ICAO WRC-23 PREPARATORY WORKSHOP

AI 1.10: NON-SAFETY AMS IN 15.4-15.7 GHz AND 22-22.21 GHz

Date: 28/08/2023

Authors:

Jérôme André jerome.andre@anfr.fr

Alexandre Marquet alexandre.marquet@anfr.fr

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ANFR
AGENCE NATIONALE DES FRÉQUENCES

01 | Description of proposed non-safety system operating under new AM(OR)S allocation

02 | Proposed methodology for some Monte Carlo simulations

03 | Coexistence studies with ARNS in 15.4-15.7 GHz

04 | Draft ICAO Position

01 | **Description of proposed non-safety system operating under new AM(OR)S allocation**

Principle

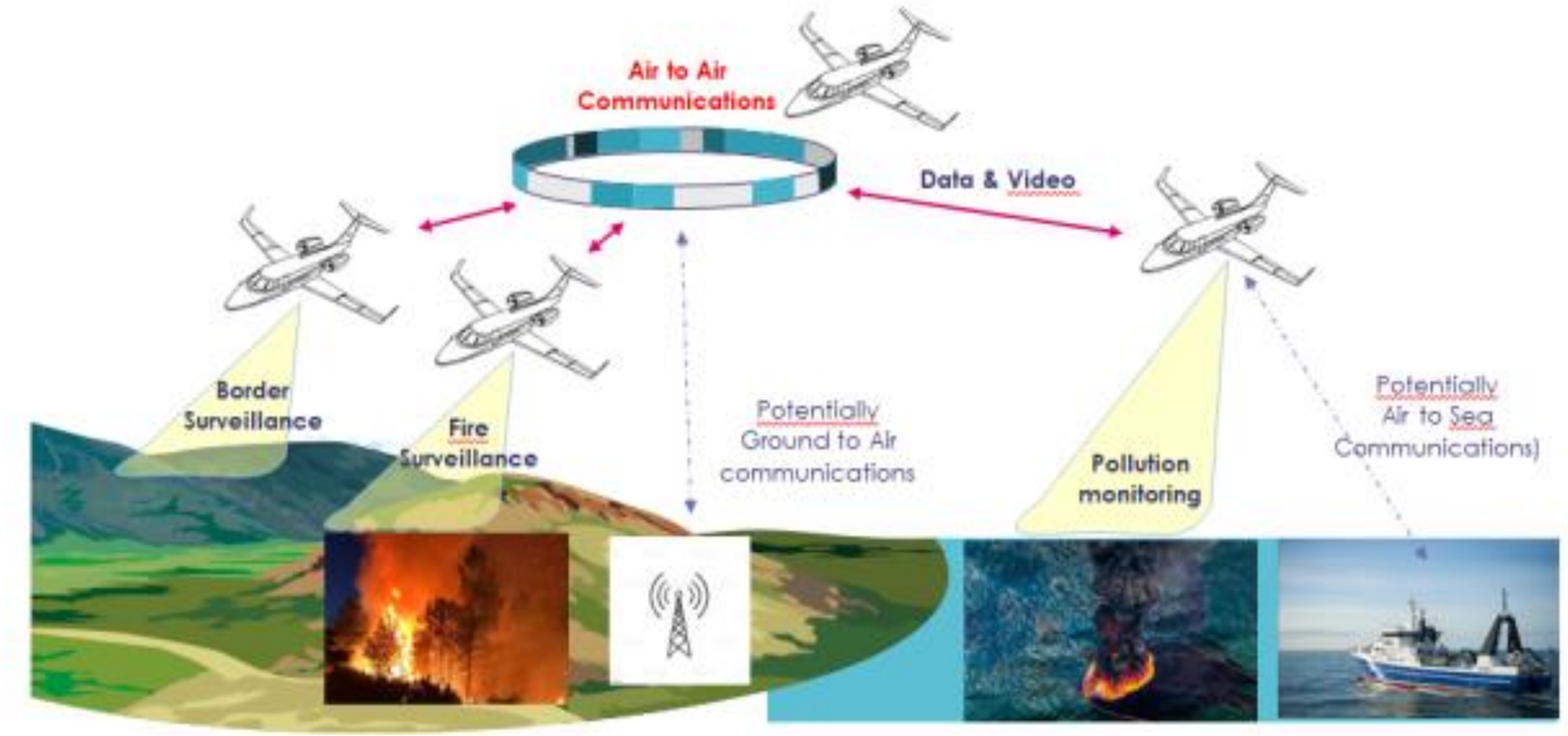
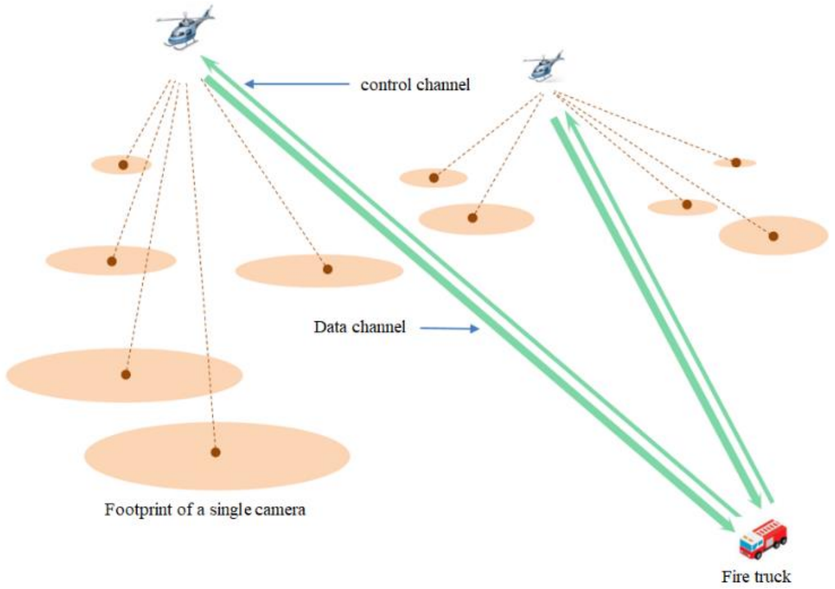


Figure from WDT PDN Rep. ITU-R [NON-SAFETY AMS CHARACTERISTICS AND SHARING STUDIES]

01 | Description of proposed non-safety system operating under new AM(OR)S allocation

Scenarios under study

Wildfire detection



Search and rescue

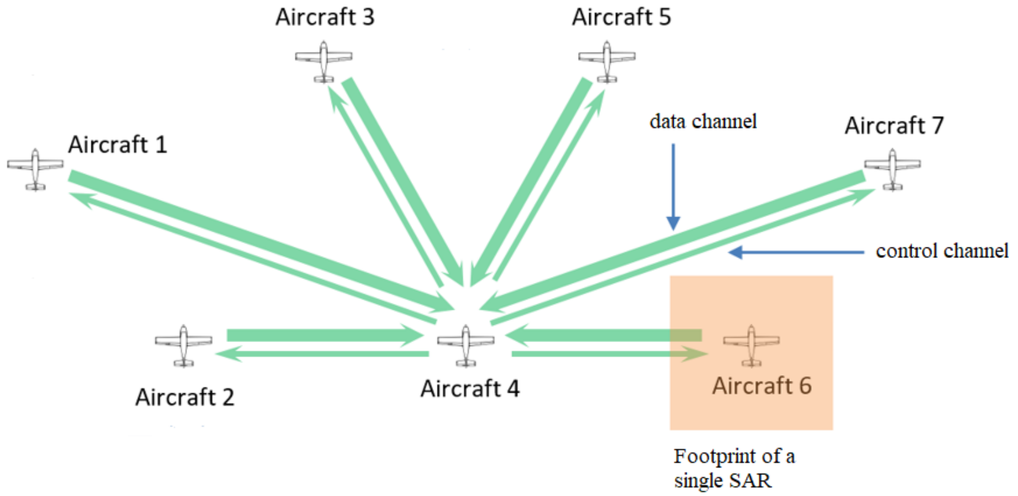
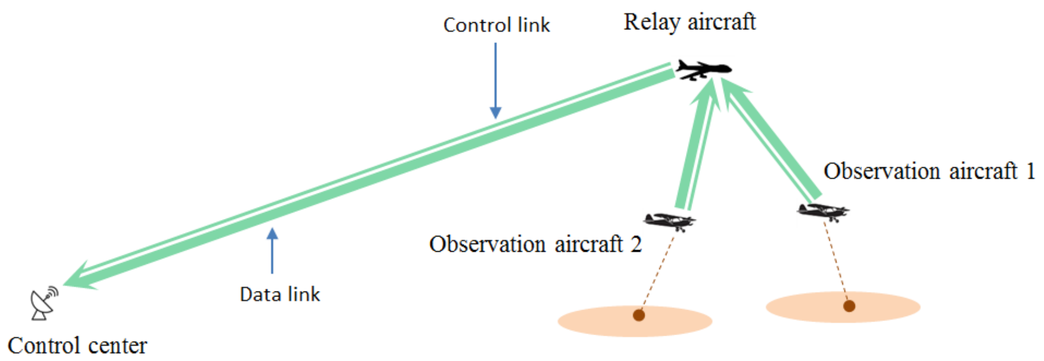


Figure from WDT PDN Rep. ITU-R [NON-SAFETY AMS CHARACTERISTICS AND SHARING STUDIES]

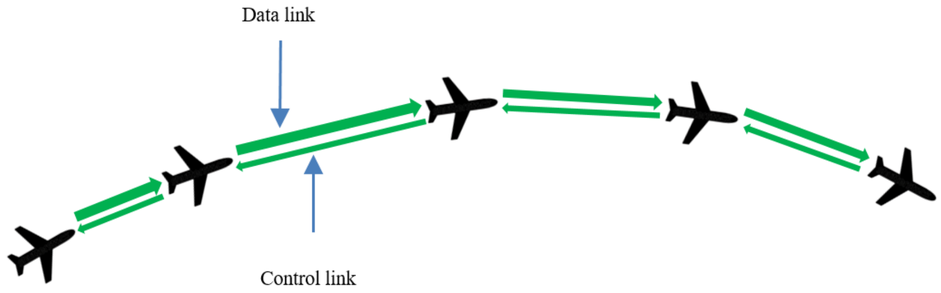
01 | Description of proposed non-safety system operating under new AM(OR)S allocation

Scenarios under study

Border surveillance



Data networks



01 | Description of proposed non-safety system operating under new AM(OR)S allocation

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ANFR
AGENCE NATIONALE DES FRÉQUENCES

Technical and operational characteristics of future non-safety AM(OR)S systems planned to operate in the frequency bands 15.4-15.7 GHz and 22-22.21 GHz

	Units	AM(OR)S system				
		1	2	3	4	5
Deployment						
Platform	–	Airborne			Ground-based	
Minimum operational altitude AGL	m	300			2	
Maximum operational altitude AGL		15 000			2	
Transmitter						
Tuning ranges	MHz	15 400 to 15 700 22 000 to 22 210				
Control link BW		0.5	0.5	0.5	0.5	0.5
Minimum data link BW		10	10	10	N/A[1]	
Maximum data link BW		200	150	150		
Maximum TPO [2]	dBm	40	25	40 in 15.4 GHz 50 in 22 GHz	40	40
Spectrum emission mask (SEM) expressed in relative power spectral density (RPSD)[3][4][5]	dB	$\text{RPSD} = \begin{cases} 0 & \text{at } f_c + 0.5\,B \\ -40 & \text{at } f_c + 1.35\,B \\ -53 & \text{at } f_c + 2.5\,B \\ -59 & \text{at } f_c + 3.1\,B \\ -69 & \text{at } f_c + 5\,B \end{cases}$				
Modulation		PSK[6]	QAM[7], PSK		BPSK[8]	
Multiplexing		FDMA				
Maximum duty cycle (DC)	%	100	100	100	100	100
Receiver						
Target SNR sensitivity threshold	dB	3	3	3	3	3
Noise figure (NF)		5	5	5	5	5

02 | **Proposed methodology for some Monte Carlo simulations**

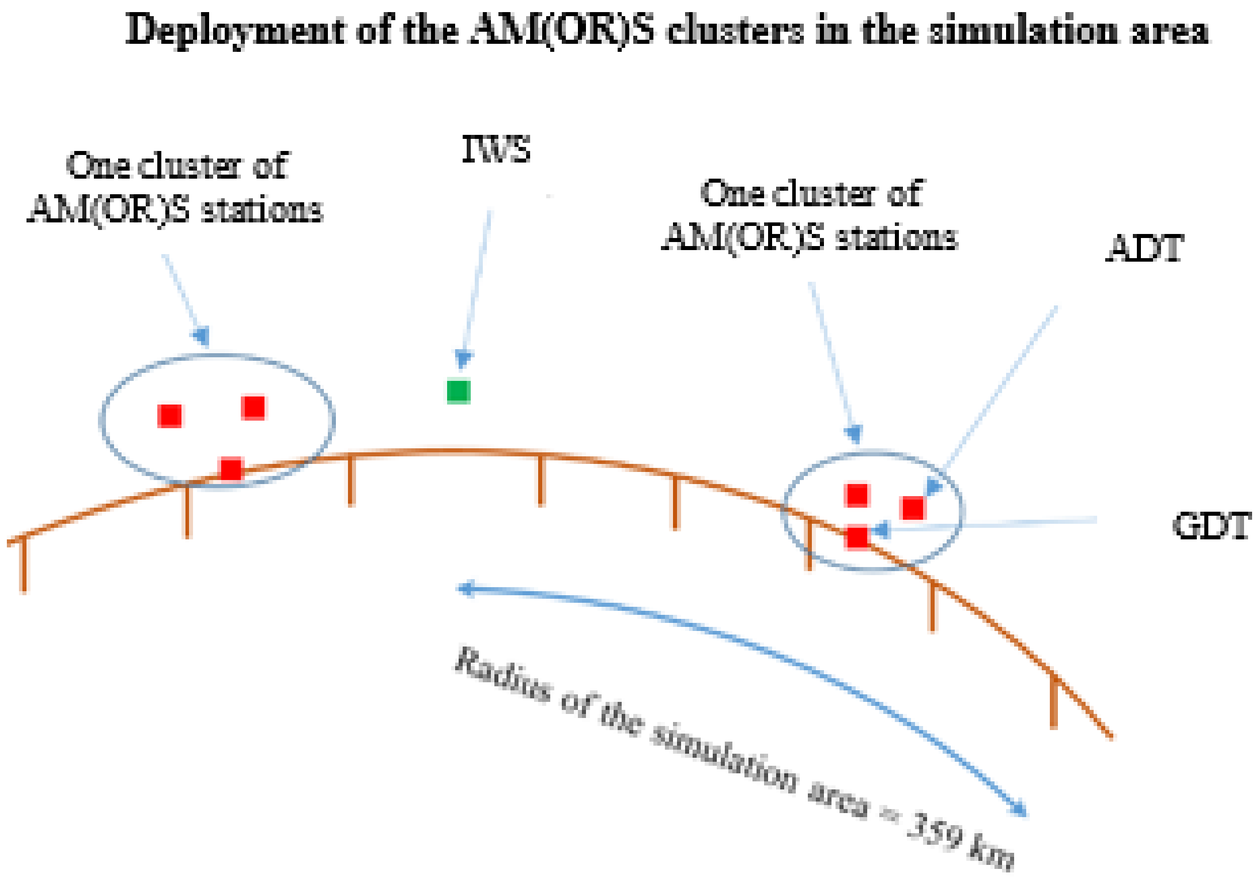
Number of deployed clusters $N_{cluster}$ in the 15 GHz band

	Scenario			
	6.2.1	**6.2.2**	**6.2.3**	**6.2.4**
RLS	5	3	4	8
ARNS DAA	7		5	9
ARNS ALS	2	1	2	4
FSS (Earth-to-space)	322	95	107	212
RAS	1			2

Number of deployed clusters $N_{cluster}$ in the 22 GHz band

	Scenario			
	6.2.1	**6.2.2**	**6.2.3**	**6.2.4**
FS	1			2
RAS				
BSS				
EESS (passive)	155	47	55	108

02 | **Proposed methodology for some Monte Carlo simulations**



02 | **Proposed methodology for some Monte Carlo simulations**

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ANFR
AGENCE NATIONALE DES FRÉQUENCES

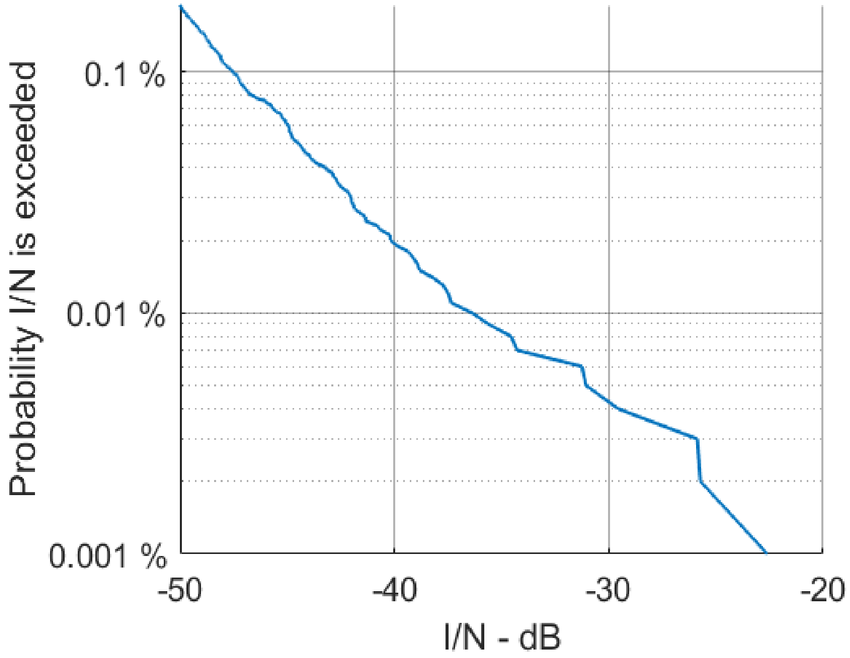
Number of simulated snapshots

IWS	Frequency band (GHz)	Maximum time percentage associated to the protection criterion	Relevant section	Minimum number of snapshots	Number of simulated snapshots
RLS	15.4-17.3	None	A2.1.3	–	100 000
ARNS ALS			A3.2.2.3		
ARNS DAA			A3.2.1.3		
FSS (Earth-to-space)	15.43-15.63	99.98	A3.3.3	5 000	10 000
RAS	15.35-15.4	98	A3.4.3	50	100 000
FS	21.2-23.6	99.9872	A4.1.4	7 813	100 000
RAS	22.21-22.5	98	A4.3.3	50	100 000
BSS	21.4-22	99.98	A4.6.3	5 000	100 000

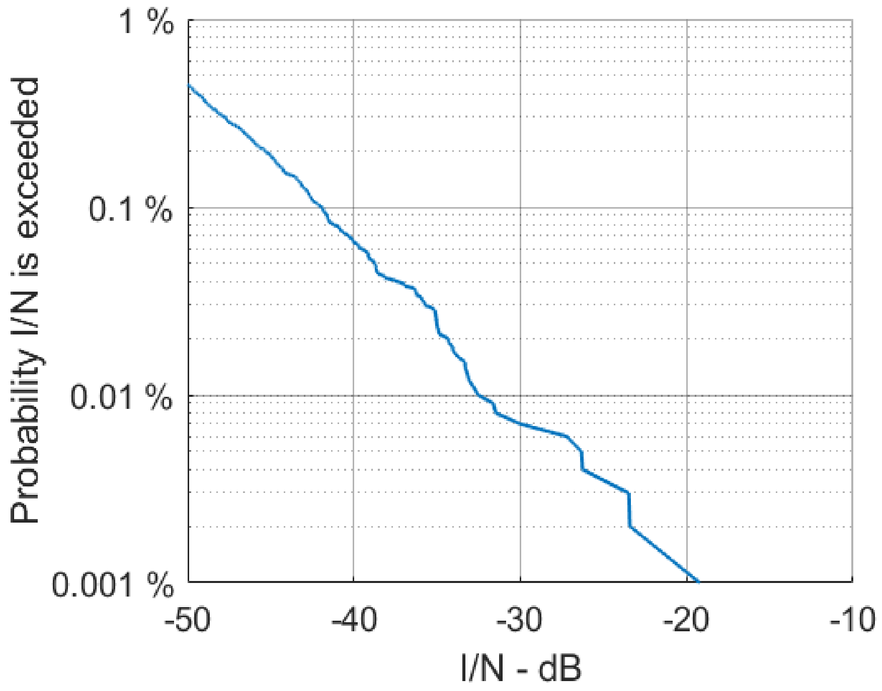
03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Sharing between systems operating in the AM(OR)S (interferer) and automatic landing system (ALS) operating in the ARNS in the frequency band 15.4-15.7 GHz

ECDF of aggregate INR at the ALS receiver in scenario 6.2.1



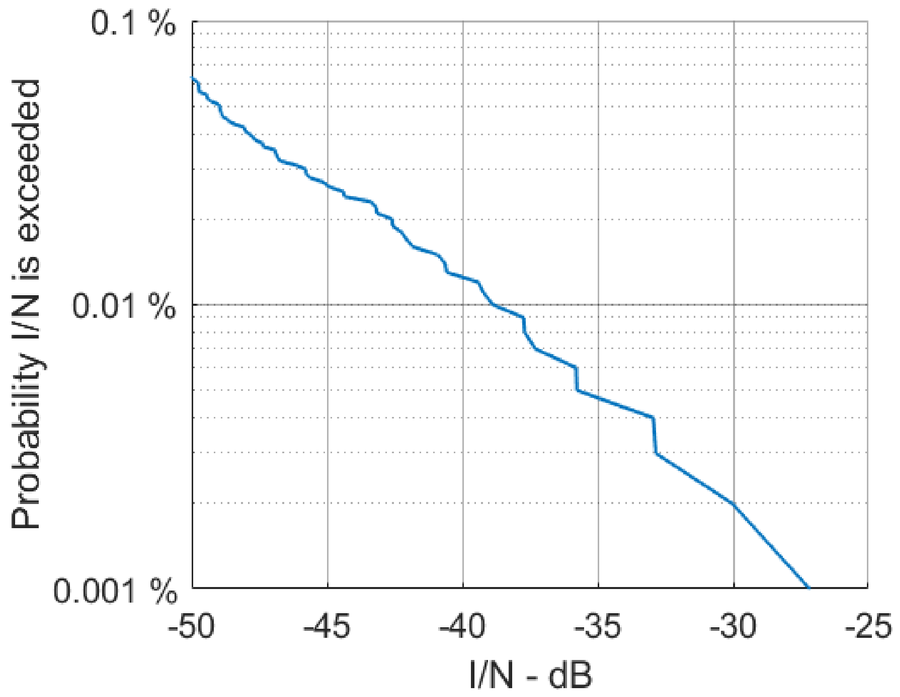
ECDF of aggregate *I/N* at the ALS receiver in scenario 6.2.2



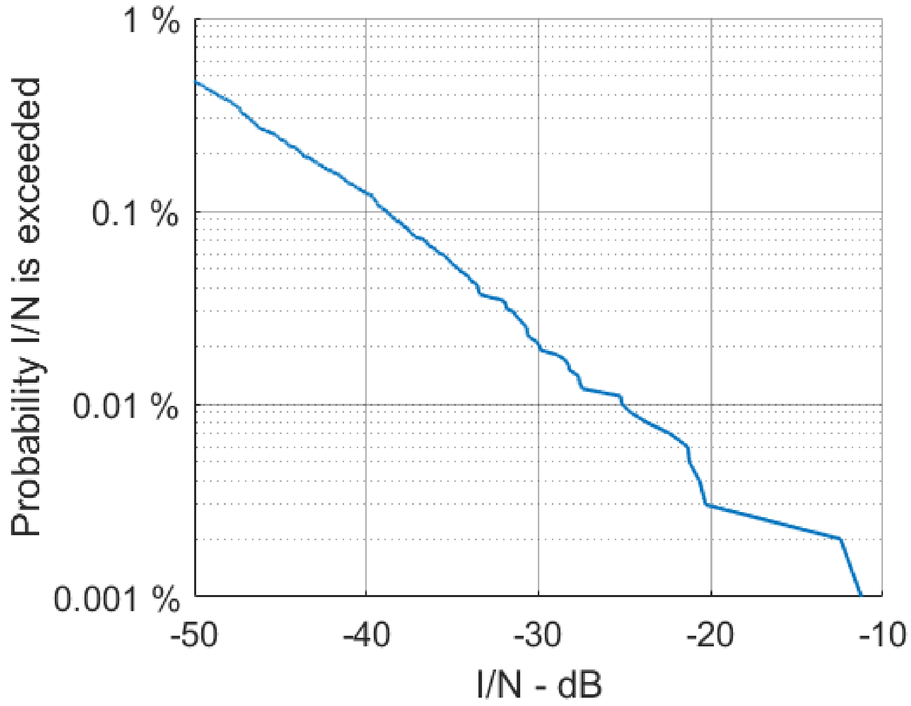
03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Sharing between systems operating in the AM(OR)S (interferer) and automatic landing system (ALS) operating in the ARNS in the frequency band 15.4-15.7 GHz

ECDF of aggregate *I/N* at the ALS receiver in scenario 6.2.3



ECDF of aggregate *I/N* at the ALS receiver in scenario 6.2.4



03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Provisional conclusions on ARNS ALS

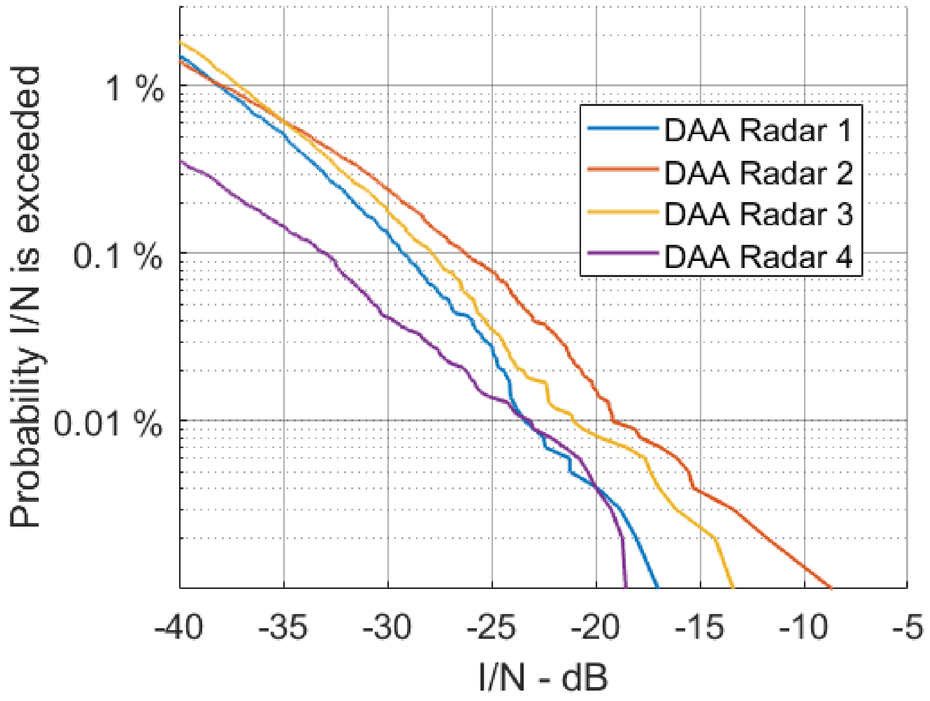
8.3.1.2 ARNS ALS in 15.4-15.7 GHz

Study A is a Monte Carlo multiple entry analysis, that assesses the impact of the envisaged AM(OR)S scenarios and systems into automatic landing system receivers operating in the ARNS. The results have shown that, in all AM(OR)S scenarios, *I/N* level at ARNS ALS receivers is more than −10 dB for at most 0.01% of the time.

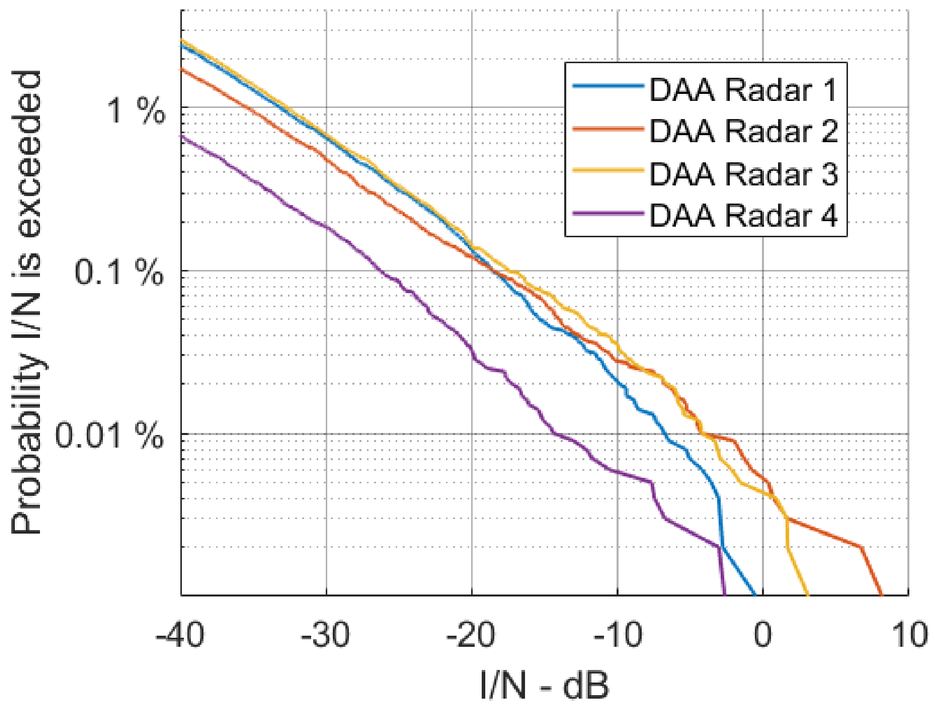
03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Sharing of the frequency band 15.4-15.7 GHz between DAA radars and future non-safety AM(OR)S systems

ECDF of aggregate I/N at the DAA radars in scenario 6.2.1



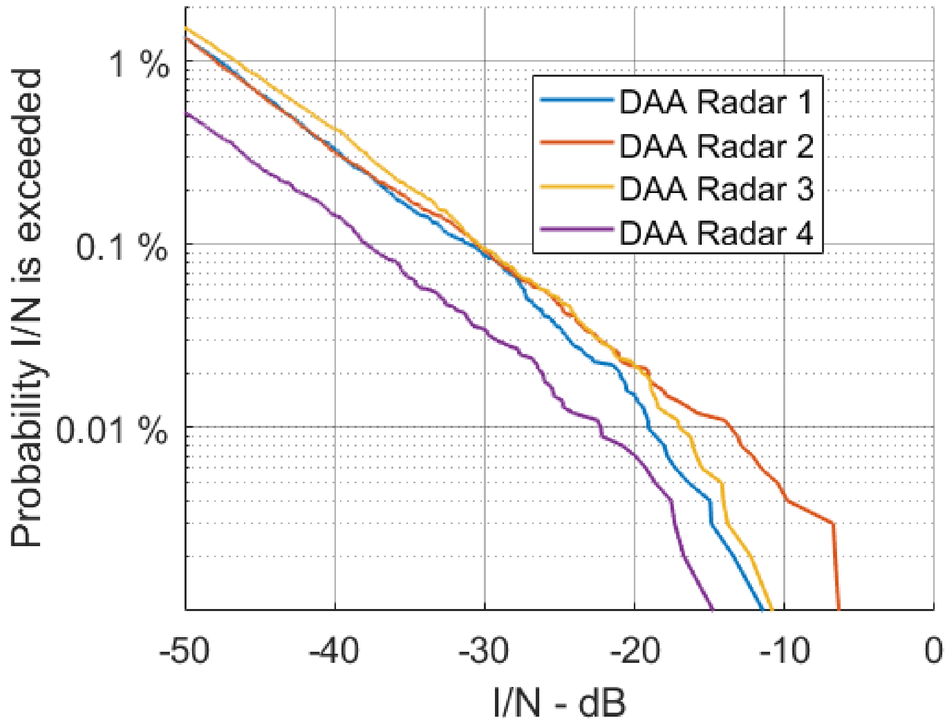
ECDF of aggregate *I/N* at the DAA receiver in scenario 6.2.2



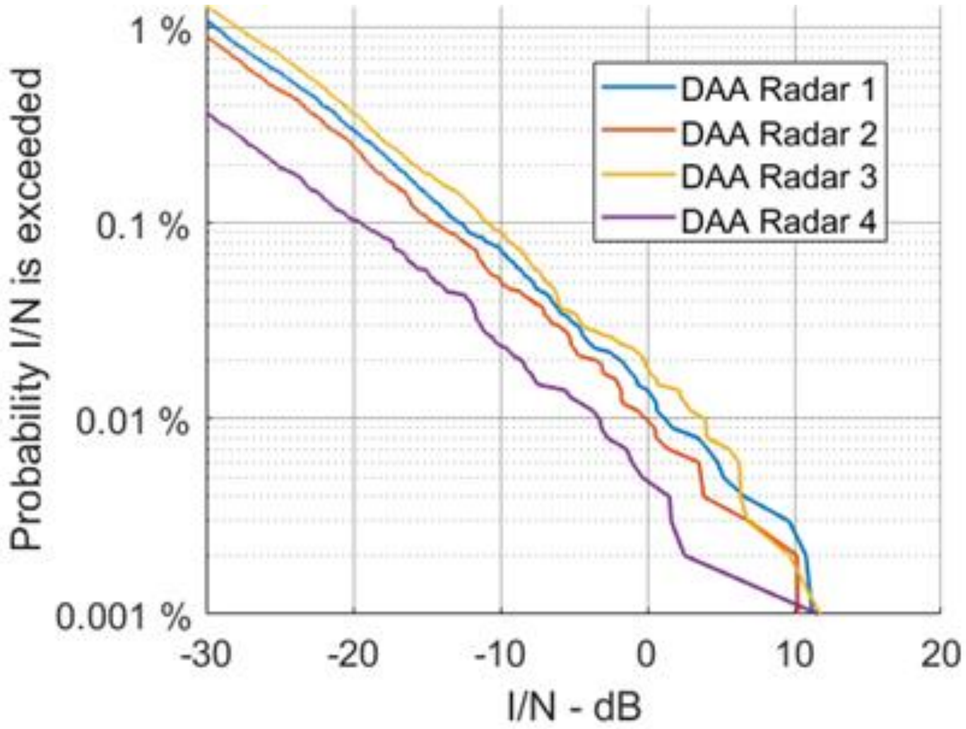
03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Sharing of the frequency band 15.4-15.7 GHz between DAA radars and future non-safety AM(OR)S systems

ECDF of aggregate *I/N* at the DAA receiver in scenario 6.2.3



ECDF of aggregate *I/N* at the DAA receiver in scenario 6.2.4



03 | Coexistence studies with ARNS in 15.4-15.7 GHz

Provisional conclusions on ARNS DAA

8.3.1.3 ARNS DAA in 15.4-15.7 GHz

Study A is a Monte Carlo multiple entry analysis, that assesses the impact of the envisaged AM(OR)S scenarios and systems into detect and avoid receivers operating in the ARNS. The results have shown that, in all AM(OR)S scenarios, *I/N* level at detect and avoid receivers operating in the ARNS is more than −10 dB for at most 0.1% of the time.

Study B is a minimum coupling loss (MCL) analysis. The study assumes aircraft stations operating in the AM(OR)S with transmit power of 25 or 40 dBm (no transmit power control), co-frequency operation, the antenna side-lobe gain of AM(OR)S and DAA are both 0 dBi and propagation from Recommendation ITU-R P.528-5. It shows such an airborne AM(OR)S system would need separation distances of 3 to 68 km when its side lobe is aligned with the side lobe of the DAA system and 12 to 720 km when its side lobe is aligned with the main lobe of the DAA system.

03 | Coexistence studies with ARNS in 15.4-15.7 GHz

ITU Working documents

PDN Rec. ITU-R M.[15.4-15.7_GHZ_ARNS]

- Proposals for Detect And Avoid (DAA) and Automatic Landing System (ALS) characteristics 5B/819 Annex 15 Annex 02

WDT PDN Rep. ITU-R M.[NON-SAFETY AMS CHARACTERISTICS AND SHARING STUDIES]

- Proposals for AMS systems in 15.4-15.7 GHz and 22-22.21 GHz (5B/819 Annex 15 Annex 01)
- Compatibility studies 5B/819 Annex 15 Annexes 04 and 05
- Preliminary conclusions 5B/ 819 Annex 15

03 | Coexistence studies with ARNS in 15.4-15.7 GHz

CEPT last update

“ […] among the four scenarios proposed at ITU level, scenarios 2 “Search and Rescue” and 3 “Border surveillance” are the most relevant for future AM(OR)S deployments in the bands 15.4-15.7 and 22-22.21 GHz.”

04 | **ICAO Position**

Based upon the agreed results of studies, not to oppose new allocations to the aeronautical mobile service for use by non-safety aeronautical mobile applications on a primary basis in the frequency bands 15.4-15.7 GHz and 22-22.21 GHz.

To ensure that any such modification does not adversely affect the status or provision of aeronautical safety services.

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ANFR
AGENCE NATIONALE DES FRÉQUENCES

Agence nationale des fréquences

T. +33 (0)1 45 18 72 72
F. +33 (0)1 45 18 73 00

78, avenue du Général de Gaulle
94707 MAISONS-ALFORT CEDEX

www.anfr.fr

Rejoignez-nous sur

/anfr