



# International Spectrum Management and Interference Mitigation



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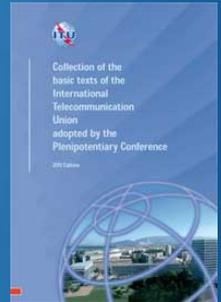
# Outline of presentation

- Related ITU documents
- Prevention of interference
- Resolving cases of interference
- Radiomonitoring as a complementary instrument of interference management
- ITU studies on interference mitigation techniques

# Related ITU documents

- ITU Constitution and Convention – basic instruments of the Union containing several related provisions, e.g.:

CS 197 - All stations must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Members which operate in accordance with the provisions of the Radio Regulations



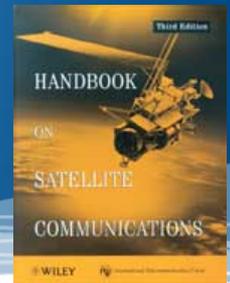
- ITU Radio Regulations (RR) - the main regulatory document on international spectrum management



- Main objective of RR is interference-free operation of stations
- Provisions aimed at compatibility between radio services

- ITU-Regional agreements

- ITU-R Recommendation, Reports and Handbooks – technical information, including mitigation techniques



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# Possible reasons for interference

- Operation in the bands **not** allocated by the Radio Regulations
- Operation of non-coordinated frequency assignments
- Operation with parameters different from the agreed ones, e.g. contained in a Plan, coordinated between administrations, recorded in the Master Register
- Non-compliance with frequency tolerances of transmitters
- Unwanted emissions i.e. out-of-band and spurious emissions
- Unauthorized operations

# Radio Regulations and preventing interference (1)

- Allocation of frequency blocks to radio services (Article 5)
  - Allocation to compatible services, e.g. fixed and land mobile
  - establishing priority in operation: primary and secondary allocations
  - Imposing regulatory/technical limitations on some allocations
- Set of coordination procedures (Art. 9) -> to ensure compatibility
  - Art. 9 lists cases of mandatory coordination of stations prior to bringing them in operation
  - Examples: all space networks, AM(R)S vs. AMS(R)S in 5030 – 5091 MHz
- Recording in Master Register, that is worldwide database of existing stations (Art. 11) -> status of international recognition
  - Stations recorded in MIFR shall be taken into account by other countries
  - This status is important for resolving cases of harmful interference

# Radio Regulations and preventing interference (2)

- Establishing limits of transmitter frequency tolerances in 9 kHz to 40 GHz (App. 2) -> reduction of out-of-band interference
- Establishing maximum power levels of unwanted emissions (App. 3) -> reduction of interference due to spurious emissions
- Establishing requirements for licenses to radio stations (Art.18) -> reduction of unauthorized emissions
- Introduction of requirements for installation and parameters of stations (Art. 15) to reduce interference, e.g.:
  - **15.2** Transmitting stations shall radiate only as much power as is necessary to ensure a satisfactory service
  - **15.4** locations of transmitting stations ... shall be selected with particular care
  - **15.5** radiation in and reception from unnecessary directions shall be minimized by ... directional antennas

# Distress and safety frequencies/services

- Special consideration for safety services: RNS, AM(R)S, AMS(R)S
  - **4.10** Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference...
  - **15.8** Special consideration shall be given to avoiding interference on distress and safety frequencies, those ...identified in Article 31 and those related to safety and regularity of flight identified in Appendix 27
- Absolute protection of distress and safety frequencies in App.15

## AP15-4

TABLE 15-2 (end) (WRC-12)

Frequency (MHz)	Description of usage	Notes
*406-406.1	406-EPIRB	This frequency band is used exclusively by satellite emergency position-indicating radio beacons in the Earth-to-space direction (see No. 5.266).
1 530-1 544	SAT-COM	In addition to its availability for routine non-safety purposes, the band 1 530-1 544 MHz is used for distress and safety purposes in the space-to-Earth direction in the maritime mobile-satellite service. GMDSS distress, urgency and safety communications have priority in this band (see No. 5.353A).

...Any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified in this Appendix is prohibited.

# ITU frequency plans

- Plan - distribution of frequencies between countries or stations aimed at compatible operation -> **stations in conformity with a Plan are supposed to operate without interference**
- Two types of plans: allotment (zones) and assignment (stations)
- ITU maintains 12 terrestrial and 3 space Plans
- 3 plans for aeronautical mobile and ARNS services:



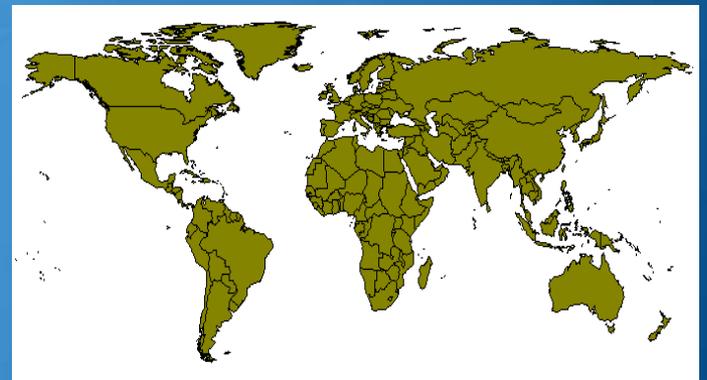
**AP26 – Worldwide allotment Plan for aeronautical mobile (off-route) service, HF (3025 – 18030 kHz )**



**AP27 - Worldwide allotment Plan for aeronautical mobile route service, HF (2850 – 22000 kHz)**



**GE85-R1-AER: Region 1 assignment plan for aeronautical radionavigation service, MF bands**



**ITU-R  
Region 1**



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# Procedure in case of interference

- Procedure in a case of harmful interference is described in Article 15 of the Radio Regulations
- Administrations try to resolve the problem bilaterally, on the basis of goodwill and mutual assistance
- Interference may be treated by operators directly, e.g. coordination of cellular networks in border areas
- Administration may report interference to ITU/BR
  - for information
  - for assistance
- Request for assistance should contain technical and operational details and copies of the correspondence
- Interference cases should be reported in form of Appendix 10

# Report of harmful interference

AP10-1

APPENDIX 10 (Rev.WRC-07)

## Report of harmful interference

(See Article 15, Section VI)

### Particulars concerning the station causing the interference:

- a* Name, call sign or other means of identification .....
- b* Frequency measured .....
- Date: .....
- Time (UTC): .....
- c* Class of emission<sup>1</sup> .....
- d* Bandwidth (indicate whether measured or estimated) .....
- e* Measured field strength or power flux-density<sup>2</sup> .....
- Date: .....
- Time (UTC): .....
- f* Observed polarization .....
- g* Class of station and nature of service .....
- h* Location/position/area/bearing (QTE<sup>3</sup>) (WRC-07) .....
- i* Location of the facility which made the above measurements .....

### Particulars concerning the transmitting station interfered with:

- j* Name, call sign or other means of identification .....
- k* Frequency assigned .....

<sup>1</sup> The class of emission shall contain the basic characteristics listed in Appendix 1. If any characteristic cannot be determined, indicate the unknown symbol with a dash. However, if a station is not able to identify unambiguously whether the modulation is frequency or phase modulation, indicate frequency modulation (F).

<sup>2</sup> When measurements are not available, signal strengths according to the QSA scale should be provided.

<sup>3</sup> See the most recent version of Recommendation ITU-R M.1172. (WRC-07)

AP10-2

- l* Frequency measured .....
- Date: .....
- Time (UTC): .....
- m* Class of emission<sup>4</sup> .....
- n* Bandwidth (indicate whether measured or estimated, or indicate the necessary bandwidth notified to the Radiocommunication Bureau) .....
- o* Location/position/area .....
- p* Location of the facility which made the above measurements .....

### Particulars furnished by the receiving station experiencing the interference:

- q* Name of station .....
- r* Location/position/area .....
- s* Dates and times (UTC) of occurrence of harmful interference .....
- t* Bearings (QTE<sup>5</sup>) or other particulars (WRC-07) .....
- u* Nature of interference .....
- v* Field strength or power flux-density of the wanted emission at the receiving station experiencing the interference<sup>6</sup> .....
- Date: .....
- Time (UTC): .....
- w* Polarization of the receiving antenna or observed polarization .....
- x* Action requested .....

NOTE – For convenience and brevity, telegraphic reports shall be in the format above, using the letters in the order listed in lieu of the explanatory titles, but only those letters for which information is provided should be used. However, sufficient information shall be provided to the administration receiving the report, so that an appropriate investigation can be conducted.

<sup>4</sup> See footnote 1.

<sup>5</sup> See footnote 3.

<sup>6</sup> See footnote 2.

# Actions in case of interference (1)

- Identification of source of interference
  - using information in the Report of harmful interference
  - using information in the Master Register
  - requesting assistance of radiomonitoring stations of different countries
- Determination of the cause of interference
- Determination of regulatory status of the stations involved
  - primary or secondary services
  - conformity with the Frequency Allocation Table and allocation conditions, e.g. coordination requirements, power limits
  - recording in the Master Register
- Technical studies, if necessary
- Development of recommendations, contacting administrations

Cases of interference to distress and safety frequencies, to AM(S)S communications are treated by the BR within 24 hour period

# Actions in case of interference (2)

- If interference persist
  - Interference case may be reported to the Radio Regulations Board (12 elected members, 2 – 3 meetings per year)
  - Interference case can be brought to the attention of a world radiocommunication conference for consideration
- Organization of treatment of interference cases in BR:
  - Centralization of processing of all interference cases in one division
  - Assistance of the services concerned, if required
- Statistics – totally 67 cases treated by the BR in 2012
  - Space services: 24 cases (8 requests for assistance, 16 information)
  - Terrestrial services: 43 cases, including 16 cases related to safety services (4 request for assistance of the BR; 23 cases for information)

# Examples of interference (1)

- Interference to HF aeronautical station of administration “A” on 13 349.4 kHz in June 2012
  - Source: probably a fishing vessel in vicinity of Administration “B”
  - Reason: operation of maritime mobile service in non-allocated band
  - BR actions: letter to “B” requesting to promptly eliminate interference
- Interference to aircraft/ship GPS receivers of administration “C” on 1227 MHz and 1575 MHz in March-May 2012
  - Source: ground-based station of neighboring Administration “D”, operating in a non-allocated band , at 9 km from border
  - BR actions: letter to Administration “D” responsible for interference -> request to identify the source, eliminate interference, avoid reoccurrence
  - Development: MOC between ICAO and ITU on GNSS protection, 17.12.12

# Actions in case of interference (2)

- Interference to reception of Nilesat satellite TV , at 17 GHz by a terrestrial station (unmodulated carrier) in June 2010
  - BR requested other satellite operators to identify the interference source by Geo-location (difficulties due to short duration of interfer.)
  - The area of location of the interfering station was eventually identified but interference stopped in July 2010
- Interference to reception of VHF/UHF terrestrial broadcasting of 14 countries of Region 1 from sound and TV stations of adm. “H”
  - Source: sound and TV stations of administration “H” in border areas
  - Reason: operation on channels assigned by Regional Agreements GE84 (89.5 – 108 MHz) and GE06 (174-230, 470-862 MHz) to other countries
  - BR actions: letters to administration “H” since 2006, multilateral meetings, submissions to RRB, consideration at WRC-12

# WRC-12 activities on issue of interference

- Prior to WRC-12 several interference cases to satellite networks seriously degrading their performance were reported to the BR and RRB
- 14 European countries proposed to WRC-12 to add a new provision on preventing cases of deliberate interference to Radio Regulations :

**15.1A § 1bis** *Member States are responsible for ending transmissions of signals originating from their territory and intended or designed to disturb or prevent the reception of other signals.*

- WRC-12 discussions in Ad hoc Group (B. Gracie) , output:
- Confirmed that intentional interference represent infringements of RR; countries having jurisdiction over interfering signals have the *obligation to take the necessary actions*

**MOD 15.21** *If an administration has information of an infringement of the Constitution, the Convention or Radio Regulations, (in particular Article 45 of the Constitution and No. 15.1 of the Radio Regulations) committed by a station ~~over which it may exercise authority~~ under its jurisdiction, the administration ~~it shall ascertain the facts, fix the responsibility and take the necessary actions.~~*

# Infringements of the Radio Regulations

- Infringement –operation of a station that is not in conformity with the RR, but not necessarily causing harmful interference
- Reports on infringements - in format of Appendix 9 to the RR
- Reports on serious infringement shall be made to the administration of the country having jurisdiction over the station, by the administrations which detect it

APPENDIX 9	AP9-1	AP9-2
<b>Report of an irregularity or infringement</b>		
(See Article 15, Section V)		
<i>Particulars concerning the station infringing the Radio Regulations:</i>		<i>Particulars concerning the transmitting station interfered with<sup>1</sup>:</i>
1 Name <sup>1</sup> if known (in BLOCK letters)	.....	14 Date and time <sup>2</sup> .....
2 Call sign or other identification (in BLOCK letters)	.....	15 Nature of the irregularity or infringement <sup>3</sup> .....
3 Nationality, if known	.....	16 Extracts from ship log or other information supporting the report .....
4 Frequency used (kHz, MHz, GHz or THz)	.....	
5 Class of emission <sup>2</sup>	.....	17 Name of the station (in BLOCK letters) .....
6 Class of station and nature of service, if known	.....	18 Call sign or other identification (in BLOCK letters) .....
7 Location <sup>3, 4, 5</sup>	.....	19 Frequency assigned (kHz, MHz, GHz or THz) .....
		20 Frequency measured at the time of the interference .....
<i>Particulars concerning the station, the centralizing office or inspection service reporting the irregularity or infringement:</i>		21 Class of emission <sup>2</sup> and bandwidth (indicate whether measured or estimated, or indicate the necessary bandwidth notified to the Radiocommunication Bureau) .....
8 Name (in BLOCK letters)	.....	22 Receiving location <sup>3, 4</sup> (in BLOCK letters) where the interference was experienced .....
9 Call sign or other identification (in BLOCK letters)	.....	23 Certificate:
10 Nationality	.....	I certify that the foregoing report represents, to the best of my knowledge, a complete and accurate account of what took place. ....
11 Location <sup>3, 4</sup>	.....	Signatures <sup>10</sup> .....
		Date: .....
<i>Particulars of the irregularity or infringement:</i>		
12 Name <sup>6</sup> of the station (in BLOCK letters) in communication with the station committing the irregularity or infringement .....		
13 Call sign or other identification (in BLOCK letters) of the station in communication with the station committing the irregularity or infringement .....		

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# International Monitoring System

- International Monitoring System (IMS): monitoring stations and centralizing offices of administrations or group of administr.
- Objectives: assistance in cases of interference, in protection of safety services, evaluation of the actual spectrum use, verification compliance of transmitted signals, detecting illegal transmitters
- Monitoring station notified to ITU and published in List VIII
- *Uniform coverage* of the world by monitoring stations of ITU monitoring programs is basis for successful operation of IMS
- BR prepares and publishes summaries of monitoring data, supplied by IMS stations, according Article 16 of the RR

Union internationale des télécommunications



Nomenclature des stations de contrôle international des émissions

List of international monitoring stations

Nomenclador de las estaciones de comprobación técnica internacional de las emisiones

GENEVE 2008



Part 1A - Centralizing Offices

Administration	Centralizing Office	Postal address	Telephone	Telex	Electronic mail	Remarks
<b>AFS</b> South Africa (Republic of)	Department of Arts and Communications Telecommunications Commission	Pretoria 001	012 300 2000			
<b>ARG</b> Argentine Republic	Secretaría de Comunicaciones Comisión Nacional de Regulación de Telecomunicaciones	Paseo 100 P.O. Box 100 1600 Buenos Aires	011 54 91 46000 011 54 91 46000			
<b>AUS</b> Australia	National Communications Authority	Communications Operations and Technology P.O. Box 99 Melbourne V.C. 3001	061 232 0000			
<b>AUT</b> Austria	Federal Ministry for Transport, Innovation and Technology Communications Division	Splügenstrasse 1 1020 Wien	043 21322 00			
<b>B</b> Brazil	Agência Nacional de Telecomunicações (ANATEL)	Av. das Nações Unidas, 12509 Luz de São Paulo, SP 05425-900	011 3033 0000 011 3033 0000 011 3033 0000			
<b>BEL</b> Belgium	Federale Reguleerder voor de Media (Regulator voor de Media)	Plaza de l'Europe 1050 Bruxelles	02 201 2000			
<b>BFA</b> Burkina Faso	Service National de Régulation des Télécommunications (SNT)	P.O. Box 100 Ouagadougou	020 30 00 00			
<b>BH</b> Bosnia and Herzegovina	Regulatorna Agencija za Telekomunikacije	Narodnih heroja 1 11000 Sarajevo	067 10 2000			
<b>BLR</b> Belarus (Republic of)	State Regulatory Support Service Communications Ministry of Communications and Information	23 Light Street 220010 Minsk	071 17 2000			

Part 1B - Alphabetical Index of Stations

Name of Station	Administration	Postal address	Telephone	Telex	Electronic mail
<b>Abidjan</b>	CI	Agence des Télécommunications de Côte d'Ivoire B.P. 2193 Abidjan 23 Côte d'Ivoire	020 20 34 50 70		020 20 34 49 65
<b>Acapulco</b>	MEX	Carretera 99-8 Caj. Juan N. Alvarez Acapulco, Gro. México	052 7474		(d) 3200 MHz - 4300 MHz (e) 4900 MHz - 8500 MHz (f) 30.7 GHz - 32.75 GHz (g) 1 GHz - 12.75 GHz (h) 12.5 GHz - 26.5 GHz
<b>Agave</b>	POR	CMR 3 Rua dos Valados Bairro 18 9000-032 Ponte de Lima Portugal	0351 226		
<b>Aden</b>	YEM	P.O. Box 1256 Tawal Aden Yemen	2352		11. MINIMUM VALUE OF MEASURABLE FIELD STRENGTH OR POWER FLUX DENSITY WITH INDICATION OF ATTAINABLE ACCURACY OF MEASUREMENT (d) -150...-151 dBW/m <sup>2</sup> ± 2.5 dB (e) -175 dBW/m <sup>2</sup> ± 1.5 dB (f) -175 dBW/m <sup>2</sup> ± 1.5 dB (g) -176 dBW/m <sup>2</sup> ± 1.5 dB (h) -175 dBW/m <sup>2</sup> ± 1.5 dB (i) -175 dBW/m <sup>2</sup> ± 1.5 dB (j) -165 dBW/m <sup>2</sup> ± 1.5 dB (k) -164 dBW/m <sup>2</sup> ± 1.5 dB Bandwidth 4 kHz, 5/2 x 20 dB
<b>Agua Calientes</b>	MEX	Inde. Eder Torres 100 Ciudad Industrial Agua Calientes, Ags. México	052 4491		12. INFORMATION AVAILABLE FOR BANDWIDTH MEASUREMENTS Bandwidth measurements in accordance with the methods described in the Spectrum Monitoring Handbook.
<b>Ahlatli</b>	TUR	Ulkekimin Bahadırli Sakir Blok Etilik Ankara Turkey	090 3322		13. INFORMATION AVAILABLE FOR SPECTRUM OCCUPANCY MEASUREMENTS Computer controlled receiving system using directional antennas for frequency ranges (d) to (j) or omni-directional antennas for frequencies > 2500 MHz. Up to 6 independent frequency bands of 100 MHz each are in line with mode recordable. The results are presented graphically as spectrograms.
<b>Al Abad</b>	IRN	P.O. Box 24955-1438 Tehran Iran Islamic Republic of)	098 21 31		14. INFORMATION AVAILABLE FOR ORBIT OCCUPANCY MEASUREMENTS Automatic orbit occupancy measurements are carried out in the frequency ranges (d) to (h).
<b>Alinga</b>	USA	United States			

List of international monitoring stations (List VII)

List of international monitoring stations (List VIII)

Part II - Monitoring stations related to stations of the Space Radiocommunication Services

Page 41 of 113

# Example of monitoring station from List VIII

## PART II

### Particulars of monitoring stations carrying out measurements related to stations of terrestrial radiocommunications services

Name of station	Geographical coordinates	Types of measurements	Ranges of frequencies for each measurement	Hours of service	Remarks
<b>AFS South Africa (Republic of)</b>					
<b>Panorama (Johannesburg)</b>	<b>(IMS)</b> 27°54'45" E 26°06'25" S	Frequency	10 kHz – 30 MHz	0430-2015	
		Field strength or power flux-density	9 kHz – 30 MHz	0430-2015	
		Bandwidth	100 kHz – 100 MHz	0430-2015	Spectrum analyser with oscilloscope display.
		Automatic spectrum occupancy surveys	9 kHz – 30 MHz	0430-2015	Automatic chart recorder connected to receiver with electronic scanning.
<b>ALS Alaska</b>					
<b>Anchorage, Alaska</b>	150°00' W 61°10' N	Frequency	10 kHz – 30 MHz	H24	
		Direction-finding	400 kHz – 30 MHz	H24	11-channel interferometer (wide aperture). Remotely controlled from Columbia, Maryland.
		Bandwidth	540 kHz – 30 MHz	H24	Manual observation with DSP data reduction.
<b>ARG Argentine Republic</b>					
<b>Altamira</b>	<b>(IMS)</b> 64°07'54" W 31°25'26" S	Frequency	9 kHz – 3 GHz	0900-1800	Available H24. The station has a GPS-referenced frequency standard. The station is incorporated in the national monitoring system by means of a satellite link. It has a computing system which enables all the technical measurements recommended by ITU to be performed automatically, while keeping the results that are obtained through the following functions: systematic monitoring of transmitters, search for unauthorized transmitters, observation of specific frequencies, channel analysis, trans-mitter occupancy, frequency occupancy, noise measurement, TV signal measurement and interference analysis. Remotely controlled in real time from an operative centre using a satellite link.

# Use of monitoring data

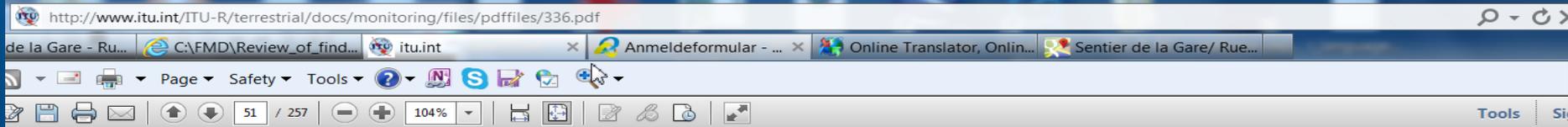
- Eliminating unauthorized and out-of-band emissions
  - Special monitoring campaigns in the bands allocated to safety services
  - Data is generally collected during 1 week
  - BR draws the attention of administrations responsible for unauthorized/out-of-band and other non-conforming emissions
- Assistance to administrations in cases of interference; BR may request the cooperation of administrations to gather:
  - data necessary for the identification and location of sources of harmful interference
  - Field strength measurements of the interfering station, to assess the level of interference (for possible comparison with corresponding criteria in the RR or in ITU-R Recommendations)

# ITU regular monitoring program

- Regular monitoring program in the HF bands 2850 - 28000 kHz
- From 1947, monitoring summaries published since 1953
- Objectives: information on spectrum utilization, identification of stations not in conformity with the RR, sharing data with administrations not having HF monitoring facilities
- Measurements: frequency, field strength, bearing, occupancy
- Submission of reports to the BR on a monthly basis
- Publication at <http://www.itu.int/ITU-R/go/terrestrial-monitoring>

# Summaries of regular monitoring program

- Extract from summary of monitoring data for 01.10.12 to 31.12.12



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KOR	CRMO	6400,000	06	11	0913	0913	84,7	PYONGYANG BS	KRE	BC	1K01E	A3E										11
KOR	CRMO	6400,000	07	11	0450	0450	70,2	PYONGYANG BS	KRE	BC	10H0E	A3E										11
KOR	CRMO	6400,000	08	11	1038	1038	76,2	PYONGYANG BS	KRE	BC	2K99E	A3E										11
KOR	CRMO	6400,000	08	11	2148	2148	75,3	PYONGYANG BS	KRE	BC	2K99E	A3E										11
KOR	CRMO	6400,000	09	11	0633	0633	79,1	PYONGYANG BS	KRE	BC	2K99E	A3E										11
KOR	CRMO	6400,000	12	11	2226	2226	74,0	PYONGYANG BS	KRE	BC	2K99E	A3E										11
KOR	CRMO	6400,000	14	11	0434	0434	58,5	PYONGYANG BS	KRE	BC	2K99E	A3E										11
KOR	CRMO	6400,000	14	11	1449	1449	56,4	PYONGYANG BS	KRE	BC	700HE	A3E										11

**RM station  
(CCRM)**

**Frequency  
(6550.0 kHz)**

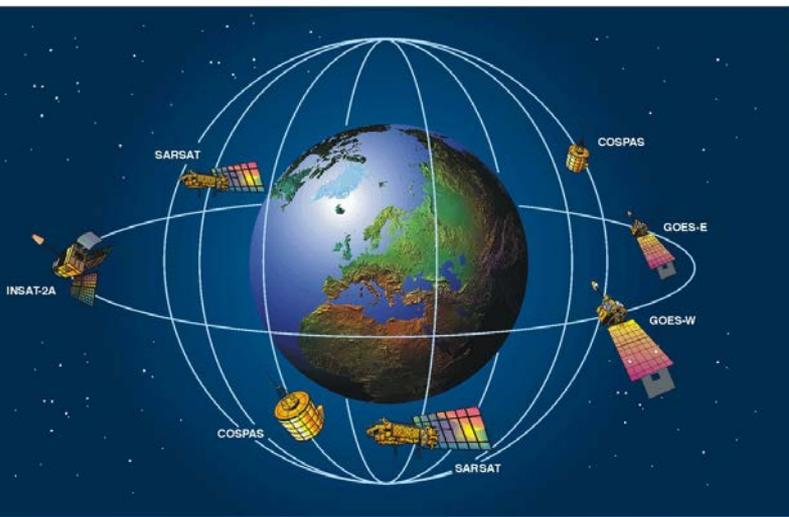
**Administration  
(F)**

**Station class  
(MS - ship)**

**Remarks  
(fisher)**

BEL	C.C.R.M.	6413,000	05	10	0858						3K00	J2D										9	Stanag-425 2400bps	
E	EL CASAR	6413,000	20	10	1900	2200	34,0	OSN4ti	BEL	FC	1K10E	F1B										22	B	
E	EL CASAR	6414,500	15	10	1000	1200	12,0		G		3K00E	G7D										4	B	
BEL	C.C.R.M.	6429,500	05	10	0900						3K00	J2D											9	
E	EL CASAR	6431,000	20	10	1900	2200	20,0				3K00E	G7D										14	B	
E	EL CASAR	6441,000	20	10			39,0		HOL		3K00E	G7D										22	A	
BEL	C.C.R.M.	6456,500	05	10	0912						3K00	J2D											9	
BEL	C.C.R.M.	6467,000	05	10	0916			LFI Rogaland Radio	NOR	FC	450HE	F1B												GW 200H 100Bd
E	EL CASAR	6467,000	20	10	1920	2200	23,0	ROGALAND RADIO	NOR	FC	340HE	F1B										16	B	
E	EL CASAR	6476,500	20	10	1920	2200	31,0		GRC		3K00E	G7D										84	B	
BEL	C.C.R.M.	6478,000	05	10	0921			SAB Goetsborg Radio	S	FC	360H	F1B												GW-FSK 100Bd
E	EL CASAR	6478,000	20	10	1920	2200	30,0	GOETEBORG RADIO	S	FC	340HE	F1B										26	C	
KOR	CRMO	6480,000	18	10	1031	1031	42,1	R.ALATURA	PRU	BC	2K99E	A3E											11	
J	TOKYO	6480,000	22	10	1021				KRE	BC		A3E	125	E	49	40	N	00	296				C	
BEL	C.C.R.M.	6487,500	05	10	0955						3K00E	J2D											9	
BEL	C.C.R.M.	6493,500	05	10	0958			Globewireless (HEC)	SUI	FC	400HE	F1B												GlobeWireless
BEL	C.C.R.M.	6501,000	05	10	1127						3K00	J2D											9	
J	TOKYO	6516,000	22	10	1023				KRE	BC		A3E	125	E	30	39	N	05	291				B	
J	TOKYO	6517,000	22	10	0811				KRE	BC		A3E	125	E	27	39	N	17	291				B	
EL	C.C.R.M.	6532,000	19	11	0839			H07 Shannon HFDL ch 5	IRL	FD	2K20E	J2D												
EL	C.C.R.M.	6550,000	19	11	0842				F	MS	2K70E	J3E											11	fishers
BEL	C.C.R.M.	6570,000	19	11	0843				E	MS	2K70E	J3E											11	fishers

# Special monitoring program (1)



- Monitoring 406 – 406.1 MHz band
- Performed in accordance with Res. 205 (Rev. WRC-12)

- Objective: to identify and locate unauthorized emissions in the band 406-406.1 MHz that cause harmful interference to the reception of satellite EPIRB signals of the COSPAS-SARSAT
- BR immediately contacts the Administrations responsible for the area where the unauthorized transmitters are located, requesting them to take immediate action to stop emissions.

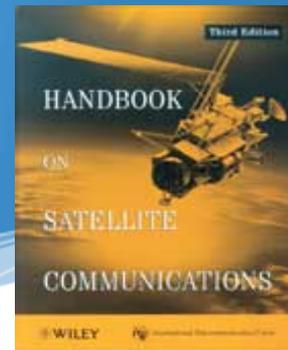
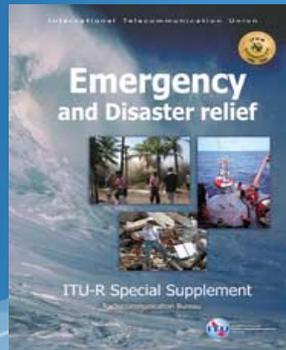
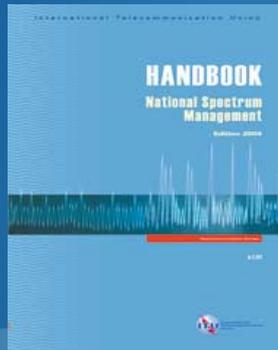
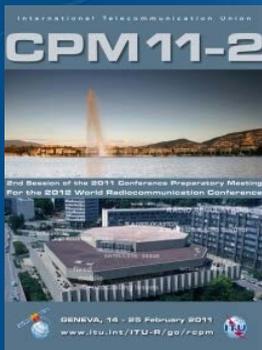


# Outline of presentation

- Related ITU documents
- Prevention of interference
- Resolving cases of interference
- Radiomonitoring as a complementary instrument of interference management
- **ITU studies on interference mitigation techniques**

# Overview of ITU-R studies

- Organization of studies: Radiocommunication Assembly -> Study Groups -> Working Parties (e.g. WP5B for maritime, aeronautical and radiodetermination services)
- Areas of studies: spectrum management, radiomonitoring, spectrum requirements, system parameters, propagation, sharing, protection criteria, **interference mitigation**, etc.
- Study Groups products:
  - Technical bases for Radiocommunication Conferences
  - ITU-R Recommendations
  - ITU-R reports and Handbooks



# Examples of ITU-R documents on mitigation

## • Documents containing general information

- ITU **Handbook** on National Spectrum Management (Edition 2005), Chapter 5
- Recommendation ITU-R **SM.1132-2** “General principles and methods for sharing between radiocommunication services or between radio stations”
- Recommendation ITU-R **SM.1446** “Definition and measurement of intermodulation products in transmitter using frequency, phase, or complex modulation techniques”,
- Recommendation **SM.1541-4** “Unwanted emissions in the out-of-band domain”,

## • Sharing between specific services

- Recommendation ITU-R M.1841 “Compatibility between FM sound-broadcasting systems in 87-108 MHz and the aeronautical ground-based augmentation system in 108-117.975 MHz”
- Recommendation ITU-R M.1459 “Protection criteria for telemetry systems in the aeronautical mobile service and mitigation techniques to facilitate sharing with BSS/MSS in 1 452-1 525 MHz and 2 310-2 360 MHz ”
- Recommendation ITU-R M.589 “Technical characteristics of methods of data transmission and interference protection for radionavigation services in the frequency bands between 70 and 130 kHz”

# Sharing frequency allocations

Handbook on National Spectrum Management, Sections 5.5.1 (Technical basis for sharing)

## Methods to facilitate sharing

Frequency separation	Spatial separation	Time separation	Signal separation <sup>(1)</sup>
Channelling plans Band segmentation Frequency agile systems Dynamic sharing: – dynamic real-time frequency assignment <sup>(2)</sup> FDMA Control of emission spectrum characteristics Dynamic variable partitioning Frequency tolerance limitation Demand assignment multiple access (DAMA) Frequency diversity	Geographical shared allocations Site separation Antenna system characteristics: – Adaptive antenna (smart antenna) – Antenna polarization discrimination – Antenna pattern discrimination – Space diversity – Antenna angle or pattern diversity Space division multiple access (SDMA) Physical barriers and site shielding	Duty cycle control Dynamic real-time <sup>(1)</sup> frequency assignment TDMA	Signal coding and processing FEC Interference rejection CDMA Spread spectrum: – direct sequence – frequency hopping – pulsed FM Interference power/bandwidth adjustments: – co-channel – dynamic transmitter level control – pfd limitation and power spectral density (psd) limitation (energy dispersal) Modulation complexity Coded modulation Adaptive signal processing Antenna polarization

<sup>(1)</sup> These techniques for signal separation may also be applied to frequency, space and time separation technology.

<sup>(2)</sup> Dynamic real-time frequency assignment facilitates sharing by simultaneously using frequency and time domains. Therefore, this method is shown in both columns.

# Conclusions

- The entire ITU regulatory framework (Constitution, Convention, RR) is aimed at interference-free operation of radio stations
- RR contain a set of regulatory, operational and technical measures to prevent interference
- Cases of harmful interference are dealt by administrations concerned with possible assistance of the BR, RRB and WRC
- Special attention is paid to prevention and elimination of interference to safety services, distress and safety frequencies
- ITU established International Monitoring System and conducts monitoring programs that assist in interference management
- ITU-R studies sharing conditions and mitigation techniques to create a technical basis for compatible operation of stations

***Thank you for  
your attention!***