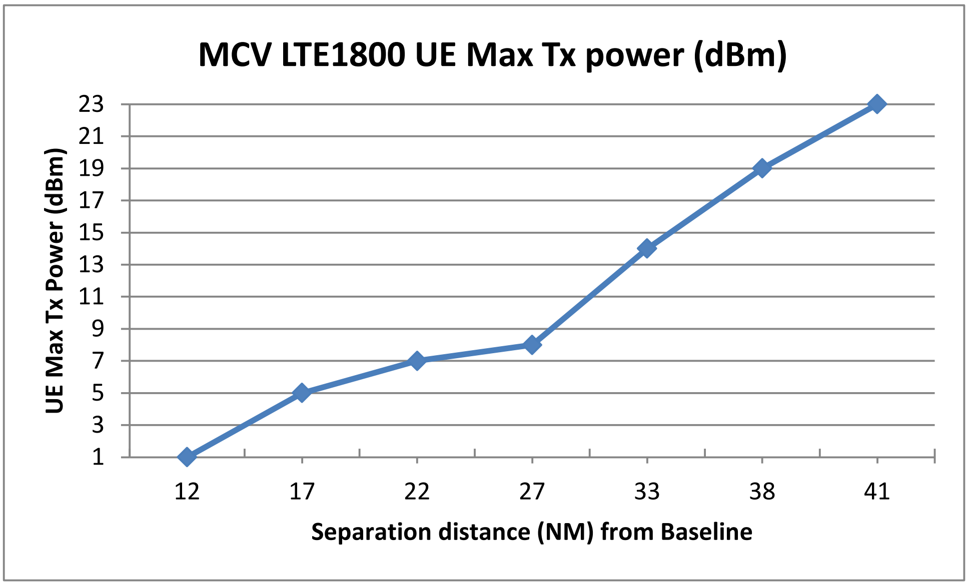

Figure 4: MCV LTE1800 UE maximum Tx power for 1% Land network uplink capacity loss

Scenario 4.4: Indoor v-BS to land UE
Assumptions: For indoor BS interference towards land, a wall loss of 30 dB is used (simulations with a wall loss of 11 dB show similar results). The composite power is 12 dBm (50 antennas with -5 dBm input).

Table 35: Capacity loss for Scenario 4.4: Indoor v-BS to land UE

LTE 1800 Indoor MCV-BS => Land UE 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	2 (3.7)	3 (5.55)	4 (7.4)	5 (9.25)	6 (11.1)	8 (14.8)	10 (18.5)	12 (22.2)
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 4.5: Indoor v-UE to land BS
Simulations using a 20 dB loss for the attenuation between indoor v-UE and land BS are shown below

Table 36: Capacity loss for Scenario 4.5: Indoor v-UE to land BS

LTE 1800 Indoor MCV-UE => Land BS 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	70	80
330 m antenna height, maxTxPowerUl = 23 dBm	23.11	16.85	5.53	2.56	1.39	0.50	0.04	0.01
70 m antenna height, maxTxPowerUl = 23 dBm	41.20	18.25	5.70	2.60	1.41	0.05	0.00	0.0
70 m antenna height, maxTxPowerUl = 9 dBm	3.75	0.9	0.23	0.1	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 5 dBm	1.37	0.37	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 3 dBm	0.89	0.23	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 0 dBm	0.46	0.11	0.03	0.01	NS	NS	NS	NS

Simulations using a 12 dB propagation loss (accounting for the vessel attenuation) for the attenuation between indoor v-UE and land BS are shown below (5 MCV UEs).

Table 37: Capacity loss for Scenario 4.5: Indoor v-UE to land BS using a 12 dB propagation loss

LTE 1800 Indoor MCV-UE => Land BS 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	40	60	70	80
300m antenna height, maxTxPowerUl = 23 dBm	57.03	NS	NS	14.09	4.99	1.13	0.27	NS
70 m antenna height, maxTxPowerUl = 23 dBm	75.23	NS	NS	14.21	2.52	0.04	NS	NS
630 m antenna height, maxTxPowerUl = 23 dBm	19.99	NS	NS	13.43	4.9	2.2	0.8	0.26
330 m antenna height, maxTxPowerUl = 0 dBm	1.03	NS	NS	0.08	NS	NS	NS	NS
330 m antenna height, maxTxPowerUl = -5 dBm	0.32	NS	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 7 dBm	12.94	3.63	0.91	0.40	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 3 dBm	5.56	1.44	0.38	0.16	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 1 dBm	3.63	0.91	0.22	0.10	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 0 dBm	2.88	0.7	0.18	0.08	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = -5 dBm	0.91	0.22	0.06	0.03	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = -14 dBm	0.11	0.03	0.01	0.00	NS	NS	NS	NS

ANNEX 5: RESULTS FOR SCENARIO 5, UMTS 2100 ON BOARD VESSEL AND UMTS 2100 ON LAND

Table 38: Overview of scenario 5 (UMTS 2100 on board vessel, UMTS1800 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
2 GHz	UMTS	UMTS	Outdoor v-BS	l-UE	5.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	5.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	5.3
			Indoor v-BS	l-UE	5.4
			Indoor v-UE	l-BS	5.5

In the tables below, the cases for which no simulation has been run are marked as “NS” (not simulated).

Scenario 5.1: Outdoor v-BS to land UE
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 39: Capacity loss for Scenario 5.1: Outdoor v-BS to land UE

UMTS 2100 to UMTS 2100 (land) Outdoor MCV-BS => Land UE 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline					
	22 (12)	30	50	100	150	200
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 5.2: Outdoor v-UE (connected to indoor antenna) to land BS
Assumptions: Noise floor rise (nfr) = 0.1 for 1 voice user in average. BS noise floor increased from 8 to 8.4 to take into account the indoor traffic.

Voice User

Table 40: Capacity loss (voice user) for Scenario 5.2: Outdoor v-UE (connected to indoor antenna) to land BS

UMTS 2100 Outdoor MCV-UE => Land BS max UEpwr = 24 dBm, Voice, 1 user and Outdoor ant OFF	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	2 (3.7)	4 (7.4)	8 (14.8)	12 (22.2)
330 m antenna height, UE on landside of the vessel	0.90	0.63	0.28	0.14
70 m antenna height, UE on landside of the vessel	1.57	0.65	0.27	0.14
70 m antenna height, UE on landside of the vessel, 11 dB vessel attenuation	0.47	0.14	0.03	0.01

Data user

The same simulation is made with one outdoor data user having 128kbps (which corresponds to a noise rise of 0.9 dB).

Table 41: Capacity loss (data user) for Scenario 5.2 (24 dBm max UE power)

UMTS 2100 Outdoor MCV-UE => Land BS 24 dBm max UEpwr 1 data user with 128kbps data Outdoor ant off	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	2 (3.7)	4 (7.4)	8 (14.8)	12 (22.2)
landside, 330 m	5.29	3.30	1.19	0.77
landside, 70 m	12.00	3.54	1.25	0.75

Table 42: Capacity loss (data user) for Scenario 5.2 (Max MCV UE power restriction)

UMTS 2100 Outdoor MCV-UE => Land BS Max MCV UE pwr restriction 128kbps data*, 1 user Outdoor ant off	Capacity loss (%) depending on the distance Km (NM) from the baseline	
	2 (3.7)	4 (7.4)
landside, 70 m, 0 dBm (nfr = 0.9)	11.70	3.26
landside, 70 m, -5 dBm (nfr = 0.9)	10.48	3.01
landside, 70 m, -10 dBm (nfr = 0.7)	6.14	1.93
landside, 70 m, -14 dBm (nfr = 0.7)	4.69	1.53
landside, 70 m, -15 dBm (nfr = 0.7)	4.35	1.51
landside, 70 m, -16dBm (nfr = 0.5)	2.82	0.95
landside, 70 m, -20 dBm (nfr = 0.3)	1.67	0.78
landside, 70 m, 0 dBm (nfr = 0.9) 11 dB hull loss	2.00	0.85
landside, 70 m, -10 dBm (nfr = 0.7) 11 dB hull loss	1.85	0.71
landside, 70 m, -15 dBm (nfr = 0.7) 11 dB hull loss	1.44	0.68
landside, 70 m, -16dBm (nfr = 0.5) 11 dB hull loss	0.43	0.09

Scenario 5.3: Outdoor v-UE (connected to outdoor antenna) to land BS
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 43: Capacity loss for Scenario 5.3: Outdoor v-UE (connected to outdoor antenna) to land BS

UMTS 2100 to UMTS 2100 (land) Outdoor MCV-UE => Land BS 24 dBm max UEpwr = 24 dBm, Voice, 1 user, 30 m MCV BS height and outdoor antennas ON	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22 (12)	30	50	100	150
330 m antenna height, UE on landside of the vessel	0.0	0.0	0.0	0.0	0.0
70 m antenna height, UE on landside of the vessel	0.0	NS	NS	NS	NS

Scenario 5.4: Indoor v-BS to land UE
Assumptions: -5 dBm input per antenna, 50 antennas give a composite power of 12 dBm. The composite wall loss is 30 dB.

Table 44: Capacity loss for Scenario 5.4: Indoor v-BS to land UE

UMTS 2100 Indoor MCV-BS => Land UE	Capacity loss (%) depending on the distance Km (NM) from the baseline						
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 5.5: Indoor v-UE to land BS

Voice users

Table 45: Capacity loss (voice user) for Scenario 5.5: Indoor v-UE to land BS

UMTS 2100 Indoor MCV-UE => Land BS 24 dBm max UEpwr Voice, 5 users	Capacity loss (%) depending on the distance m (NM) from the baseline			
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)
330 m land ant height	0.01	0.0	0.0	0.0
70 m land ant height	0.01	0.0	0.0	0.0
70 m land ant height, 12 dB loss accounting for the vessel structure attenuation	0.01	0.0	0.0	0.0

Data Users

Table 46: Capacity loss (data user) for Scenario 5.5 (24 dBm max UE power)

UMTS 2100 Indoor MCV-UE => Land BS 24 dBm max UEpwr 128kbps data, 5 users, noise rise 6 dB on MCV BS	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)
330 m land ant height	0.01	0.01	0.0	0.0
70 m land ant height*	0.04	0.01	0.0	0.0
70 m land ant height, 12 dB loss accounting for the vessel structure attenuation	0.54	0.07	0.0	0.0

A noise floor rise of 6 is used to get 5 128kbps MCV users.

ANNEX 6: RESULTS FOR SCENARIO 6, UMTS 2100 ON BOARD VESSEL AND LTE 2100 ON LAND

Table 47: Overview of scenario 6 (UMTS 2100 on board vessel, LTE 2100 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
2 GHz	UMTS	LTE	Outdoor v-BS	l-UE	6.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	6.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	6.3
			Indoor v-BS	l-UE	6.4
			Indoor v-UE	l-BS	6.5

Scenario 6.1: Outdoor v-BS to land UE
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 48: Capacity loss for Scenario 6.1: Outdoor v-BS to land UE

UMTS 2100 to LTE 2100 (land) Outdoor MCV-BS => Land UE 30 m MCV BS height, 10 MHz channel bandwidth in land network	Capacity loss (%) depending on the distance Km (NM) from the baseline					
	3,7 (2)	22 (12)	30	50	100	150
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 6.2: Outdoor v-UE (connected to indoor antenna) to land BS

Voice users

Table 49: Capacity loss for Scenario 6.2: Outdoor v-UE (connected to indoor antenna) to land BS

UMTS 2100 to LTE 2100(land) Outdoor MCV-UE => Land BS 30 m MCV BS height maxTxPowerUl = 24 dBm (voice) 1 user and Outdoor antenna OFF	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	2 (3.7)	4 (7.4)	8 (14.8)	12 (22.2)
330 m antenna height, UE on land side	0.05	0.04	0.01	0.00
330 m antenna height, UE on land side	0.15	0.0	0.01	0.00

Data users

The same simulation done with one outdoor data user

Table 50: Capacity loss (data users) for Scenario 6.2

UMTS 2100 to LTE 2100(land) Outdoor MCV-UE => Land BS 30 m MCV BS height 24 dBm max UE-pwr 1 user, 128kbps Outdoor antenna OFF	Capacity loss (%) depending on the distance Km (NM) from the baseline 3.7 (2)
landside, 330 m	0.58
landside, 70 m	1.55

Scenario 6.3: Outdoor v-UE (connected to outdoor antenna) to land BS
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 51: Capacity loss for Scenario 6.3: Outdoor v-UE (connected to outdoor antenna) to land BS

UMTS 2100 to LTE 2100 (land) Outdoor MCV-UE => Land BS 30 m MCV BS height maxTxPowerUl = 21 dBm (voice) Outdoor antennas ON	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22 (12)	30	50	100	150
landside, 330 m	0.0	0.0	0.0	0.0	0.0
landside, 70 m	0.0	0.0	0.0	0.0	0.0

Scenario 6.4: Indoor v-BS to land UE
Assumptions: -5 dBm input per antenna, 50 antennas give a composite power of 12 dBm. The composite wall loss is 30 dB.

Table 52: Capacity loss for Scenario 6.4: Indoor v-BS to land UE

UMTS 2100 to LTE 2100 (land) Indoor MCV-BS => Land UE 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline						
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	100
330 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario 6.5: Indoor v-UE to land BS
Assumptions: the uplink frequency is 1932 MHz and the downlink frequency is 2122 MHz

Table 53: Capacity loss for Scenario 6.5: Indoor v-UE to land BS

UMTS 2100 to LTE 2100(land) Indoor MCV-UE => Land BS maxTxPowerUl = 21 dBm (voice) 30 m MCV BS height, 5 users	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)
330 m antenna height	0.0	0.0	0.0	0.0
70 m antenna height	0.0	0.0	0.0	0.0

ANNEX 7: RESULTS FOR SCENARIO 7, LTE 2600 ON BOARD VESSEL AND LTE 2600 ON LAND

Table 54: Overview of scenario 7 (LTE 2600 on board vessel, LTE 2600 on land)

Band	MCV Techno	Land Techno	Interferer	Victim	Scenario #
2.6 GHz FDD	LTE	LTE	Outdoor v-BS	l-UE	7.1
			Outdoor v-UE (connected to indoor v-BS antenna)	l-BS	7.2
			Outdoor v-UE (connected to outdoor v-BS antenna)	l-BS	7.3
			Indoor v-BS	l-UE	7.4
			Indoor v-UE	l-BS	7.5

In the tables below, the cases for which no simulation has been run are marked as “NS” (not simulated).

Scenario 7.1: Outdoor v-BS to land UE
Assumptions: The simulations have been performed only for distances greater than 12 NM, assuming the outdoor antennas are not to be allowed between 2 and 12 NM.

Table 55: Capacity loss for Scenario 7.1: Outdoor v-BS to land UE

LTE 2600 to LTE 2600 (land) Outdoor MCV-BS => Land UE 30 m MCV BS antenna height	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	22 (12)	30	50	100	150
330 m antenna height	0.00	0.00	0.0	0.0	0.0
70 m antenna height	0.00	0.00	0.0	0.0	0.0

Scenario 7.2: Outdoor v-UE (connected to indoor antenna) to land BS

Table 56: Capacity loss for Scenario 7.2: Outdoor v-UE (connected to indoor antenna) to land BS

LTE 2600 Outdoor MCV-UE => Land BS 30 m MCV BS height and outdoor antennas OFF	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	50	80	100
330 m antenna height, UE on landside and maxTxPowerUl = 23 dBm	81.49	75.28	52.51	37.45	27.10	13.48	0.23	0.03
70 m antenna height, UE on landside and maxTxPowerUl = 23 dBm	91.49	77.40	53.57	38.00	27.42	1.31	0.01	0.00

Table 57: Capacity loss for Scenario 7.2 (with reduced maxTxPowerUl)

LTE 2600 Same assumptions as above with reduced maxTxPowerUl	Capacity loss (%) depending on the distance Km (NM) from the baseline		
	2 (3.7)	4 (7.4)	12 (22.2)
330 m antenna height, UE on landside and maxTxPowerUl = 0 dBm	5.02	NS	0.46
330 m antenna height, UE on landside and maxTxPowerUl = -5 dBm	1.67	NS	NS
330 m antenna height, UE on landside and maxTxPowerUl = -10 dBm	0.54	NS	NS

Table 58: Capacity loss for Scenario 7.2 (maxUEpwr restriction)

LTE 2600 Outdoor MCV-UE => Land BS maxUEpwr restriction 30 m MCV BS height Outdoor ant off	Capacity loss (%) depending on the distance Km (NM) from the baseline				
	2 (3.7)	4 (7.4)	6 (11.1)	8 (14.8)	12 (22.2)
landside, 70 m 0 dBm	12.64	3.76	1.68	0.94	0.43
landside, 70 m -3 dBm	6.99	1.94	0.85	0.49	0.22
landside, 70 m -5 dBm	4.59	1.22	0.54	0.30	0.14
landside, 70 m -6dBm	3.74	0.96	0.43	0.24	0.11
landside, 70 m -10 dBm	1.50	0.38	0.17	0.10	0.04
landside, 70 m -12 dBm	0.96	0.25	0.11	0.06	0.03

For the indoor-outdoor propagation loss accounting for the vessel structure attenuation, using 11 dB or 20 dB gives similar simulation results.

Scenario 7.3: Outdoor v-UE (connected on outdoor antenna) to land BS
When the v-UE is located on the sea side of the vessel, an additional 30 dB attenuation is used accounting for the loss through the vessel.

Table 59: Capacity loss for Scenario 7.3: Outdoor v-UE (connected on outdoor antenna) to land BS

LTE 2600 Outdoor MCV-UE => Land BS 30 m MCV BS height maxTxPowerUl = 23 (vessel) Outdoor antenna ON	Capacity loss (%) depending on the distance Km (NM) from the baseline						
	3.7 (2)	22	30	50	70	80	100
630 m antenna height, UE on landside	NS	35.86	NS	NS	NS	0.97	NS
330 m antenna height, UE on landside	81.7	37.30	27.03	13.29	1.03	0.23	0.02
70 m antenna height, UE on landside	NS	37.97	27.54	1.39	0.03	0.01	0.00
70 m antenna height, UE on sea side	NS	0.10	0.06	0.02	0.00	0.0	0.0
70 m antenna height, UE on sea landside	91.49	38.07	NS	NS	NS	NS	NS

Table 60: Capacity loss for Scenario 7.3 (with reduced maxTxPowerUl)

LTE 2600 Outdoor MCV-UE => Land BS Same assumptions as above with reduced maxTxPowerUl	Capacity loss (%) depending on the distance Km (NM) from the baseline	
	3.7 (2)	22
330 m antenna height, UE on landside maxTxPowerUl = 0 dBm	5.13	0.42
70 m antenna height, UE on landside maxTxPowerUl = 0 dBm	12.65	0.42
70 m antenna height, UE on landside maxTxPowerUl = -5 dBm	4.59	NS
70 m antenna height, UE on landside maxTxPowerUl = -10 dBm	1.51	NS
70 m antenna height, UE on landside maxTxPowerUl = -12 dBm	0.96	NS

Table 58: Capacity loss for Scenario 7.3: Outdoor v-UE (connected on outdoor antenna) to land BS(Antenna height of 330m) at different MCV UE maximum transmit power

NM	12	17	22	27	33	38	40
Km	22,224	31,484	40,744	50,004	61,116	70,376	74,08
23 dBm	37,441	NS	NS	NS	NS	0,965	0,556
20 dBm	NS	NS	NS	NS	NS	NS	NS
19 dBm	NS	NS	NS	NS	1,711	NS	NS
17 dBm	NS	NS	NS	NS	1,068	NS	NS
16 dBm	NS	NS	NS	NS	0,86	NS	NS
15 dBm	NS	NS	NS	NS	0,689	NS	NS
14 dBm	NS	NS	NS	NS	0,543	NS	NS
11 dBm	NS	NS	NS	1,041	NS	NS	NS
10 dBm	NS	NS	1,231	0,841	NS	NS	NS
9 dBm	NS	NS	0,992	NS	NS	NS	NS
8 dBm	NS	NS	NS	NS	NS	NS	NS
7 dBm	NS	1,041	NS	NS	NS	NS	NS
6 dBm	NS	0,841	NS	NS	NS	NS	NS
5 dBm	1,295	NS	NS	NS	NS	NS	NS
4 dBm	1,038	NS	NS	NS	NS	N S	N S
3 dBm	0,822	NS	NS	NS	NS	NS	NS
1 dBm	0,528	NS	NS	NS	NS	NS	NS
0 dBm	NS	NS	NS	NS	N S	N S	N S

Table 58: Capacity loss for Scenario 7.3: MCV UE maximum transmit power for <1% land network uplink capacity loss at different separation distances from baseline

Distance (NM)	UE Max Tx power (dBm)
12	3
17	6
22	9
27	10
33	16
38	23
41	23

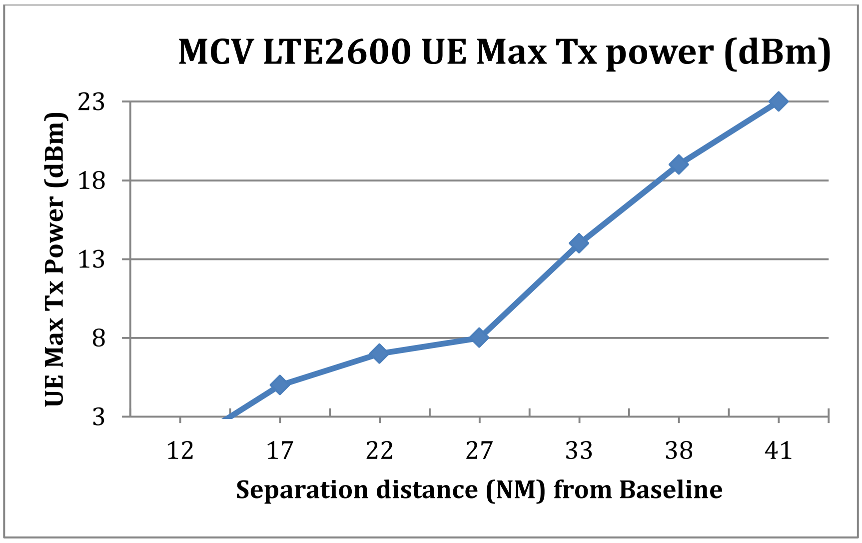

Figure 5: MCV LTE2600 UE maximum Tx power for 1% Land network uplink capacity loss

Scenario 7.4: Indoor v-BS to land UE

Assumptions: A 30 dB wall loss is used between the indoor MCV BS and the land MS. The composite power is 12 dBm (50 antennas with -5 dBm input).

Table 61: Capacity loss for Scenario 7.4: Indoor v-BS to land UE

LTE 2600 Indoor MCV-BS => Land UE 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline			
	2 (3.7)	4 (7.4)	8 (14.8)	12 (22.2)
330 m antenna height,	0.0	0.0	0.0	0.0
70 m antenna height,	0.0	0.0	0.0	0.0

Scenario 7.5: Indoor v-UE to land BS
With a 20 dB wall loss, the results are as follows

Table 62: Capacity loss for Scenario 7.5: Indoor v-UE to land BS

LTE 2600 Indoor MCV-UE => Land BS maxTxPowerUl = 23 dBm, 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	30	70	80	100
330 m antenna height	15.94	11.30	3.49	1.62	0.90	0.02	0.01	0.0
70 m antenna height	31.29	12.40	3.66	1.66	0.91	0.00	0.0	0.0
70 m antenna height, maxTxPowerUl = 5 dBm	0.93	0.23	NS	NS	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 11 dBm	3.598	0.933	0.235	0.104	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 10 dBm	2.950	0.729	0.187	0.083	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 5 dBm	0.931	0.231	0.059	0.027	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 3 dBm	0.579	0.150	0.037	0.017	NS	NS	NS	NS
70 m antenna height, maxTxPowerUl = 0 dBm	0.305	0.072	0.019	0.008	NS	NS	NS	NS

With a 12 dB propagation loss accounting for the vessel attenuation, the results are as follows

Table 63: Capacity loss for Scenario 7.5: Indoor v-UE to land BS (12 dB propagation loss)

LTE 2600 Indoor MCV-UE => Land BS maxTxPowerUl = 23 dBm, 30 m MCV BS height	Capacity loss (%) depending on the distance Km (NM) from the baseline							
	3.7 (2)	7.4 (4)	14.8 (8)	22.2 (12)	40	50	60	70
330 m antenna height	46.6	NS	NS	9.14	3.35	2.04	0.63	NS
70 m antenna height	66.62	NS	NS	9.35	1.63	0.17	0.02	NS
630 m antenna height	13.23	NS	NS	8.57	3.05	1.99	1.35	0.46
330 m antenna height, maxTxPowerUl = 0 dBm	0.67	NS	NS	0.05	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, 9 dBm	12.41	3.625	0.932	0.418	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, 6dBm	6.816	1.857	0.472	0.211	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, 3 dBm	3.692	0.923	0.235	0.106	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, 0 dBm	1.891	0.463	0.120	0.052	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, -3 dBm	0.938	0.237	0.059	0.026	NS	NS	NS	NS
70 m, 11+1 dBm hull loss, -5 dBm	0.587	0.148	0.037	0.017	NS	NS	NS	NS

ANNEX 8: MEASUREMENTS PERFORMED IN INTERNAL WATERS

This section presents the measurements performed on board a vessel sailing inside of coast at typically less than a Nautical Mile from land. The MCV system was operating on exact same frequencies as the one used by the land-based network.

The land-based network signal strength measured on board was always lower than -80 dBm, and most of the time lower than -90 dBm (given the land-network EIRP, the path loss was greater than 113 dB.) The maximum additional uplink interference measured in MCV network was in the +0,2 dB range. Furthermore, tests done in an area with path loss >130 dB and mobile sending at full power shows no detectable uplink interference.

This shows that at path loss greater than 130 dB, a mobile in a MCV 3G network, sending at the same frequency, will never cause any uplink interference on land mobile network even when sending at full power (24 dBm). If MCV limits max MS power to 18 dBm, the level of harmful interference will not exist if path loss is >124 dB (that is land mobile network MS signal strength < -91 dBm, at cpich-pwr = 33).

Figure 6: Field test 1: Bergen – Haugesund – Tananger

Figure 7: Field test 1: Bergen – Haugesund – Tananger

Figure 8: Field test 2: Oslofjorden (Slagentangen – Oslo)

Field test 1: Bergen – Haugesund – Tananger.
The MCV system was operating on the same frequency as used in the land-based network. The vessel sailed from Bergen to Haugesund and Stavanger (Tananger) inside the baseline, less than 1 NM from land.

Land-based network signal strength measured on board was always lower than -80 dBm, and most of the time lower than -90 (with land-based network e.i.r.p. the path loss is greater than 113 dB (-80 dBm).) The maximum additional uplink interference measured in the MCV network was in the +0,2 dB range. Furthermore, tests done in an area with path loss >130 dB and mobile sending at full power shows no detectable uplink interference.

From MCC network we always had -70 or better pilot signal (cpich-power = 30 dBm).

Table 64: noise reading (sailing Bergen-Haugesund-Tananger, inside the baseline)

MS-SS	Land MS-SS	Land MSpwr	RBS UL-SS	Comment
			-105.5	DAS disconnected
			-102.3	DAS connected

Noise readings when sailing Bergen-Haugesund-Tananger., sailing inside of coast, typically < 1 NM from land all the way:

Table 65: Noise reading (sailing Bergen-Haugesund-Tananger, inside of coast)

MS-SS	Land MS-SS	Land MSpwr	RBS UL-SS	Comment
			-102.3	
			-102	
			-101.7	
			-99.6	
			-101.3	
			-100,6	
			-102.2	
			-102.2	
			-99.7	
			-102.5	
			-102.4	
			-100.8	
			-102.2	
			-102.3	While using 3G on land-based network
			-101.3	
			-102.1	Voice call on land-based network
			-102.4	
			-102	
			-102.3	
			-102.3	<1 NM from Haugesund
			-102.3	<0.5 NM from Haugesund
			-95.5	200m from Haugesund (under the Bridge)
			-102.4	<0.5 NM from Haugesund
			-101	<0.5 NM from Haugesund
-65	-90		-101.6	<0.5 NM from Haugesund, sending data in Land-based network 3G
			-101.1	<0.5 NM from Haugesund, sending data in Land-based network 3G
			-101.6	<0.5 NM from Haugesund, sending data in Land-based network 3G
			-102.4	<0.5 NM from Haugesund, sending data in Land-based network 3G
-70	-90		-102.4	<0.5 NM from Haugesund, sending data in Land-based network 3G
			-102.2	<0.5 NM from Haugesund, sending data in Land-based network 3G

Test in Tananger:

Table 66: Noise reading (Test in Tananger)

MS-SS	Land MS-SS	Land MSpwr	RBS UL-SS	Comment
-62	-100		-94.6	Voice call in Land-based network
-40	-80		-99.9	Call dropped
-70	-93		-101	Voice call in Land-based network
-60	-96		-82 -94 - 96	Voice call in Land-based network
-73	-90	-15	-102.2	Voice call in Land-based network, no interference
-70	-86	16	-88	Voice call in Land-based network
-70	-86	9	-87	Voice call in Land-based network

From the tests above we can estimate UL interference at different path losses and MS powers.

The path loss was 100 dB in most of the tests.

Table 67: UL interference for different path losses and MS powers

path loss.	MSpwr	UL interf.inc.		Comment
100	9	15.3 dB		Worst case reading from the test above
103	-15	0.1 dB		

Below are estimated results of the worst case reading above:

Table 68: Worst case reading of UL interference for different path losses and MS powers

path loss.	MSpwr	UL interf.inc.		Comment
100	24	30 dB		
110	24	20 dB		
120	24	10 dB		
130	24	0.1 dB		

Field test 2: Oslofjorden (Slagentangen – Oslo).
Measurements are taken outside on top deck aft, on board DFDS Crown of Scandinavia:

Table 69: Measurement of RxLev (outside on top deck aft, on board DFDS Crown of Scandinavia)

From Slagentangen to Oslo				
time	min	ch	RxLev	Position
07	00	10737-10712-10687	-90	Slagentangen
	13		-84	south of Moss-Horten
	16		-90	
	20		-78	Jeløy
	23	10737-10712	-87	
	26		-82	
	28	10737-10712-10687	-82	
	36		-87	
	38		-90	
	44		-91	
	47		-87	
	49		-90	Tofte
	52		-86	
	55		-70	
08	00		-88	
	08		-91	
	15		-77	
	20		-88	Oscarsborg
	29		-98	
	33		-99	
	54		-90	Slemmestad
09	00		-92	
	03		-89	
	08		-91	
	12		-88	
	15		-80	Fornebu

ANNEX 9: ESTIMATION OF THE INDOOR-OUTDOOR PENETRATION LOSS ON A VESSEL

This annex presents the measurements done on vessel, static in the Oslo cruise terminal. The signal strength received from a macro base station located on the land has been measured at several spots on the vessel (inside and outside). The measurements have been done for GSM900 channel 60 and for UMTS 2100 channel 10663. The vessel (Royal Princess) was 330 m long with 16 decks.

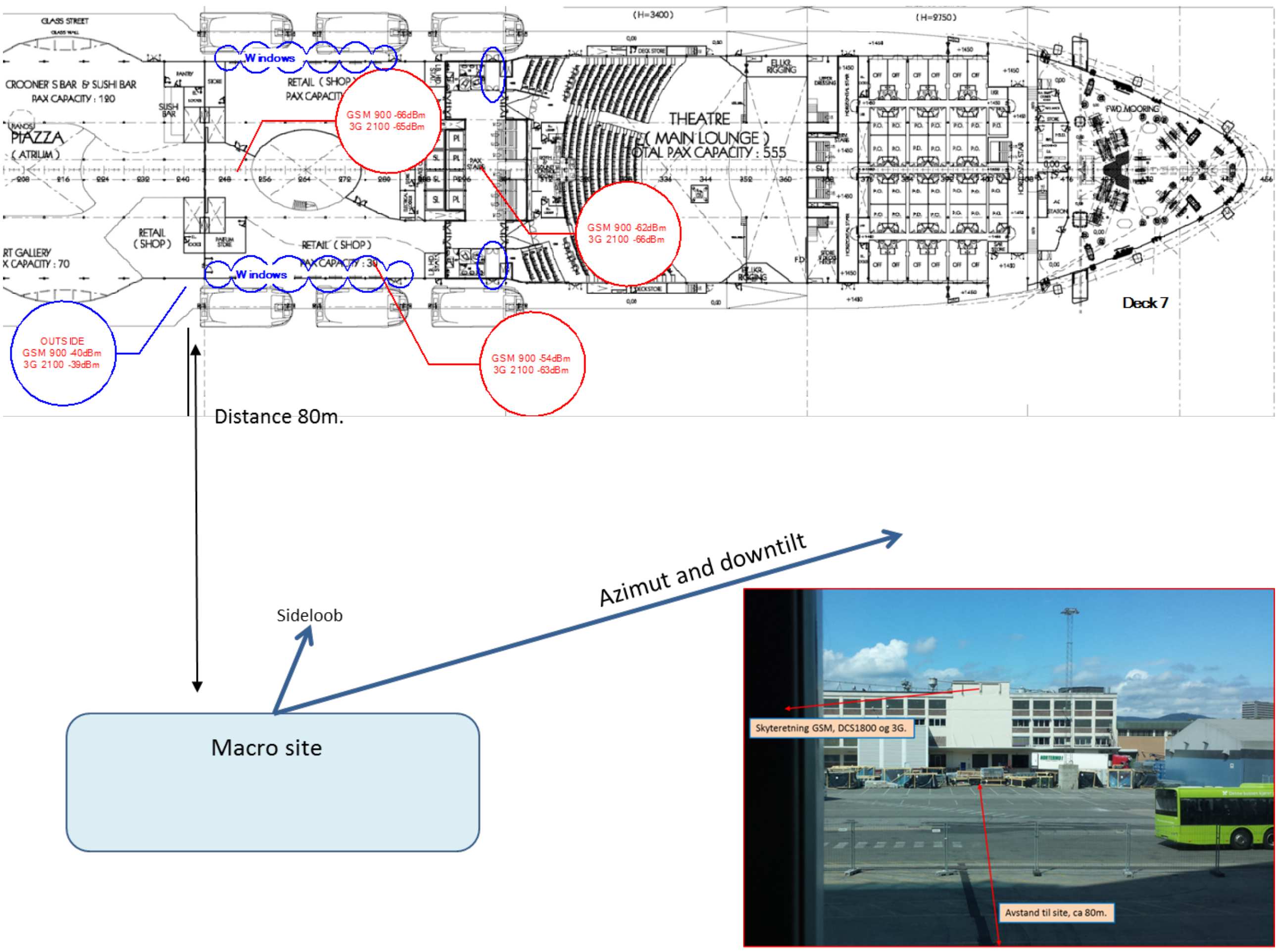

Figure 9: Measurement layout

Table 70: Measurement results

	Cabin		Stairs		Atrium window		Atrium mid		Outside	
	GSM	3G	GSM	3G	GSM	3G	GSM	3G	GSM	3G
Deck 10	-99 dBm	------	-81 dBm	-92 dBm	------	------	------	------	------	------
Deck 9	-97 dBm	------	-85 dBm	-85 dBm	------	------	------	------	------	------
Deck 8	-90 dBm	-90 dBm	-73 dBm	-77 dBm	------	------	------	------	------	------
Deck 7	------	------	-62 dBm	-66dBm	-54 dBm	-63 dBm	-66dBm	-65 dBm	-40 dBm	-39 dBm
Deck 6	------	------	-67 dBm	-72 dBm	-42 dBm	-45 dBm	-53 dBm	-54 dBm	------	------
Deck 5	------	------	-62 dBm	-70 dBm	-39 dBm	-41 dBm	-55 dBm	-58 dBm	------	------

These measurements lead to estimating the indoor-outdoor penetration loss in the range of 20-30 dB.

ANNEX 10: EVALUATION OF THE ATTENUATION OF THE VESSEL'S SIDE

In order to evaluate the attenuation of the vessel's side for the signal from the UE to the Land the comparison of the results with model of the vessel's side and without it are prepared in the Method of the Moments software. The UE Tx antenna was assumed as vertical dipole operating on frequency 2.6 GHz.

Figure 10 (and Figure 11) presents the model of the vessel's side with MCV UE and the area, perpendicular to the ground/sea in which BS antennas may be expected. The distance between MCV Tx and Land BS Rx was assumed to be 12 NM and the considered area cover Land BS antenna height up to 650 m above sea level.

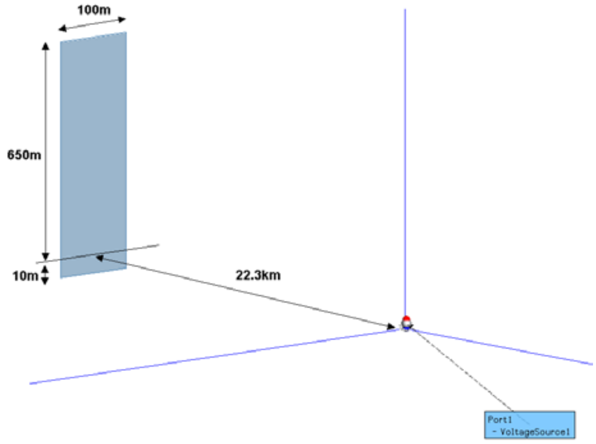

Figure 10: Model of the vessel's side, MCV UE Tx antenna and are of possible location of the Land BS (12 NM (≈22.3 km) from the vessel)

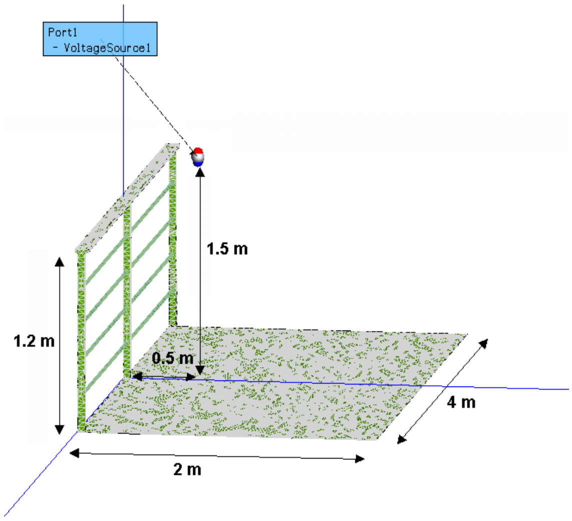

Figure 11: Zoom in on the model of the vessel's side (all parts are metallic, including board (floor)). Vessel's side 1.2 m height, Tx antenna: 1.5 m height

The difference of the electric field strength for the Tx UE only and for the presence of the vessel's side is presented in Figure 12 (vessel's side made of metallic rods) and Figure 13 (vessel's side as a full metallic surface).

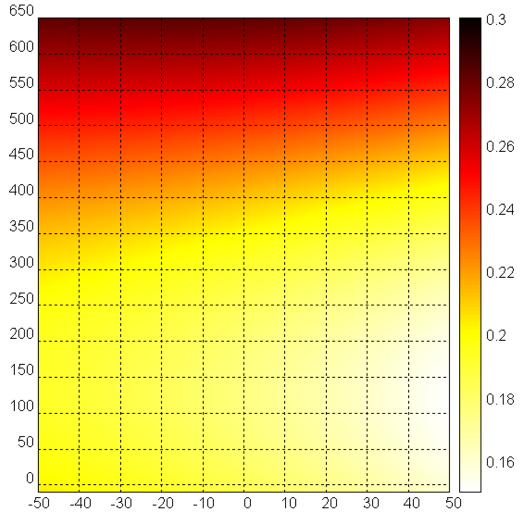

Figure 12: Results of the prediction of the attenuation given by the vessel's side made of metallic rods

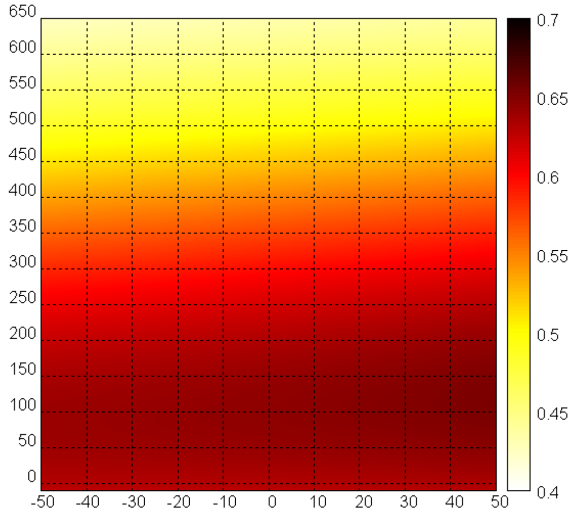

Figure 13: Results of the prediction of the attenuation given by the vessel's side as a full metallic surface

The maximum attenuation given by the vessel's side on the area of the expected presence of the Land BS in the 12 NM distance is:

- 0,28 dB (0,0279mV/m - 0,0270 mV/m) – for the vessel's side made of metallic rods
- 0,65 dB (0,0279mV/m - 0,0259mV/m) – for the vessel's side as a full metallic surface.

ANNEX 11: RESPONSES TO THE ECO QUESTIONNAIRE IN 2012

Table 71: Responses to the ECO questionnaire in 2012 – question 3

Question 3:	
Have interference issues with land-based mobile networks been reported	
Austria	Not applicable
Bosnia and Herzegovina	No
Czech Republic	N/A
Denmark	Yes – once
Estonia	No reported
Finland	No real interference cases reported; however sometimes cruise vessels do not shut down their transreceivers. Therefore mobile terminals may connect to vessels network and cause higher bills.
Iceland	No
Ireland	No
Latvia	Have not been reported
Lithuania	No
Malta	No
Montenegro	No
Netherlands	There are no interference issues reported in The Netherlands.
Norway	No
Poland	No
Portugal	No
Romania	None for the time being.
Russian Federation	Yes (one case on international GSMOBV was not switched off)
Slovak Republic	No
Slovenia	Yes, two times, station on board vessels was not switched off in port.
Spain	No
Sweden	Is some cases subscribers to Swedish operator have been connected to the GSMOBV operator and thus been charged for roaming (before the licence exempt usage was allowed in part of the 1800 MHz band)
Switzerland	No

ANNEX 12: SPECTRUM EMISSION MASKS

Spectrum emission masks to be taken from TS 36.101 and TS 36.104 SEM not ACLR.

A12.1 MCV LTE BS TX MASK

It is assumed that MCV LTE BS is a local area BS. The BS Tx power at BS antenna connector is unknown. The MCV BS Tx power was supposed to be at antenna input which includes the feeder cable loss.

Table 72: MCV Indoor LTE BS Tx mask (10 MHz)

Indoor BS	Tx Power (dBm)	-5	
Offset	dBm	dB	BW (kHz)
0	-5.0	0.0	9000
4.5	-5.0	0.0	9000
6	-38.3	33.3	100
7.5	-40.4	35.4	100
10	-37	32.0	100
15	-37	32.0	100
20	-37	32.0	100
25	-37	32.0	100

Table 73: MCV outdoor LTE BS Tx mask (10 MHz)

Outdoor BS	Tx Power (dBm)	1	
Offset	dBm	dB	BW (kHz)
0	1.0	0.0	9000
4.5	1.0	0.0	9000
6	-38.3	39.3	100
7.5	-40.4	41.4	100
10	-37	38.0	100
15	-37	38.0	100
20	-37	38.0	100
25	-37	38.0	100

A12.2 LTE UE TX MASK (10 MHz CHANNEL BANDWIDTH)

Table 74: LTE UE Tx mask (10 MHz)

UE Tx Mask	Tx Power (dBm)	23	
Offset	dBm	dB	BW (kHz)
0	23.0	0.0	9000
4.5	23.0	0.0	9000
5.5	-18.0	41.0	30
6.5	-10.0	33.0	1000
10.5	-10	33.0	1000
11.5	-13	36.0	1000
14.5	-13	36.0	1000
16.5	-25	48.0	1000

A12.3 LTE 10 MHZ BS RECEIVER MASK

Table 75: LTE 10 MHz BS receiver mask (3 dB Noise Figure)

Frequency offset (MHz)	Rejection (dB)
<-25	81.7
-25 to -10	53.7
-10 to -5	44.7
-4.5 to 4.5	200
5 to 10	44.7
10 to 25	53.7
-25	81.7

Table 76: LTE 10 MHz BS receiver mask (8 dB Noise Figure)

Frequency offset (MHz)	Rejection (dB)
<-25	76.7
-25 to -10	48.7
-10 to -5	39.7
-4.5 to 4.5	200
5 to 10	39.7
10 to 25	48.7
-25	76.7

In Table 75 and Table 76, the blocking level of 200 dB is used in order to present SEAMCAT to double count the co-channel interference level, since in SEAMCAT, I_total=I_unwanted + I_blocking.

A12.4 LTE 10 MHz UE RECEIVER MASK

Table 77: LTE 10 MHz channel UE receiver mask (8 dB noise figure)

Frequency offset (MHz)	Rejection (dB)
-90 to -65	61.7
-65 to -20	48.7
-20 to -10	35.7
-10 to -5	32.6
-4.5 to 4.5	200
5 to 10	32.6
10 to 20	35.7
20 to 65	48.7
65 to 90	61.7

A12.5 GSM 900 BTS TX MASK (3GPP TS 45.005 V12.2.0 [11])

Table 78: GSM900 BTS Tx mask (3GPP TS 45.005 v12.2.0)

Offset	dB	BW(kHz)
0.1	0.5	200.0
0.2	-30.0	30.0
0.25	-33.0	30.0
0.4	-60.0	30.0
0.6	-60.0	30.0
1.2	-60.0	30.0
1.201	-63.0	30.0
1.8	-63.0	30.0
1.801	-70.0	100.0
6.0	-70.0	100.0

A12.6 GSM 900 MS EMISSION MASK (3GPP TS 45.005 V12.2.0 [11])

Table 79: GSM 900 MS emission mask (3GPP TS 45.005 v12.2.0)

Offset	dB	BW(kHz)
0.1	0.5	200.0
0.2	-30.0	30.0
0.25	-33.0	30.0
0.4	-60.0	30.0
0.6	-60.0	30.0
1.2	-60.0	30.0
1.8	-60.0	30.0
1.801	-63.0	100.0
3.0	-63.0	100.0
3.001	-68.0	100.0
6.0	-68.0	100.0
6.001	-71.0	100.0
10.0	-71.0	100.0

A12.7 GSM 1800 BTS EMISSION MASK (3GPP TS 45.005 V12.2.0 [11])

Table 80: GSM 1800 BTS emission mask (3GPP TS 45.005 v12.2.0)

Offset	dB	BW(kHz)
0.1	0.5	200.0
0.2	-30.0	30.0
0.25	-33.0	30.0
0.4	-60.0	30.0
0.6	-60.0	30.0
1.2	-60.0	30.0
1.201	-63.0	30.0
1.8	-63.0	30.0
1.801	-76.0	100.0
6.0	-76.0	100.0

A12.8 GSM1800 MS EMISSION MASK (3GPP TS 45.005 V12.2.0 [11])

Table 81: GSM1800 MS emission mask (3GPP TS 45.005 v12.2.0)

Offset	dB/200 kHz
0.1	0
0.2	-21.8
0.4	-51.8
0.6	-51.8
0.8	-51.8
1	-51.8
1.2	-51.8
1.4	-51.8
1.6	-51.8
1.8	-56.8
2	-56.8
4	-56.8
6	-56.8

A12.9 UMTS BS EMISSION MASK (3GPP TS 25.104 (BS) [12])

Note that this has to adapted to the actual power level, and the below is relative for 0 dBm BTS power.

Table 82: UMTS BS emission mask (3GPP TS 25.104 (BS))

Offset	dB	BW(kHz)
2.5	-22.0	30.0
2.7	-22.0	30.0
3.499	-34.0	30.0
3.5	-21.0	1000.0
7.499	-21.0	1000.0
7.5	-25.0	1000.0
12.0	-25.0	1000.0

A12.10 UMTS UE EMISSION MASK (3GPP TS 25.101 (UE) [13])

Table 83: UMTS UE emission mask (3GPP TS 25.101 (UE))

Offset	dB	BW(kHz)
2.5	-35.0	30.0
3.499	-50.0	30.0
3.5	-35.0	1000.0
7.499	-39.0	1000.0
7.5	-39.0	1000.0
8.499	-49.0	1000.0
8.5	-49.0	1000.0
12.5	-49.0	1000.0

ANNEX 13: INTERFERENCE MITIGATION AND MONITORING PROCEDURE FOR MCV IN INTERNATIONAL WATER

In this Report, the simulation results show that when the MCV outdoor antennas are switched on after leaving the territorial waters, the UE transmitting its maximum power (24 dBm for UMTS and 23 dBm for LTE) will create severe interference to land network uplink. The interference mitigation solutions described in chapter 5 are proposed for application only in national water between 2 NM and 12 NM.

The MCV system changes its configuration when the vessel enters in the international water. All “floating” vessels are subject to the exclusive jurisdiction of their flag nation. Systems are operated according to ITU RR5 and international laws in the area outside the territorial border.

With regard of ITU Constitution (article 6) “The Member States are bound

- to abide by the provisions of this Constitution, the Convention and the Administrative Regulations in all telecommunication offices and stations established or operated by them which engage in international services or which are capable of causing harmful interference to radio services of other countries;
- to take the necessary steps to impose the observance of the provisions of this Constitution, the Convention and the Administrative Regulations upon operating agencies authorised by them to establish and operate telecommunications and which engage in international services or which operate stations capable of causing harmful interference to the radio services of other countries.”

The simulations show that MCV network in the international water can interfere the land networks if the User equipment power is not controlled.

Following the procedure mentioned in the Radio Regulation:

- Administrations agree to continue the development of monitoring facilities and, to the extent practicable, to cooperate in the continued development of the international monitoring system to help ensure efficient and economical use of the radio-frequency spectrum and to help in the prompt elimination of harmful interference (RR.16);
- Transmitting stations shall radiate only as much power as is necessary to ensure a satisfactory service (RR 15.2);
- Transmission in unnecessary directions shall be minimized by taking the maximum practical advantage of the properties of directional antennae whenever the nature of the service permits (RR 15.5 b).

Administrations shall take all practicable and necessary steps to ensure that the operation of the equipment on board vessel does not cause harmful interference to a radiocommunication service (RR15.12)

It is essential that Member States exercise the utmost goodwill and mutual assistance in the application of the provisions of Article 45 of the Constitution and of this Section to the settlement of problems of harmful interference.

Article 45 of the ITU Constitution states that:

“a). All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorised operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations.

b). Each Member State undertakes to require the operating agencies which it recognizes and the other operating agencies duly authorised for this purpose to observe the provisions of No. 197 above.

c). Further, the Member States recognize the necessity of taking all practicable steps to prevent the operation of electrical apparatus and installations of all kinds from causing harmful interference to the radio services or communications mentioned in No. 197 above."

In order to avoid a harmful interference from MCV system in the international waters towards the terrestrial networks base stations, it is recommended to implement an appropriate interference mitigation solution, e.g. to limit MCV UE Tx power to the values given in Table 84 and Figure 14 between 76 km(41 NM) and the 22.2 km (12 NM).

Table 84: MCV LTE1800 and LTE2600 UE maximum transmit power

Distance (NM)	LTE1800 UE Max Tx power (dBm)	LTE2600 UE Max Tx power (dBm)
12	1	3
17	5	6
22	7	9
27	8	10
33	14	16
38	19	23
41	23	23

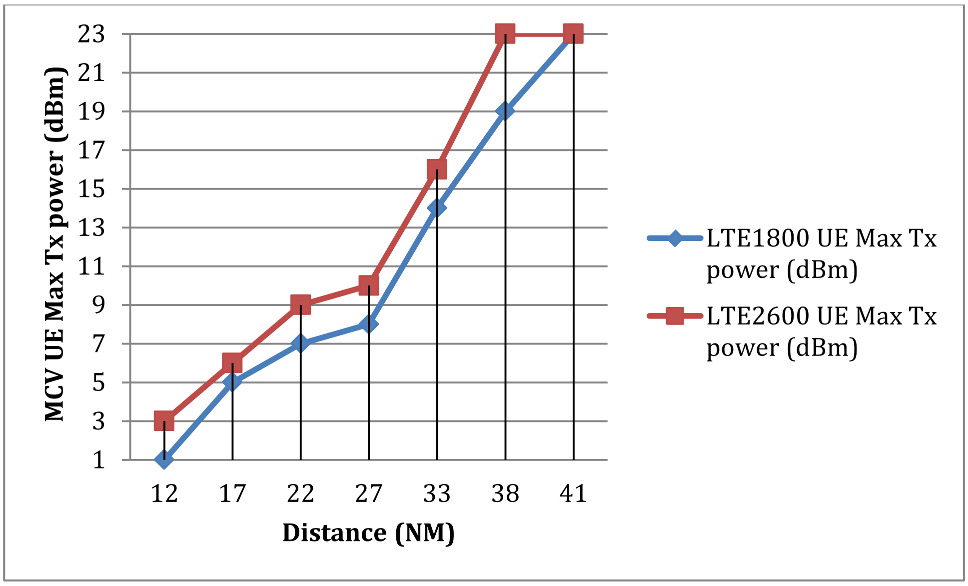

Figure 14: MCV LTE1800/LTE2600 UE maximum transmit power

ANNEX 14: PARAMETERS DESCRIPTION

A14.1 POWER CONTROL IN UMTS

maxTxPowerUl = 24 { -50..33 }
Maximum UE transmission power on the RACH when accessing the system. Used in UE functions for cell selection/reselection in idle mode and connected mode and to control the maximum TX power level that a UE may use. If the current UE uplink transmit power is above the indicated power value, the UE shall decrease power to a level below that power value.

Unit: 1 dBm

Ref: ETSI TS 136.101 [16]

POWER CONTROL IN LTE
The UE is allowed to set its configured maximum output power PCMAX, c for serving cell c. The configured maximum output power PCMAX,c is set within the following bounds:

PCMAX_L,c ≤ PCMAX,c ≤ PCMAX_H,c with

PCMAX_L,c = MIN {PEMAX,c– ΔTC,c, PPowerClass – MAX(MPRc + A-MPRc + ΔTIB,c + ΔTC,c, P-MPRc)}

PCMAX_H,c = MIN {PEMAX,c, PPowerClass}

where

- PEMAX,c is the value given by IE P-Max for serving cell c
- PPowerClass is the maximum UE power specified in ETSI TS 136 101;
- MPRc and A-MPRc for serving cell;
- ΔTIB,c is the additional tolerance for serving cell;
- ΔTC,c = 1.5 dB or 0 dB

Ref: ETSI TS 136 101 [16]

A14.2 QRXLEVMIN = -140 { -140..-44 }

The required minimum received Reference Symbol Received Power (RSRP) level in the E-UTRA frequency for cell reselection. Corresponds to parameter Qrxlevmin in 3GPP TS 36.304 [14]. This attribute is broadcast in SIB1. Unit: 1 dBm, Resolution: 2

The cell selection criterion S is fulfilled when: Srxlev > 0

where: Srxlev = Qrxlevmeas – (Qrxlevmin – Qrxlevminoffset) - Pcompensation

where:

- the signalled value QrxlevminOffset is only applied when a cell is evaluated for cell selection as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN. During this periodic search for higher priority PLMN the UE may check the S criteria of a cell using parameter values stored from a different cell of this higher priority PLMN;
- Srxlev: Cell Selection RX level value (dB);

- Qrxlevmeas: Measured cell RX level value (RSRP);
- Qrxlevmin: Minimum required RX level in the cell (dBm);
- Qrxlevminoffset: Offset to the signalled Qrxlevmin taken into account in the Srxlev evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN.

Ref. ETSI TS 136 304 [17]

A14.3 CELLRANGE = 15 { 1..100 }

Defines the maximum distance from the base station where a connection to a UE can be setup and/or maintained.

ANNEX 15: POSSIBLE DISCONNECTION OF UMTS MCV OUTDOOR UE CONNECTED TO AN INDOOR MCV ANTENNA BECAUSE OF LAND NETWORK SIGNAL

This annex is an illustration of the possibility of having an outdoor UMTS MCV UE connected to an indoor MCV antenna being disconnected because of the signal from land networks.

This illustration has the following limitations:

- Land BS load power 3 dB (the worst case would be 0 dB)
- Body loss 4 dB (1 dB could be used)
- Free space model is used while in the simulations SEAMCAT JTG 5-6 sea model was used

A land UMTS network covering sea will have received signalling strength (seen as DL noise on the MCV system) according to the table shown below. The table also shows what DL signal strengths level the MCV 128kbps data user will be lost.

Table 85: Received signalling strength of a land UMTS network covering sea

	3.7Km (2 NM)	7.4 Km (4 NM)	9.25 Km (5 NM)	11.1 Km (6 NM)	14.8 Km (8 NM)	18.5 Km (10 NM)	22.2 Km (12 NM)
Land BS power Pilot (CPICH) +3 dB load power (dBm)	36	36	36	36	36	36	36
Land BS antenna gain (dBi)	18	18	18	18	18	18	18
Free space path loss, 2100 MHz (dB)	110.2	116.3	118.2	119.8	122.3	124.3	125.8
UE antenna gain (dBi)	-3	-3	-3	-3	-3	-3	-3
Body loss (dB)	4	4	4	4	4	4	4
Land signal strength on deck (dBm)	-63.2	-69.3	-71.2	-72.8	-75.3	-77.2	-78.8
MCV signal strength where MCV 128k data user on deck is dropped (SIR<-13)	-76.2	-82.3	-84.2	-85.8	-88.3	-90.2	-91.2

For MCV it is assumed a maximum loading of a system of 75%. One data user can get DL power corresponding to -3 dB of total power, or +7 dB compared to pilot power (CPICH).

The signal/noise power from land will cause DL failure to the UE on deck connected to the MCV system when the signal/noise power from land is 13 dB higher than the MCV-DL signal power for a 128kbps data user on the MCV system.

SIR for dropping 128kbps data user in downlink is equal to -13 dB (2 dB EbNo – 15 dB processing gain)

The interference level on land network (from the MCV-UE) is reaching 1% at 8 NM (as scenario 5.2 simulations shows) for 128kbps data user and 20 dB hull loss.

So limiting MCV data channel signal strength to -88 dBm according to the table is enough to cause DL disconnection of 128kbps data user on deck, and by that avoid interference to the land network.

Based on the above table and that the pilot power is 7 dB lower than received data channel power -88 dBm, maximum pilot power (CPICH) on deck should be -95 dBm.

ANNEX 16: POSSIBLE DISCONNECTION OF LTE MCV OUTDOOR UE CONNECTED TO AN INDOOR MCV ANTENNA BECAUSE OF LAND NETWORK SIGNAL

This annex is an illustration of the possibility of having an outdoor LTE MCV UE connected to an indoor MCV antenna being disconnected because of the signal from land networks.

This illustration has the following limitations:

- Land BS load power 3 dB (the worst case would be 0 dB);
- Body loss 4 dB (1 dB could be used);
- Free space model is used while in the simulations SEAMCAT JTG 5-6 sea model was used.

A land LTE network covering sea will have received signalling strength (seen as DL noise on the MCV system) according to the tables shown below.

The signal/noise power from land will cause DL failure to the UE on deck connected to the MCV system when the signal/noise power from land is more than 11 dB higher than the MCV-DL signal power (SINR<-11 dB).

Reference signal (RS) power for a LTE system is:
RSRP = BS_max_power – 10*LOG(N*resource-bearers) + 3 (additional boost of RS typical).

For a 5 MHz LTE system with maximum BS power of 24 and 43 dBm the RSRP will be:
RSRP = 24 – 10*LOG(300) + 3 = 24 – 24.77 + 3 = 2.23 dBm
RSRP = 43 – 10*LOG(300) + 3 = 43 – 24.77 + 3 = 21.23 dBm
So RSRP is typical 21,77 dB lower than BS maximum power for a 5 MHz LTE system.

For a 10 MHz LTE system with maximum BS power of 24 and 43 dBm the RSRP will be:
RSRP = 24 – 10*LOG(600) + 3 = 24 – 27.77 + 3 = -0.77 dBm
RSRP = 43 – 10*LOG(600) + 3 = 43 – 27.77 + 3 = 18.23 dBm
So RSRP is typical 24,77 dB lower than BS maximum power for a 10 MHz LTE system.

The table below shows what DL signal strengths level the MCV-UE LTE data user will be lost due to interference from land LTE 1800 network.

Table 86: MCV-UE LTE signal strength where data user on deck is dropped (SINR<-11) due to interference from land LTE 1800 network

LTE 1800	7.4 Km (4 NM)	9.25 Km (5 NM)	11.1 Km (6 NM)	14.8 Km (8 NM)	18.5 Km (10 NM)	22.2 Km (12 NM)
Land BS power (dBm / 5 MHz)	43	43	43	43	43	43
Land BS antenna gain (dBi)	18	18	18	18	18	18
Free space path loss, 1800 MHz (dB)	114.9	116.9	118.5	121	122.9	124.5
UE antenna gain (dBi)	-3	-3	-3	-3	-3	-3
Body loss (dB)	1	1	1	1	1	1
Land signal strength on deck (dBm)	-71.9	-73.9	-75.5	-78	-79.9	-81.5
MCV signal strength where data user on deck is dropped (SINR<-11)	-82.9	-84.9	-86.5	-89	-90.9	-92.5

The interference level on land LTE 1800 network (from the MCV-UE) is reaching 1% at 10 NM for on deck MCV connected UE when limiting MCV-UE maximum power to 0 dBm. So limiting data channel signal strength to -91 dBm according to the table above is enough to cause DL disconnected of MCV data user on deck, and by that avoid interference to the land network.

The reference signal (pilot) is 22 dB lower than received data channel power -91 dBm, so maximum reference signal power on deck should be -113 dBm(15kHz), and Qrxlevmin should be set 5-10 dB higher than this this value.

The table below shows what DL signal strengths level the MCV-UE LTE data user will be lost due to interference from land LTE 2600 network.

Table 87: MCV-UE LTE signal strength where data user on deck is dropped (SINR<-11) due to interference from land LTE 2600 network

LTE 2600	7.4 Km (4 NM)	9.25 Km (5 NM)	11.1 Km (6 NM)	14.8 Km (8 NM)	18.5 Km (10 NM)	22.2 Km (12 NM)
Land BS power (dBm / 5 MHz)	43	43	43	43	43	43
Land BS antenna gain (dBi)	18	18	18	18	18	18
Free space path loss, 1800 MHz (dB)	118.1	120.1	121.6	124.1	126.1	127.7
UE antenna gain (dBi)	-3	-3	-3	-3	-3	-3
Body loss (dB)	1	1	1	1	1	1
Land signal strength on deck (dBm)	-75.1	-77.1	-78.6	-81.1	-83.1	-84.7
MCV signal strength where data user on deck is dropped (SINR<-11)	-86.1	-88.1	-89.6	-92.1	-94.1	-95.7

The interference level on land LTE 2600 network (from the MCV-UE) is reaching 1% at 8 NM for on deck MCV connected UE when limiting MCV-UE maximum power to 0 dBm. So limiting data channel signal strength to -92 dBm according to the table below is enough to cause DL disconnected of data user on deck, and by that avoid interference to the land network.

The reference signal (pilot) is 22 dB lower than received data channel power -92 dBm, so maximum reference signal power on deck should be -114 dBm, and Qrxlevmin should be set 5-10 dB higher than this this value.

ANNEX 17: LIST OF REFERENCES

[1] ECC Decision (08)08: on the harmonised use of GSM system on board vessels in the frequency bands 880-915/925-960 MHz and 1710-1785/1805-1880 MHz
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[3] Recommendation ITU-R P.1546: Method for point-to-area predictions for terrestrial services in the frequency range 30 to 3000 MHz
[4] EC Decision 2011/251/EU: amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community
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[6] ECC Recommendation (11)05: Frequency planning and frequency coordination for terrestrial systems for Mobile Fixed Communications Networks in the frequency band 2500-2690 MHz
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[12] 3GPP TS 25.104: Technical Specification Group Radio Access Network; Base Station (BS) radio transmission and reception (FDD)
[13] 3GPP TS 25.101: Technical Specification Group Radio Access Network; User Equipment (UE) radio transmission and reception (FDD)
[14] 3GPP TS 36.304: Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode
[15] ITU-R Recommendation P.1812: A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands
[16] ETSI TS 136.101: Technical specification, LTE; Evolved Universal Terrestrial Radio Access (E-UTRA);User Equipment (UE) radio transmission and reception
[17] ETSI TS 136.104: Technical specification, LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception