INTERNATIONAL CIVIL AVIATION ORGANIZATION

TWELFTH MEETING ON THE IMPROVEMENT OF THE AIR TRAFFIC SERVICES IN THE SOUTH ATLANTIC

(Sal, Cape Verde, 15 – 17 December 2004)

Agenda Item 4: Communications

CAFSAT Migration to IS 10.02 @ 359 degrees East

Summary

This paper presents SAT/12 Meeting with an overview of the issues to be addressed by CAFSAT Members when implementing SAT Conclusion 11/12.

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TABLE OF CONTENTS

TABLE LIST

1. Introduction.

1.1 Propose and Scope.

This document wants to be a base of consult for countries present in SAT 12 where will be discuss the opportunity or not about the satellite change in CAFSAT network.

2. Present Situation.

It will present a little summary about the present configuration of the stations, working over the IS801 satellite.

2.1 Frequency Plan.

The communications are sent through hemispheric or Global beam depending of coverage area and collateral destination

From 328°E Satellite, 20/20

TX E/S	*CXR*	*RX E/S*	*FROM 328°E*	*TX. FREQ*	*RX. FREQ.*
EPG-01F1	0,064	CAF-01F1	20/20/EH/EH	5925,325	3700,325
DKR-04F1	0,128	CAF-01F1	20/20/EH/EH	5925,685	3700,685
CAF-01F1	0,128	EPG-01F1	20/20/EH/EH	5926,09	3701,09
SMI-03F1	0,128	CAF-01F1	20/20/EH/EH	5925,1	3700,1
NLV-02F1	0,128	CAF-01F1	20/20/EH/EH	5924,8975	3699,8975
RAB-04F1	0,128	CAF-01F1	20/20/EH/EH	5925,4825	3700,4825

From 328°E Satellite, 37/37

JHN-05F1	0,192	CAF-01F1 + DKR-04F1	37/37/GA/GA	6377,505	4152,505
DKR-04F1	0,064	JHN-05F1+CAF-01F1	37/37/GA/GA	6377,7075	4152,7075
CAF-01F1	0,064	JHN-05F1+DKR-04F1	37/37/GA/GA	6377,82	4152,82
RCF-01F1	0,064	JHN-05F1+ DKR-04F1 +CAF-01F1	37/37/GA/GA	6377,9325	4152,9325

Table 2-1: Present frequency plan.

Polarization of transponder 37 is A Tx=LHCP/RX=RHCP.

2.2 Antenna Pointing.

Here below the present antenna pointing data for each station over the IS-801 satellite are presented:

Station Location			Antenna Pointing	
	Longitude	Latitude	Elevation	Azimuth (Real North)
LAS PALMAS	-15,39 º E	27,95 º N	68,12 º	207.56 º
SAL	-22,95 º E	16,74 º N	68,12 º	220,56 º
DAKAR	-17,29 º E	14,44 º N	66,39 º	224,42 º
CASABLANCA	-7,58 º E	33,65 º N	43,4 º	219,2 º
RECIFE	-34,93 º E	- 8,13 º N	79,85 º	22,97 º
LISBON	-9,15 º E	38,72 º N	39,53 º	213,32 º
SANTA MARIA	-25,15 º E	36,98 º N	46,65 º	190,48 º
JOHANNESBURG	-28,0 º E	- 26,2º N	18,9 º	352,1 º

Table 2-2: Antennas pointing over IS 801.

2.3 Present Transceiver Power Installed.

All stations within CAFSAT network have the same transceiver power, independently of data rate, beam, transponder, coverage, etc.

Present value is 10 W.

3. Future Situation with IS1002.

It presents a little summary about the future stations configuration if CAFSAT network moves onto IS1002 satellite.

3.1 Frequency Plan.

All communications are sent through Global beam simplifying the present network topology.

From 328°E Satellite, 20/20

TX E/S	*CXR*	*RX E/S*	*1002*	*TX FREQ.*	*RX. FREQ.*
EPG-01F1	0,064	CAF-01F1	86/86/GB/GB	6322,07	4097,07
DKR-04F1	0.192 vice (0.128)	CAF-01F1+EPG-01F1 +NLV-02F1+JHN-05F1 +RAB-04F1+RCF-01F1	86/86/GB/GB	6322,475	4097,475
CAF-01F1	0,192	All Stations	86/86/GB/GB	6322,7675	4097,7675
SMI-03F1	0,128	CAF-01F1	86/86/GB/GB	6321,9125	4096,9125
NLV-02F1	0,128	CAF-01F1	86/86/GB/GB	6321,71	4096,71
RAB-04F1	0,128	CAF-01F1	86/86/GB/GB	6322,2275	4097,2275

From 328°E Satellite, 37/37

JHN-05F1	0,192	CAF-01F1 + DKR-04F1	86/86/GB/GB	6323,06	4098,06
DKR-04F1	0,064	JHN-05F1+CAF-01F1	DELETED		
CAF-01F1	0,064	JHN-05F1+DKR-04F1	DELETED		
RCF-01F1	0,064	JHN-05F1+ DKR-04F1 +CAF-01F1	86/86/GB/GB	6323,2625	4098,2625

Table 3-1: Future frequency plan.

Polarization of transponder 86 is B Tx=RHCP/RX=LHCP.

3.2 Antenna Pointing.

Here below the present antenna pointing data for each station over the IS1002 are presented:

Station Location			Antenna Pointing	
	Longitude	Latitude	Elevation	Azimuth (Real North)
LAS PALMAS	-15,39 º E	27,95 º N	40,2º	216,7º
SAL	-22,95 º E	16,74 º N	58,1º	234,5º
DAKAR	-17,29 º E	14,44 º N	64,64 º	229,52 º
CASABLANCA	-7,58 º E	33,65 º N	50,6º	191,5º
RECIFE	-34,93 º E	- 8,13 º N	49,6 º	78,13 º
LISBON	-9,15 º E	38,72 º N	44,4º	192,9º
SANTA MARIA	-25,15 º E	36,98 º N	40,2º	216,7º
JOHANNESBURG	-28,0 º E	- 26,2º N	47,2º	310,9º

Table 3-2: Antennas pointing over IS 1002.

3.3 New Transceiver Power for the New Satellite.

Here are presented the link budget results done with INSA algorithm.

The important specifications in this link are:

- Availability: 99,99% with rain at both sides.
- Margin=6.5 dB for FEC=1/2 Sequential.

With these satellite parameters:

SATELLITE PARAMETERS:		
Sat Receiver G/T	dB/ºK	-8.3 (beam peak); -10.7 (beam edge) used= -9,5
IPFD for saturation	dBW/m^2	-76.2(beam peak)/-73.7(beam edge) used=-75,0
EIRP saturation	dBW	35.9 dBW (beam peak)/ 32 dBW (beam edge) used=33,9
Operating Conditions	dB	
IBO	dB	7,1
OBO	dB	4,2

Table 3-3: IS1002 parameters

SOURCE	Lisboa	Las Palmas	Lisboa	Santa Maria	Lisboa	Casablanca	Santa Maria	Las Palmas	Santa Maria	Sal
DESTINATION	**Las Palmas**	**Lisboa**	**Santa Maria**	**Lisboa**	**Casablanca**	**Lisboa**	**Las Palmas**	**Santa Maria**	**Sal**	**Santa Maria**
Satellite	IS1002	IS1002	IS1002	IS1002	IS1002	IS1002	IS1002	IS1002	IS1002	IS1002
Antenna Tx	3,8	3,7	3,8	3,8	3,8	3,7	3,8	3,7	3,8	3,7
HPA (W)	20,0	30,0	20,0	20,0	20,0	30,0	20,0	30,0	20,0	10,0
Antenna Rx	3,7	3,8	3,8	3,8	3,7	3,8	3,7	3,8	3,7	3,8
Data Rate	128	192	128	128	128	128	128	192	128	64
Sat Receiver G/T	-9,5	-9,5	-9,5	-9,5	-9,5	-9,5	-9,5	-9,5	-9,5	-9,5
IPFD for saturation	-75,0	-75,0	-75,0	-75,0	-75,0	-75,0	-75,0	-75,0	-75,0	-75,0
EIRP saturation	33,9	33,9	33,9	33,9	33,9	33,9	33,9	33,9	33,9	33,9
Margin										
No Rain	2,8	2,8	2,6	2,6	2,5	2,1	2,5	2,5	1,8	2,5
Rain Uplink	1,6	2,2	2,2	1,8	1,4	1,6	1,7	1,9	1,1	2,0
Rain Downlink	2,2	2,0	2,1	2,1	2,0	1,3	2,0	1,8	1,4	1,9
Rain Both	1,1	1,4	1,5	1,3	0,9	0,8	1,2	1,3	0,6	1,3

SOURCE	Las Palmas	Johanesburgo	Johanesburgo	Recife
DESTINATION	**Johanesburgo**	**Las Palmas**	**Recife**	**Johanesburgo**
Satellite	IS1002	IS1002	IS1002	IS1002
Antenna Tx	3,7	3,7	3,7	3,7
HPA (W)	30,0	30,0	30,0	10,0
Antenna Rx	3,7	3,7	3,7	3,7
Data Rate	192	192	192	64
Sat Receiver G/T	-9,5	-9,5	-9,5	-9,5
IPFD for saturation	-75,0	-75,0	-75,0	-75,0
EIRP saturation	33,9	33,9	33,9	33,9
Margin				
No Rain	2,3	2,3	2,3	2,3
Rain Uplink	1,5	1,8	1,9	1,0
Rain Downlink	1,8	1,7	1,4	1,9
Rain Both	1,0	1,1	1,0	0,6

Table 3-4: Link budget summary

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Here are presented the link budget results done by INTELSAT. Note that availability is different from INSA consideration.

Sales Engineering and Technical Services
Transmission Analysis
Link Budget Report for:

Opportunity-ID / SSR-ID **1-OPID - 1-SSRID**
Done by: J.Akumu Date: 5-Nov-04

Application: Strip-7

Satellite and Role: IS-1002@359ºE
Transponder: 86/86 (GB/GB)
Dw-link Beam Pointing: 0°E; 0°N
Sat. TWT Power [Watts]: n/a
Sat. D/L EIRP at be/bp [dBW]: 32.0 / 35.9
SFD at be/bp [dBW/m²]: -73.6 / -76.1
Band Up/Dw [MHz]: (6302 - 6338 / 4077 - 4113)
Polarization Up/Dw: R / L

Total lease resource [MHz]: 1.9
Total D/L EIRP Avail. at be/bp [dBW]: 15.2 / 19.2
Total D/L EIRP Used at be/bp [dBW]: 12.7 / 16.7
Total BW Used [MHz]: 1.7
Xp Operational Mode: Multicarrier OBO= -5.9 dB

Intelsat. inspiring connections

Antennas	Diameter [m]	Gtx [dBi]	G/T [dB/K]	Latitude [°N]	Longitude [°E]	Xpol [dB]	Location (Nearest City and Country)	Notes	TOTAL HPA Power [W]
NVL-02F1	3.80	45.7	22.7	38.7	350.9	28.0	,		13.7
SMI-03F1	3.80	45.7	22.7	36.0	335.0	28.0	,		14.2
CAF-01F1	3.70	45.8	22.7	27.9	344.6	27.8	,		17.5
DKR-04F1	3.70	45.8	22.7	-14.7	17.5	27.8	,		18.2
EPG-01F1	3.70	45.8	22.7	16.7	337.1	27.8	,		5.7
JHN-05F1	3.70	45.4	22.7	-26.1	28.2	27.8	,		35.6
RAB-04F1	3.70	45.4	22.7	33.4	352.4	27.8	,		13.5
RCF-01F1	3.70	45.4	22.7	-8.1	325.1	27.8	,		11.7

Tx E/S	Rx E/S	Carrier Type	Per Carrier Link Parameters and Results															
		#, Type, [I.R, OH, FEC, RS, modulation]	Noise BW [MHz]	Space Factor (Roll-off)	Alloc. BW [MHz]	PEB [MHz]	b.e. D/L EIRP [dBW]	C/N thresh. [dB]	Clear Sky C/N [dB]	Eb/No thresh. [dB]	Clear Sky Eb/No [dB]	Link Availab. [%/yr]	U/L EIRP [dBW]	HPA size (Watt)	HPA OBO [dB]	WGL [dB]	UPC [dB]	Gx apprvl
NVL-02F1	CAF-01F1	IBS (128 Kbps, OH=8.5, 1/2 FEC, OQPSK)	0.14	1.48	0.20	0.11	2.8	4.6	7.7	4.6	7.7	>99.96	55.1	13.7	1	1	0	NO
SMI-03F1	CAF-01F1	IBS (128 Kbps, OH=8.5, 1/2 FEC, OQPSK)	0.14	1.48	0.20	0.11	2.7	4.6	7.7	4.6	7.7	>99.96	55.3	14.2	1	1	0	NO
EPG-01F1	CAF-01F1	IBS (64 Kbps, OH=4.3, 1/2 FEC, OQPSK)	0.07	1.65	0.11	0.05	-0.3	4.6	7.7	4.6	7.7	>99.96	51.4	5.7	1	1	0	NO
RAB-04F1	CAF-01F1	IBS (128 Kbps, OH=8.5, 1/2 FEC, OQPSK)	0.14	1.48	0.20	0.11	2.7	4.6	7.7	4.6	7.7	>99.96	54.7	13.5	1	1	0	NO
DKR-04F1	NVL-02F1	IBS (192 Kbps, OH=19.2, 1/2 FEC, OQPSK)	0.21	1.38	0.29	0.18	5.1	4.6	7.8	4.6	7.7	>99.96	56.4	18.2	1	1	0	NO
	JHN-05F1								7.9		7.9	>99.96						
	RCF-01F1								8.0		8.0	>99.96						
	RAB-04F1								8.1		8.1	>99.96						
	CAF-01F1								8.3		8.2	>99.96						
	EPG-01F1								8.5		8.4	>99.96						
CAF-01F1	SMI-03F1	IBS (128 Kbps, OH=8.5, 1/2 FEC, OQPSK)	0.14	1.48	0.20	0.16	4.4	4.6	7.8	4.6	7.7	>99.96	56.2	17.5	1	1	0	NO
	DKR-04F1								8.7		8.6	>99.96						
	JHN-05F1								8.9		8.9	>99.96						
	RCF-01F1								9.0		9.0	>99.96						
	RAB-04F1								9.2		9.1	>99.96						

Tx E/S	Rx E/S	Carrier Type #, Type, [I.R, OH, FEC, RS, modulation]	Per Carrier Link Parameters and Results Noise BW [MHz]	Space Factor (Roll-off)	Alloc. BW [MHz]	PEB [MHz]	b.e. D/L EIRP [dBW]	C/N thresh. [dB]	Clear Sky C/N [dB]	Eb/No thresh. [dB]	Clear Sky Eb/No [dB]	Link Availab. [%/yr]	U/L EIRP [dBW]	HPA size (Watt)	HPA OBO [dB]	WGL [dB]	UPC [dB]	Gx apprvl
	EPG-01F1								9.5		9.4	>99.96						
JHN-05F1	CAF-01F1	IBS (192 Kbps, OH=12.8, 1/2 FEC, OQPSK)	0.20	1.43	0.29	0.26	6.6	4.6	7.8	4.6	7.7	>99.96	58.9	35.6	1	1	0	NO
	RCF-01F1								9.4		9.4	>99.96						
	DKR-04F1								10.1		10.1	>99.96						
RCF-01F1	CAF-01F1	IBS (64 Kbps, OH=4.3, 1/2 FEC, OQPSK)	0.07	1.65	0.11	0.09	1.9	4.6	7.8	4.6	7.7	>99.96	54.1	11.7	1	1	0	NO
	JHN-05F1								9.3		9.3	>99.96						
	DKR-04F1								10.1		10.1	>99.96						
		TOTAL: 8 carriers			1.70	1.07	12.72											

ISCO comments:

Antenna pattern comments:

Notes: Clear Sky C/N includes 1.5 dB additional margin for terrestrial interference, antenna mis-pointing, and ASI. Eb/No includes 0.4 dB IF-RF degradation.

Table 3-5: INTELSAT link Budget summary.

Note: INTELSAT supposes a minimal power necessary to perform the link; this power value is not normalized to commercial transceiver power and it does not take into account any percentage for future. The commercial normalized transceiver powers are 10W, 20W, 30W and 40 W.

3.4 Transceiver Power Summary.

The next table shows how much power will be necessary in IS1002. These values are taken from INSA link budget analysis.

The "HPA Power Necessary" column shows the minimum power necessary for present data rate.

The "Standard" column shows the commercial transceiver power closer to the necessary.

The "Expansion Capability" column shows the necessary commercial transceiver power to maintain the present expansion capability of 64 Kbps from the present data rate.

Station	HPA Power necessary	Standard	Expansion Capability
LAS PALMAS	13.01. dBW	20 W	30 W
SAL	10 dBW	10 W	20 W
DAKAR	13.01 dBW	20 W	30 W
CASABLANCA	13.98 dBWW	25 W	50 W
RECIFE*	10 dBW	10 W	20 W
LISBON**	12.04 dBW	20 W	30 W
SANTA MARIA**	11.76 dBW	20 W	30 W
JOHANNESBURG	13.8 dBW	30 W	40 W

Table 3-6: HPA necessary power.

*** There is a discrepancy between Intelsat and INSA analysis in the link budget of Recife station. The required HPA power could be between 10 and 11,5 dBW, what means a commercial transceiver from 10 to 20 W to guarantee the data rate of 64 Kbps. (Satellite parameters to be specifically confirmed with Intelsat).**

**** Lisbon and Santa Maria have a nominal data rate of 128 Kbps, for this rate is necessary to have 20-Watts transceiver power. For un upgrade to 192 Kbps, the link budget done in the 'worst case' shows that 22-Watts are required (30W commercial), but due to the 'worst case' analysis it could be enough with the previous one of 20-Watts. (Satellite parameters to be specifically confirmed with Intelsat).**

4. Scope of Works.

4.1 Las Palmas Station.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Release the actual transceiver configuration 2:1 Hemispheric + Global with diplexer, wave-guide and wave-guide switch.
- Supply two transceivers with power increase (20 W or 30W).
- Install a new transceiver configuration 1:1 with wave-guide and wave-guide switch.
- Modify the present transceiver box or make a new one.
- Release or Modify the transmit modem configuration, one modem for Hemispheric and other for Global.
- Modify M&C program, including redundancy procedures.
- Modify Frame Relay configuration.
- Adjust Levels in coordination with IOC.
- Could be necessary to do BERtest and M&C test.
- ROM prices: 57000 € for standard data rate (20 W), or 62000 € for expansion capability (two 30-Watts transceivers).

4.2 Dakar Station.

Dakar station would be an AFISNET node therefore this station requires special consideration because ASECNA could concentrate all communications in one station, (AFISNET or CAFSAT), or let the present configuration (one antenna per network). Once ASECNA informs about the desired configuration option, INSA would study the specific scenario for Dakar node.

4.3 Sal Station.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Adjust Levels in coordination with IOC.
- ROM prices: 5500 € for standard data rate (10 W), or 21000 € for expansion capability (one 20-Watts transceiver).

4.4 Casablanca.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Supply two transceivers with power increase (25 W or 50 W).
- Modify the transceivers rack.
- Modify M&C program.
- Adjust Levels in coordination with IOC.
- Could be necessary to do BERtest.
- ROM prices: 38000 € for standard data rate (20 W), or 60000 € for expansion capability (two 50-Watts transceivers).

4.5 Recife Station.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- *Could be necessary to change the transceiver power to guarantee the 64 Kbps (20 W).
- Adjust Levels in coordination with IOC.
- *ROM prices: 5900 € for standard data rate (10 W), or 22000 € for expansion capability (one 20-Watts transceiver).

  *** With the note indicate in point 3.4.**

4.6 Lisbon.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Supply two transceivers with power increase (20W).
- Modify the transceiver frame support and release or install new twist waveguide.
- Adjust Levels in coordination with IOC.
- Could be necessary to do BERtest.
- **ROM prices: 37000 € for standard and expansion capability (two 20-Watts transceivers).

**** With the note indicate in point 3.4.**

4.7 Santa Maria.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Supply two transceivers with power increase (20W).
- Modify the transceiver frame support and release or install new twist waveguide.
- Adjust Levels in coordination with IOC.
- Could be necessary to do BERtest.
- **ROM prices: 37000 € for standard and expansion capability (two 20-Watts transceivers).

**** With the note indicate in point 3.4.**

4.8 Johannesburg.

It will be necessary to do the next works:

- Study if there is any obstacle in the new pointing.
- Antenna Pointing.
- Supply to transceivers with power increase (30 W or 40 W).
- Modify the transceiver frame support and release or install new twist waveguide.
- Adjust Levels in coordination with IOC.
- Could be necessary to do BERtest and M&C test.
- ROM prices: 46000 € for standard data rate (30 W), or 51000 for expansion capability (two 40-Watts tranceivers).