INTERNATIONAL CIVIL AVIATION ORGANIZATION

MIGRATION PLAN WORKING GROUP

REPORT

Madrid, Spain, 2-3 July 2008

The Migration Plan Working Group (MP/WG) is a working Group to over see the smooth migration of CAFSAT network from IS -801 to IS -909.

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PART I – HISTORY OF THE MEETING

1. Introduction

1.1 The First CAFSAT Migration Plan Working Group Meeting (MP/WG/1), was held in Madrid, Spain, from 2 to 3 July, 2008. Participants from all the members except Morocco, Argentina and South Africa attended the meeting. Representatives of INSA and ICAO were also present. The attendance list is attached as **Annex A**.

1.2 Mr. Antonio Arias, on behalf of Spain, welcomed all the representatives and presented the time schedule for the day meeting.

2. Officers and Secretariat

2.1 Mr Antonio Arias was rapporteur of the meeting and Ms. Mary Obeng, Regional Officer CNS was the Secretary of the meeting.

3. Attendance

3.1 The meeting was attended by 16 participants from 5 States and 2 International Organization namely ASECNA and ICAO. The list of participants is given at **Appendix A** to this report.

4. Working Language

4.1 The meeting was conducted in English language.

5. AGENDA

5.1 The following Agenda was adopted**:**

Agenda Item 1

Study and select available satellites that may meet, in terms of services, coverage and cost, the parameters offered by IS-801 up-to-date.

Agenda Item 2

Develop a Migration Plan schedule

Agenda Item 3

Analyse the coordination to perform of D-Day migration

Agenda Item 4

Future work Programme

Agenda Item 5

Any other business

LIST OF DRAFT CONCLUSIONS /DECISION

Number	Title
Conclusion 1/1:	**Study and select available satellites that may meet, in terms of services, coverage and cost, the parameters offered by IS-801 up-to-date** The meeting agreed to migrate the CAFSAT network to satellite Intelsat 901, Transponder 36/36.
Conclusion 1 /2:	**Develop a Migration Plan schedule** The agreed date for migration is October 15th. States will ensure the implementation of internal procedures and take the necessary steps to acquire required spares in order to apply all tasks for the migration as explained in Annex C. Satellite clearance must be confirmed in all sites.
Conclusion 1/3:	**Analyse the coordination to perform of D-Day migration** All States should inform, before September 15th, the coordination team, about the model of support needed if any.
Decision 1/4:	**Names of the Coordination Team** In order to coordinate the migration, the following "Coordination Team" was nominated : Ms. Mary Obeng for ICAO Mr. Ángel Crespo for Spain (Rapporteur) Mr. François Xavier Salambanga for ASECNA (One more to be decided from Brazil; Cape Verde or Portugal)
Conclusion 1/5:	**States to nominate a focal point person** Each State will nominate a focal point for migration and submit to the Coordination team before 15 August 2008. See Annex C
Conclusion 1/6:	**Creation of a CAFSAT Management Committee** The meeting proposed the creation of a CAFSAT Management Committee under the SAT technical Working Group. The Terms of Reference will be defined during next SAT meeting and will follow the model of AFISNET Management committee

PART II: REPORT ON AGENDA ITEMS

Report on Agenda Item 1

Study and select available satellites that may meet, in terms of service, coverage and cost, the parameters offered by IS-801 up to date.

1.1 INSA made presentation to meeting on "Satellite Migration Study" (attached as **Annex C**) analyzing the INTELSAT fleet requirements for the new satellite and alternatives. The main identified requirements are:

C-Band

Coverage over Europe, Africa and Central and South America (special attention to the Northeast region of Brazil and the archipelagos of Canaries, Cape Verde and Azores).

Preferably in hemi beam, but at least in global beam with reasonable EIRP and G/T.

Keep a reasonable price, equalling or improving the present amounts paid to Intelsat, and offering same price to carriers in Hemi beam and global beam.

The visibility to proposed satellite/s must be confirmed in order to avoid re-allocations of antennas caused by unexpected obstacles and/or interfering radio systems.

From the analysis of INTELSAT current fleet, it was noted that:

Capacity on the EH/EH beam on visible satellites is not currently available

Intelsat compromise to keep current carriers fares for each station up to contract renovation dates

The proposed solution is based on a global coverage, taking into account the following cons and pros:

Cons:

Worse transponder conditions ◊ Higher stations power will be required

Worse operational (recurrent) costs increase in carrier price

Pros:

Present Satellite BW scenario: Similar situation at other satellite operators for C-Band over Africa

After revision of current Intelsat visible fleet INSA came out with Intelsat solution to migrate all stations to a global beam. This solution have the following advantages :

- Simplification of current stations: no need of future upgrades for new links on different beams. Although Las Pamas (LPA) and Dakar (DKR) station would require equipment refurbishment but
- Simplification of future stations
- More network expansion capability:

Links not restricted by hemi coverage to new nodes or to new circuits between present nodes will gain Greater Coverage.

1.2 Based on these considerations and the characteristics of available satellites, it was proposed to migrate to Satellite IS-901, transponder 36/36.

CONCLUSION MPWG 01/01:

The meeting agreed to migrate the CAFSAT network to satellite Intelsat 901, Transponder 36/36.

Agenda Item 2: Develop a Migration Plan schedule

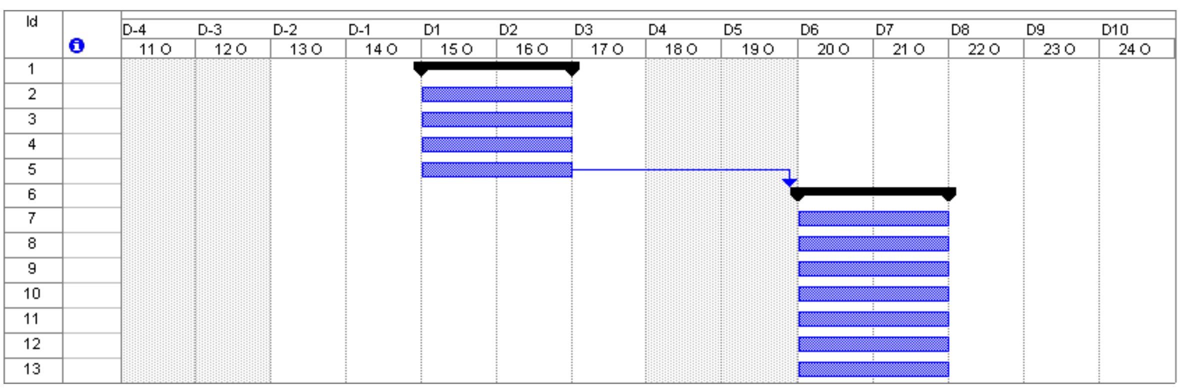
2.1 INSA presented a summary of the migration tasks to be carried by each station to complete the migration. The specific tasks per station are described in **Annex B.**

2.2 It was noted that, due to the demanding timetable, efforts should be put by all the organizations in order to accomplish in time the technical, bureaucratic and contractual modifications in order to achieve the migration.

Agenda Item 3: Analyze the coordinations to perform of D-Day migration

3.1 A draft migration plan was presented to the meeting as attached in **Annex B.** The plan proposes a 3 steps migration in order to avoid the difficulties of migrating 10 teams on both sides of the Atlantic at the same time.

The schedule is shown below:



3.2 Aena proposes that LPA CATS be migrated with the first group, in order not to loose the AFTN service with Johannesburg (JNB) and allow for the re-routing to second group stations. The proposal was accepted. ASECNA is to confirm the services, which will be re-routed through Las Palmas station.

CONCLUSION MPWG 01/02:

The agreed date for migration is October 15th. States will ensure the implementation of internal procedures and take the necessary steps to acquire required spares in order to apply all tasks for the migration as explained in Annex C. Satellite clearance must be confirmed in all sites.

3.3 INSA indicated that they are in a position to provide technical assistance for up to 7 stations simultaneously. States have the following three alternatives for migration:

1. The organisation does it by itself (i.e. using its internal staff);
2. INSA could do the work (i.e. subcontracting the migration process to INSA)
3. Mix solution with online support (i.e. using its internal staff as above, but with online technical support from INSA).

CONCLUSION MPWG 01/03 :

All States should inform the coordinating team, before September 15th, about the model of support needed if any.

Agenda Item 4: Future work programme

4.1 In order to implement the actions and meet the dead-lines, it is proposed that a team of four (4) people (including ICAO representative) be established to coordinate day-to-day activities. A focal point for each organization is to be nominated.

4.2 Organizations are reminded that all the administrative procedures and needed procurement (spare parts) shall be done in advance locally. Brazil, in particular will confirm the availability of the service on the same satellite after 01 September which is the formal limit date in their contract.

4.3 In order to ensure the availability of the service from a contractual point of view, each organization will confirm the conditions established in their contracts with Intelsat and communicate to the coordinating team.

4.4 Provided there are no problems on this side, the group proposed that Day 1 on the migration be **15th October 2008**.

CONCLUSION MPWG 01/05:

In order to coordinate the migration, the following "Coordination Team" was nominated (Annex D):

Ms. Mary Obeng for ICAO

Mr. Ángel Crespo for Spain (Rpporteur)

Mr. François Xavier Salambanga for ASECNA

(One more to be decided from Brazil, Cape Verde or Portugal)

CONCLUSION MPWG 01/06:

Each State will nominate a focal point for migration and submit to the Coordination team (Form attached as Annex E) and a substitute for coordination before 15 August 2008.

Agenda Item 5: Any other business.

5.1 It was noted that the CAFSAT network was established with up-to-date equipment at the conception time. However, due to the evolution of systems, some equipment or functionalities (multiplexers, software…) should be updated. This evolution cannot be undertaken individually by each state.

5.2 It was noted that there was no centralized supervision of the network, nor any existing forum to coordinate evolution of the network. Discussions are carried during SAT meetings, but the agenda does not allow in-depth discussions. It was therefore proposed that CAFSAT Users SG be created under the umbrella of ICAO, which could plan not only, these immediate evolutions issues, but also, plan a long term managing of the network, including possible evolution of the technologies, centralized management, and interoperability with other networks.

5.3 The CAFSAT Users SG would submit its report to the SAT technical WG. The CAFSAT WG would review the activities of the CAFSAT users.

CONCLUSION MPWG 01/07:

The meeting proposed the creation of a CAFSAT Management Committee under the SAT technical Working Group. The Terms of Reference will be defined during next SAT meeting and will follow the model of AFISNET Management committee.

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Documento: *Document*	CAFM-INSA-NT-01	
Proyecto: *Project*	**CAFSAT**	
Título: *Title*	**Satellite Migration**	
Edición: *Issue*	1.0	
Fecha: *Date*	2008-06-05	**Page** : 1 de 94 *Page*

SIGNATURES TABLE

	Nombre y cargo: *Name and Position*	**Firma:** *Signature*	**Fecha:** *Date*
Escrito: *Written*	Domingo Soltero Rogelio Marante		
Verificado: *Checked*	Domingo Soltero		
V. Calidad: *QA Checked*	César Martín		
Autorizado: *Authorized*	Isaac Domínguez		

Copia: *Copy*	**Controlada:** *Controlled*	**Informativa:** *Informative*

CHANGE RECORD

Páginas: *Pages*	**Fecha:** *Date*	**Edición/Revisión:** *Issue/Revision*	**Descripción de los cambios:** *Changes Description*
All	2008-06-05	1.0	Initial version

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1 INTRODUCTION

This document analyses the impact of the IS-801 satellite end of life in the CAFSAT network. This satellite has been servicing CAFSAT network since its creation but it is foreseen to enter in elliptic orbit in October 2008.

CAFSAT network has been growing from its origins in 1.999, when five were the initials nodes. At this time, CAFSAT network provides the communication between the ten nodes of Las Palmas, Dakar, Sal, Recife, Casablanca, Lisbon, Santa Maria, Johannesburg, Ezeiza and Nouakchott.

This document has been structured in three main sections:

- Trade-off study of the possible satellites
- Link budgets analysis for the new satellite
- Impact of the migration at each station, detailing on one hand the minimum required tasks in order to migrate the network operation with the minor service interruption, from the point of view of the whole network, and on the other hand later tasks or stations modifications for refurbish current service level through stations upgrade, but impacting just at station level not at the network level

After revision of this document by all CAFSAT members, a separated migration plan will be agreed taking into account each station resources and time availability to achieve migration goal.

2 PRESENT SITUATION

The initial network design took into account five stations: Las Palmas, Dakar, Sal, Recife, and Casablanca.

For these stations the IS-801 satellite was the best choice since offered hemispheric coverage to four of the five stations, and the fifth station had reduced traffic with just two stations.

In the comparison between hemispheric or global coverage special consideration has the lower recurrent cost of the hemi carriers and initial cost savings also in transceiver power since the hemispheric transponders have greater gain. The main inconvenient regarding hemi coverage is obviously that the network expansion is limited to this coverage.

Then the better solution at this situation was taking advantage of the lower $/MHz/month recurrent cost of hemi carriers although making LPA & DKR stations more complex to allow transmission of two carriers at separated transponders:

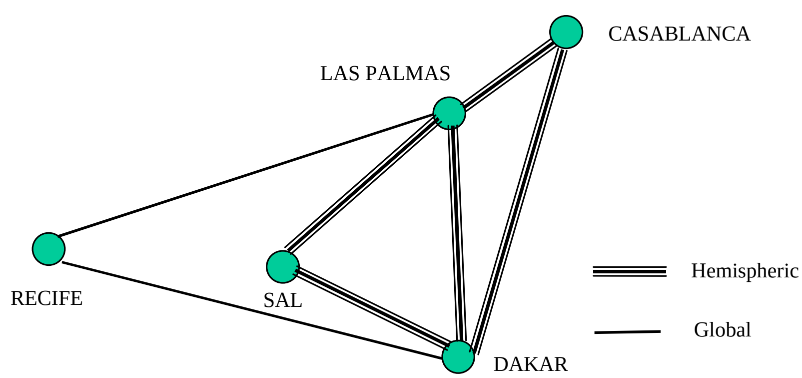


Figure 2-1: Initial design of Satellite Carriers.

This “hybrid” solution consisting in two subnets grow up to the 10 nodes operating nowadays:

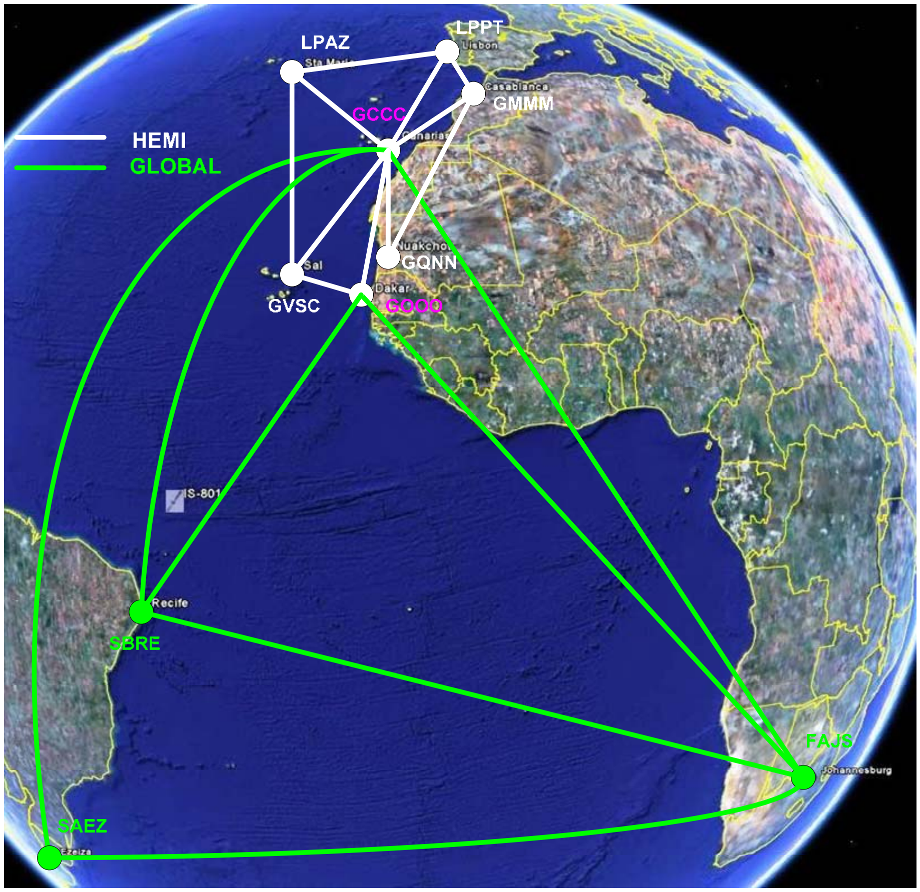


Figure 2-2: Present network topology

- Three stations are operating in the global beam of IS-801: Recife, Johannesburg and Ezeiza
- Five stations in the east hemispheric beam: Sal, Casablanca, Lisbon, Santa Maria and Nouakchott
- Two stations has the double beam capability: Las Palmas and Dakar

But now Intelsat has announced the end of life of the IS-801 satellite, which was launched in 1997. This means that from October of this year this satellite will not make orbital maneuvers to keep it in its expected geosynchronous orbital window so degrading fixed earth stations pointing. After a couple of months the pointing loss will became inoperative the satellite link except to stations having motorized antennas and tracking capabilities.

3 NEW SATELLITE STUDY

3.1 Satellites Visibility

The current Intelsat satellites that are visible from all the nodes with more than 10º of elevation are (from west to east):

- IS-903
- IS-907
- IS-905
- IS-603
- IS-901
- IS-10-02

The IS-603 is too old and must be already in extended orbital maneuver lifetime

The Intelsat IX series were launched between 2001 and 2003 with a design lifetime of 13 to 15 years

Obviously the first choice would be to use to use the younger satellite since capabilities are better apart of the greater lifetime. Here follows a comparison between different Intelsat generations:

Comparison of the Communications Subsystems

Description	Intelsat VI	Intelsat VII	Intelsat VII-A	Intelsat VIII	Intelsat VIII-A	Intelsat IX		Intelsat X
Prime Contractor	Hughes Aircraft Company	SS/Loral	SS/Loral	Lockheed Martin	Lockheed Martin	SS/Loral	SS/Loral	ASTRIUM
Spacecraft Designation	601, 603, 605	701, 702, 704, 705, 709	706, 707	801, 802	805	902-905 & 907	901 & 906	10-02
Year of First Launch	1989	1993	1995	1997	1998	2001	2001	2004
Number of Transponders: C-Band Ku-Band	38 10	26 10	26 14	38 6	28 3	47 14	42 14	45 16
Maximum Marketable Capacity (in equivalent 36 MHz units)	C-Band: 64 Ku-Band: 24	C-Band: 42 Ku-Band: 20	C-Band: 42 Ku-Band: 28	C-Band: 64 Ku-Band: 12	C-Band: 36 Ku-Band: 6	C-Band: 76 Ku-Band: 22	C-Band: 72 Ku-Band: 23	C-Band: 61 Ku-Band: 32
C-Band Beam Coverages	2 Hemi, 4 Zone, Global A and B	2 Hemi, 4 Zone, Global A and B, C-Spot A and B	2 Hemi, 4 Zone, Global A and B, C-Spot A and B	2 Hemi, 4 Zone, Global A and B	Landmass Hemi A and B	2 Hemi, 4 or 5 Zone, Global A and B	2 Hemi, 4 Zone, Global A and B	3 Hemi, 2 Zone Global A and B
Ku-Band Beam Coverages	West Spot and East Spot	Spot 1, Spot 2, Enhanced Spot 2/2A, and Spot 3	Spot 1/1X, Spot 2/2X, Enhanced Spot 2/2A, and Spot 3	Spot 1 and Spot 2	Spot 1	Spot 1 and Spot 2	Spot 1 and Spot 2	Spot 1 Spot 2 Spot 3/3X
Operating Frequency Band for C-Band (in MHz)	Uplink: 5850 to 6425 Downlink: 3625 to 4200	Uplink: 5925 to 6425 Downlink: 3700 to 4200	Uplink: 5925 to 6425 Downlink: 3700 to 4200	Uplink: 5850 to 6425 Downlink: 3625 to 4200	Uplink: 5890 to 6650 Downlink: 3400 to 4200	Uplink: 5850 to 6425 Downlink: 3625 to 4200		Uplink: 5850 to 6425 Downlink: 3625 to 4200
Operating Frequency Band for Ku-Band (in GHz)	Uplink: 14.0 to 14.5 Downlink: 10.95 to 11.2 plus 11.45 to 11.7	Uplink: 14.0 to 14.5 Downlink: 10.95 to 11.2 or 11.7 to 11.95 or 12.5 to 12.75 plus 11.45 to 11.7	Uplink: 14.0 to 14.5 Downlink: 10.95 to 11.2 or 11.7 to 11.95 or 12.5 to 12.75 plus 11.45 to 11.7	Uplink: 14.0 to 14.5 Downlink: 10.95 to 11.2 or 11.7 to 11.95 or 12.5 to 12.75 plus 11.45 to 11.7	Uplink: 14.0 to 14.25 Downlink: 12.5 to 12.75	Uplink: 14.0 to 14.5 Downlink: 10.95 to 11.2 plus 11.45 to 11.7		Uplink: 13.75 to 14.5 Downlink: 10.95 to 11.2 plus 11.45 to 11.7 plus 12.5 to 12.75
Extent of Frequency Reuse in Hemi/Zone	6-fold; with a 4-fold option on a Channel-by-Channel	4-fold with enhanced Zone connectivity	4-fold with enhanced Zone connectivity	6-fold; with a 5-fold option for the POR	2-fold in Hemi only	6-fold; except in Channels (1-2) and (3-4) which are 7-fold	6-fold	5 fold

Table 3-1: Intelsat generations capabilities

Intelsat Spacecraft – Special Capabilities

Intelsat VI	Intelsat VII	Intelsat VII-A	Intelsat VIII	Intelsat VIII-A	Intelsat IX	Intelsat X
– Channel 9 is switchable between Hemi/Zone and Global – Dynamic switch network for SST-DMA in Channels 1-2 and 3-4 – SSTDMA broadcast mode into multiple downlink Beams – Switchable "Pseudo-Global" coverage in Channel (1'-2') – Compatible to operate with up to 3° IOO	– Channel 9 is switchable between Hemi/Zone and Global/C-Spot – Compatible to operate with up to 3° IOO* – Operates in normal or inverted attitude – Split uplink in Channel 5-6 – Switchable Global or C-Spot in Channels 9 to 12 – Switchable transponder and enhanced U/L connectivity in Zone Beams – 12 GHz D/L capability – Enhanced Ku-Band Spot 2 coverage for POR – Capability to switch in-orbit Ku-Band S3 beam polarization by ground command (704, 705, 709)	– Channel 9 is switchable between Hemi/Zone and Global – Compatible to operate with up to 3° IOO* – Operates in normal or inverted attitude – Split uplink in Channel 5-6 – Switchable Global or C-Spot in Channels 9 to 12 – Switchable transponder and enhanced U/L connectivity in Zone Beams – 12 GHz D/L capability – Enhanced Ku-band Spot 2 coverage for POR – Ku to C-Band connectivity in Channel 12 – Paralleling of TWTA in Ku-Band – Capability to switch in-orbit Ku-Band S3 beam polarization by ground command	– Channel 9 is switchable between Hemi/Zone and Global – Compatible to operate with up to 3° IOO* – Operates in normal or inverted attitude – 12 GHz D/L capability – TV broadcast mode in Zone Beams for a West Quasi-Hemi coverage – Ku to C-Band X-strap connectivity in Channel 12 with a return path – Flexible transponder activation for 6 out of 10 Channels in Ku-Band	– Compatible to operate with up to 3° IOO* – Operates in normal or inverted attitude – C-Band Operates in Linear polarization	– Capability for SSTDMA services in Channels 1-2 and 3-4 – Compatible to operate with up to 3° IOO* – Selectable split uplink in Global Channel 12 for SNG – Selectable split uplink in Hemi Channel 9 for DAMA – Switchable to 4 or 5 Zone configuration – Switchable transponder allocation between SW and SE Zone Beams [1] – Flexible transponder activation for 12 out of 16 Channels in Ku-Band – Equipped with an overdrive control feature for Ku-Band transponders – Capability to switch in-orbit Ku-Band S1 & S2 beam polarization senses by grounding command – Cross-connectivity between C- and Ku-Band in channels (1-2), (3-4), (5-6) and (7-8)	– Capability to switch between Hemi/Zone and Global C-Band beam coverages in channels 10, 11 and 12 – Compatible to operate with up to 3° IOO* – Inter-connectivity capability among C-Band beams, and cross-connectivity between Hemi/Zone beams and Ku-Band Spot 3/3X beam in channel banks (1'-2'), (1-2), (3-4) – Equipped with ALC feature to maintain the TWTA input power to within 0.5 dB for an overdrive variation of up to 12 dB for any SFD setting – Capability to rotate in-orbit Ku-Band S1 and S2 Beams

Table 3-2: Intelsat generations special capabilities

3.2 Satellites Coverage

Here follows east hemispheric beam footprints of each visible satellite to compare with the used IS-801:

Figure 3-1: IS-801 EH (dB from 34.5 dBW ERIP @ Beam Edge)

- Current operational configuration of transponder 20/20 (19 May 2008):

  -78.1 dBw/m^2 @ B.E.
  -83.1 dBw/m^2 @ B.C.
  1'-2' channel bank

Figure 3-2: IS-903 EH (dB from 37.4 dBW ERIP @ Beam Edge)

- **Azores Islands are out of EH coverage**

Figure 3-3: IS-907 EH (dB from 37.4 dBW ERIP @ Beam Edge)

- **Azores Islands are out of EH coverage**
- **Sal Island is at the EH beam edge**

Figure 3-4: IS-905 EH (dB from 37.4 dBW ERIP @ Beam Edge)

- **Azores Islands are out of EH coverage**
- **Sal Island is below the EH beam edge**

Figure 3-5: IS-901 EH (dB from 36 dBW ERIP @ Beam Edge)

- **Azores Islands are out of EH coverage**
- **Sal Island is out of EH coverage**
- **Dakar is below the EH beam edge**

Figure 3 3: IS-1002 EH (dB from 37 dBW ERIP @ Beam Edge)

- **Azores Islands are out of EH coverage**
- **Sal Island is below the EH beam edge**

Independently of the new satellite choice Santa Maria station would have to change to global beam, and its circuits with Sal and Lisbon stations would drag Sal station to the global beam too and Lisbon station to implant an hybrid solution like Las Palmas and Dakar.

Then the same multi-beam solution will lead to:

- Five stations operating in the global beam: Recife, Johannesburg, Ezeiza, Santa Maria and Sal.
- Two stations in the east hemispheric beam: Casablanca and Nouakchott
- Three stations with double beam capability: Las Palmas, Dakar and Lisbon

3.3 Satellites Bandwidth

The present satellite bandwidth scenario is changing: the demand for satellite capacity in some regions continues to strain the bandwidth supply

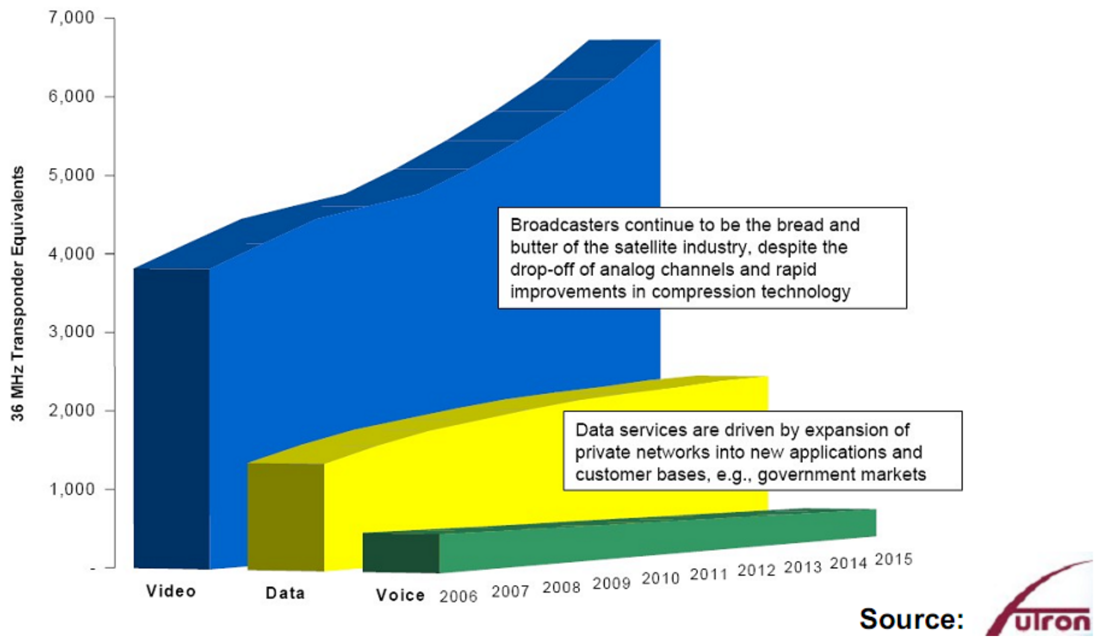
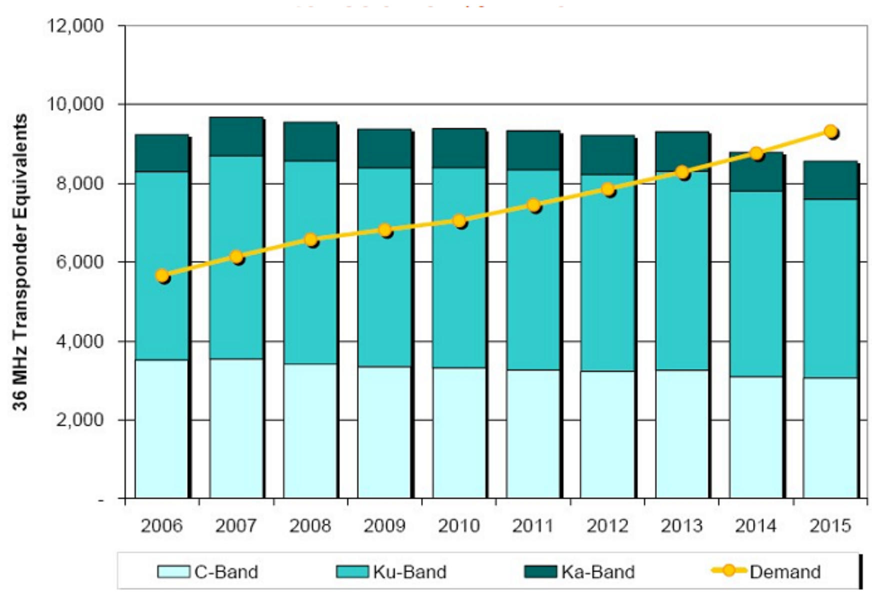


Figure 3-6: Total demand forecast for fixed satellite capacity by service

The whole market grew by around 10% in both 2005 and 2006.

Global utilization exceeds 60% for the first time in several years and is forecast to reach 84% in 2012:



Source: Futron

Figure 3-7: Global utilization vs bandwidth capacity

The industry has had it good for the past few years with low capacity pricing. This phase is now well and truly over and prices are up as a result of:

- Economically unsustainable rates for the long term
- Growing TDMA and SCPC average bandwidth
- Huge demand for GSM backhaul
- Launch failures

By regions:

Difficult Areas	Good News / Bad News
Africa for C-band	• This is a 12-24 month problem
Middle East for Ku-band	• Prices will fall again, but not to 2006 levels
Europe for Ku-band	• High pricing for 12-24 months, low availability to 2009
Russia for Ku & C-band	• Restricted capacity 12-24 months
North America for Ku-band	• Continued shortages, increased requirement for Ka-band
Latin America Ku-band	• Restricted capacity 6-12 months
Asia, parts for C-band	• Gradual relief over 6-18 months as Spaceway bites • Situation unclear, IPStar vs GSM demand
India/Pakistan Ku & xC-ba	• Possible shortages until 2009/10nd

Source: comsys

Table 3-3: Bandwidth Constraints

Europe, Middle East & Africa:

- 90% of the 1,700 operational transponders targeting Europe, the Middle East & North Africa are fully or partially used (Source: Euroconsult & London Satellite Exchange)
  - Actual usage was around 27,500 MHz
- Transponder demand will experience compound annual growth of 6.7% per annum between 2007 and 2010 in the Africa and Middle East region (Source: Light Reading)
  - Supply is forecast to grow at 3.2% per annum between 2007 and 2010 in the Africa and Middle East region

- **The exposed above is confirmed by Intelsat: there is no current Hemi/Hemi capacity (except high demand) on these analyzed Intelsat satellites.**

- **The good new is the Intelsat compromise to keep current carriers fares for each station up to contract renovation dates**

3.4 Expansion Forecast

The INSA news about possible CAFSAT network expansions are:

- Short-term:
  - Lisbon and Santa Maria carriers increase to 192 kbps
  - Angola could join new hemi beam but requires link with Recife → Global
  - Trinidad and Tobago → Global coverage, would drag Sal station to global independently of new satellite choice
- Medium-term: Madrid/Sevilla or Argel would balance hemi/global allotment
- Long-term: Montevideo → global

3.5 Proposed Solution

After revision of current Intelsat visible fleet INSA agrees with Intelsat the best solution is to migrate all stations to a global beam. Here follows the main pros & contras:

- ✓ Simplification of current stations: no need of future upgrades for new links on different beams. Although LPA & DKR station would require equipment refurbishment but
- ✓ Simplification of future stations
- ✓ More network expansion capability:
  - ✓ Links not restricted by hemi coverage nor to new nodes neither to new circuits between present nodes
  - ✓ Greater coverage
- ✗ Worse transponder conditions → Higher stations power required
- ✗ Worse operational (recurrent) costs from scratch → Higher carrier price
- ✓ **Intelsat compromise to keep current carriers fares**

4 LINK BUDGETS ANALYSIS

4.1 Proposed Satellite

Taking into account coverage and elevation, the recommended satellite is IS-901 since is the more centered one for current stations (CAFSAT center @ 15ºW), giving better coverage for network expansion.

Here follows the main features:

	IS-801	IS-901
Launch Date	February 28, 1997	June 11, 2001
Degrees East	328.5 – 31.5º W	342ºE – 18ºW
Design Lifetime	10 years	13 years
C-band EIRP	Global 29.0 up to 33.4 dBw Hemi 34.5 up to 40.4 dBw	Global 31.0 up to 35.7 dBw Hemi 36.0 up to 41 dBw
C-band G/T	Global -12.0 up to -7.8 dB/K Hemi -8.0 up to -1.3 dB/K	Global -11.2 up to -6.3 dB/K Hemi -8.0 up to -1.6 dB/K
C-band SFD	-67.0 to -89.0 dBw/m2	67.0 to -89.0 dBw/m2

Table 4-1: New satellite main features

Special mention has to be made to current operating conditions: transponder gains have high dynamic margins translated to SFD values:

- Although global beams have similar parameters, proposed transponder is 36/36 with a lower SFD value. Other transponders with better SFD have not BW available
- IS-801 37/37 transponder is near maximum gain right now and JNB is near saturation
- Always have to take into account that data rates growths always lead to power upgrades

4.2 Global Coverage

Here follows global beam footprints of the new proposed satellite to compare with the used IS-801:

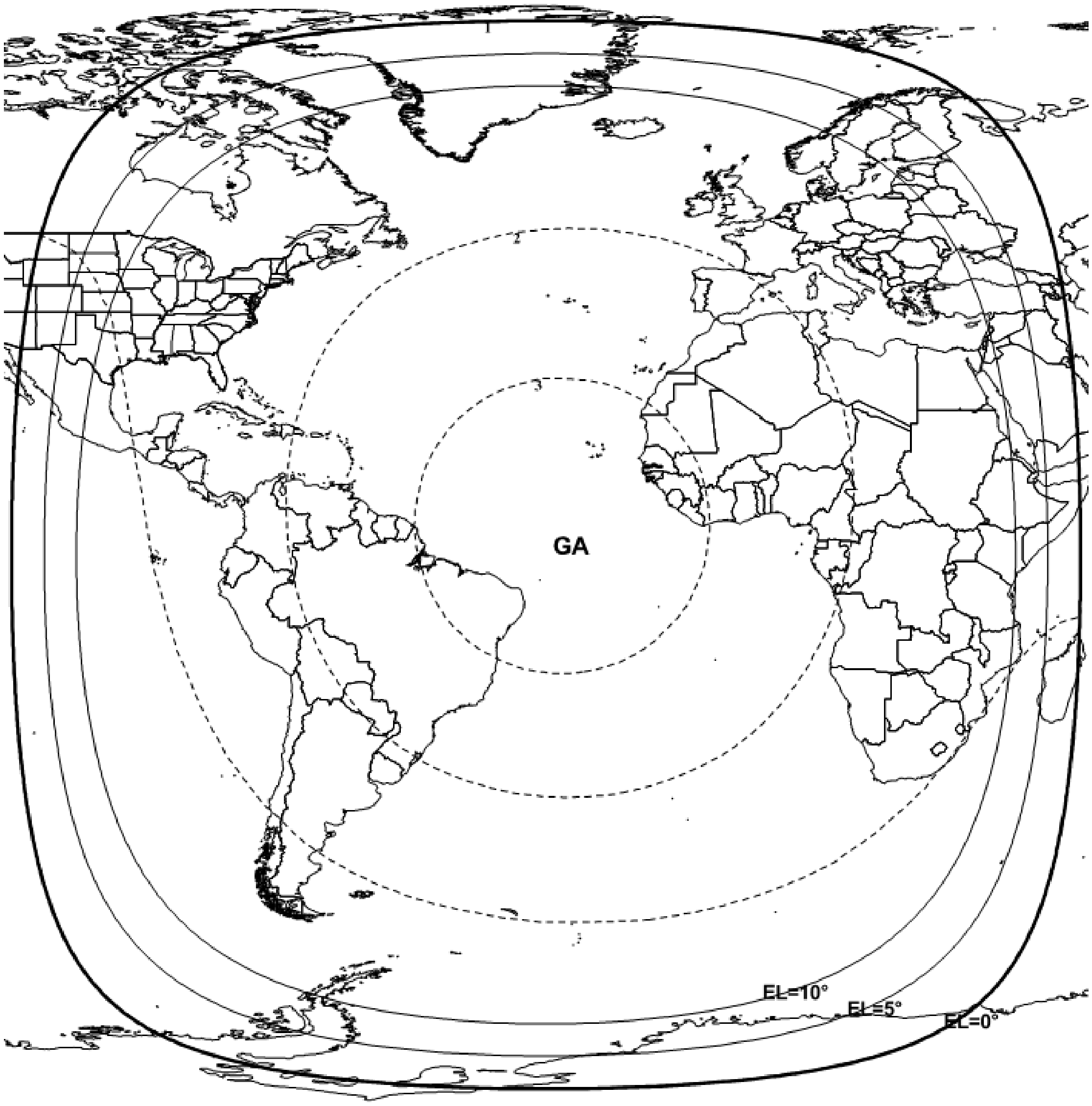


Figure 4-1: IS-801 GA (dB from 29 dBW ERIP @ Beam Edge)

- Current operational configuration of transponder 37/37 (19 May 2008):

  -80.5 dBw/m^2 @ B.E.
  -84.5 dBw/m^2 @ B.C.
  11P channel bank

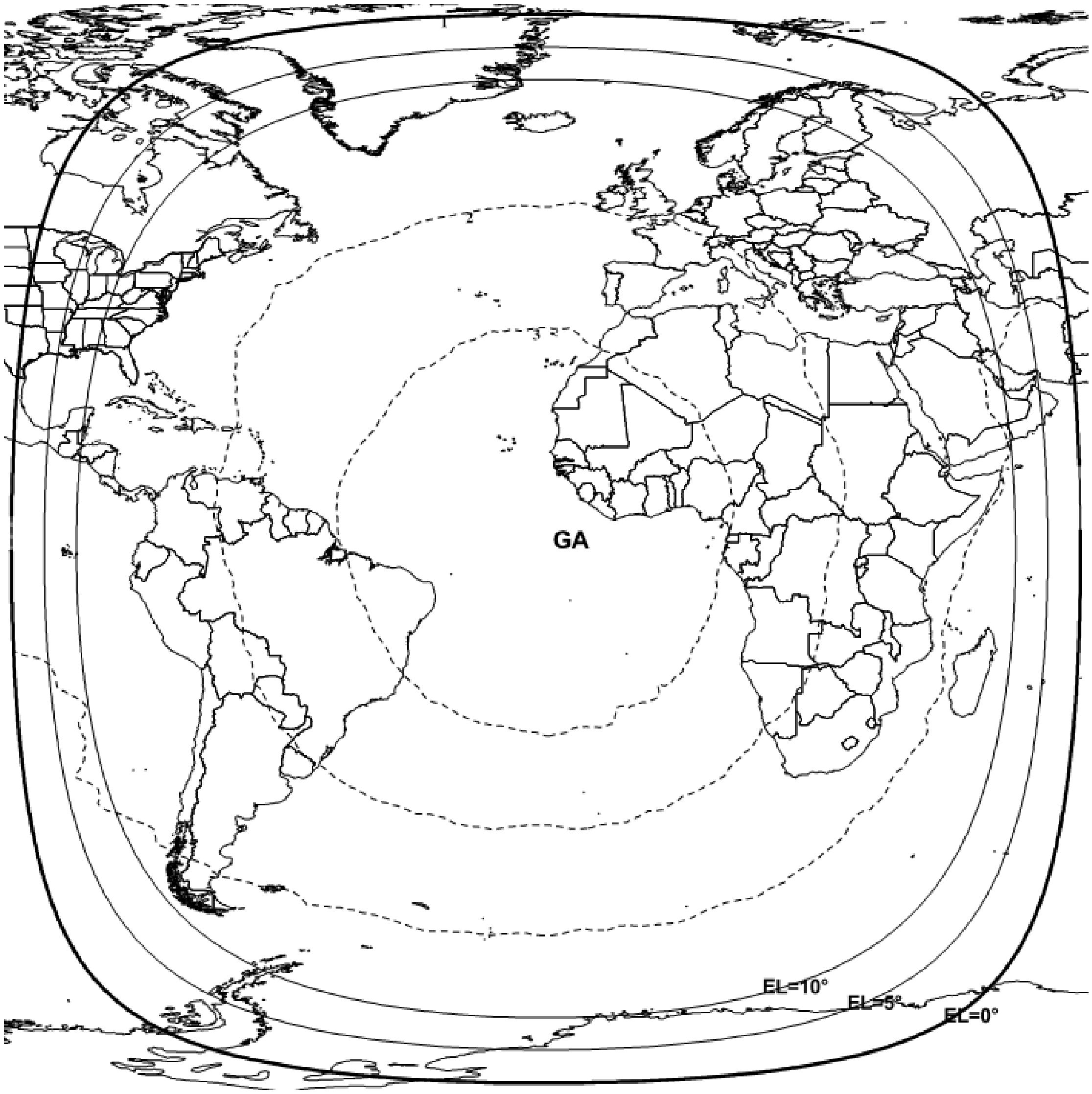


Figure 4-2: IS-901 GA (dB from 31 dBW ERIP @ Beam Edge)

- Current operational configuration of transponder 36/36 (8 Apr 2008):

  -74.9 dBw/m^2 @ B.E.
  10P channel bank

4.3 Link Budgets Analisys

The link budgets data provided by Intelsat for the new satellite IS 901 is showed in the table below:

	Relocate to IS-901/342E						
TX E/S	**Transp**	**Uplink freq.**	**Downlink freq.**	**Info Rate**	**U/L eirp**	**D/L eirp**	**(C0+N0)/N0**
CAF-01F1	36/36	6318,3350	4093,3350	128	51,9	5,6	8,4
CAF-01F1	36/36	6325,6475	4100,6475	64	51,6	5,4	8,7
RCF-01F1	36/36	6325,7600	4100,7600	64	51,0	5,3	8,7
JHN-05F1	36/36	6321,5550	4096,5550	192	56,5	8,0	8,4
DKR-04F1	36/36	6318,1325	4093,1325	128	53,6	6,3	8,4
DKR-04F1	36/36	6321,7575	4096,7575	64	50,9	5,4	8,7
NVL-02F1	36/36	6314,0850	4089,0850	128	53,3	6,3	8,4
SMI-03F1	36/36	6314,2875	4089,2875	128	53,0	6,3	8,4
BUE-01F1	36/36	6321,3525	4096,3525	64	53,4	5,3	8,7
RAB-04F1	36/36	6325,2475	4100,2475	320	57,0	10,4	8,5
NOU-06F1	36/36	6302,1275	4077,1275	64	49,3	3,7	8,7
EPG-01F1	36/36	6325,5350	4100,5350	64	49,2	3,6	8,5

Table 4-2: Intelsat computation

Two reservations should be made related to these calculations:

- Las Palmas (CAF-01F1) and Dakar (DKR-04F1) stations maintain two carriers each, since they have two carriers in the present scenario.
- The Rx station used in every calculation does not represent the worst case in all the samples.

Taking into account the points above, we have calculated the link budgets with the following assumptions:

- Las Palmas (CAF-01F1) and Dakar (DKR-04F1) stations have a 192 kbps single carrier each.
- The Rx station used represents the worst case in all the samples.

The results are showed in the following table:

	Relocate to IS-901/342E				
TX E/S	**Transp**	**Uplink freq.**	**Downlink freq.**	**Info Rate**	**U/L eirp**
CAF-01F1	36/36	6318,3350	4093,3350	192	56,2
RCF-01F1	36/36	6325,7600	4100,7600	64	49,0
JHN-05F1	36/36	6321,5550	4096,5550	192	58,7
DKR-04F1	36/36	6318,1325	4093,1325	192	55,8
NVL-02F1	36/36	6314,0850	4089,0850	128	53,4
SMI-03F1	36/36	6314,2875	4089,2875	128	53,3
BUE-01F1	36/36	6321,3525	4096,3525	64	53,6
RAB-04F1	36/36	6325,2475	4100,2475	320	57,2
NOU-06F1	36/36	6302,1275	4077,1275	64	49,2
EPG-01F1	36/36	6325,5350	4100,5350	64	49,2

Table 4-3: LST results

The Up link EIRP values that exceed 55 dBm are highlighted.

According to LST v5 these stations should increase their Tx power levels in order to achieve a operational satellite link with all their collaterals.

According to Intelsat the LST have very conservative values so previous table from Intelsat shows less required EIRP for JNB, 56.5 dBW, according to current real transponder operating performance.

- **If data rate at JNB station is reduced to 128 kbps then current EIRP would be enough to start operations with IS-901 36/36 transponder**

According to latest configurations known by INSA, JNB station requires only 59 kbps (user rate).

Applying the same consideration to Las Palmas and Dakar stations then its 55 dBW EIRP would be enough to keep the 192 kbps aggregate rate. These values should be confirmed by Intelsat.

Finally Casablanca station would need to increase the transmitted power above 55 dBW EIRP to keep 320 kbps aggregate rate, but according to current circuits definition this station only requires 192 kbps, and according to current real transponder operating performance, then the required EIRP would be 54.8 dBW

- **If data rate at CAS station is reduced to 192 kbps then current EIRP would be enough to start operations with IS-901 36/36 transponder**

According to latest configurations known by INSA, CAS station requires only 145 kbps (user rate).

4.4 Conclusions

The conclusions consequential of this analysis are the following:

- The use of Global beam for all CAFSAT station simplifies the earth station architecture.
- It is not needed further upgrades independently of future links because all nodes operate in the same beam.
- The new stations that wished to be added to CAFSAT network will reduce their initial investment cost.
- The stations upgrade to L-band intermediate frequency Tx & Rx can be carried out in an easier way.
- This satellite migration could mean a good chance to change used scrambler to avoid future modems incompatibilities.
- The IS 901 Global beam less EIRP obliges some station to increase their Tx power levels.
  - LPA:
    - Increase to 192 kbps single carrier
    - No Tx power lever increment needed but few margin to increase the total data rate
  - JNB:
    - Tx power lever increment needed or
    - Adjust the carrier BW to the total data rate actually used
  - DKR:
    - Increase to 192 kbps single carrier
    - No Tx power lever increment needed (new 40W BUC to be installed at this station)
  - CAS:
    - Tx power lever increment needed or
    - Adjust the carrier BW to the total data rate actually used
- Recommendation: Detail study of current stations circuits' data rate.

Taking into account the most time-efficient action at network level is to achieve satellite migration with existing equipment and that each station would upgrade later, then:

- **JNB would start operations with IS-901 but at 64 kbps**
- **CAS would start operations with IS-901 but at 192 kbps**

5 STATIONS ANALYSIS

5.1 Las Palmas - ACC (AENA)

- Global coverage allows a RF and IF redundant system simplification.
- Less satellite EIRP implies higher Tx amplification capabilities for transceivers.
- Rx chain is not affected by the satellite migration.
- Simpler M&C redundant algorithms.

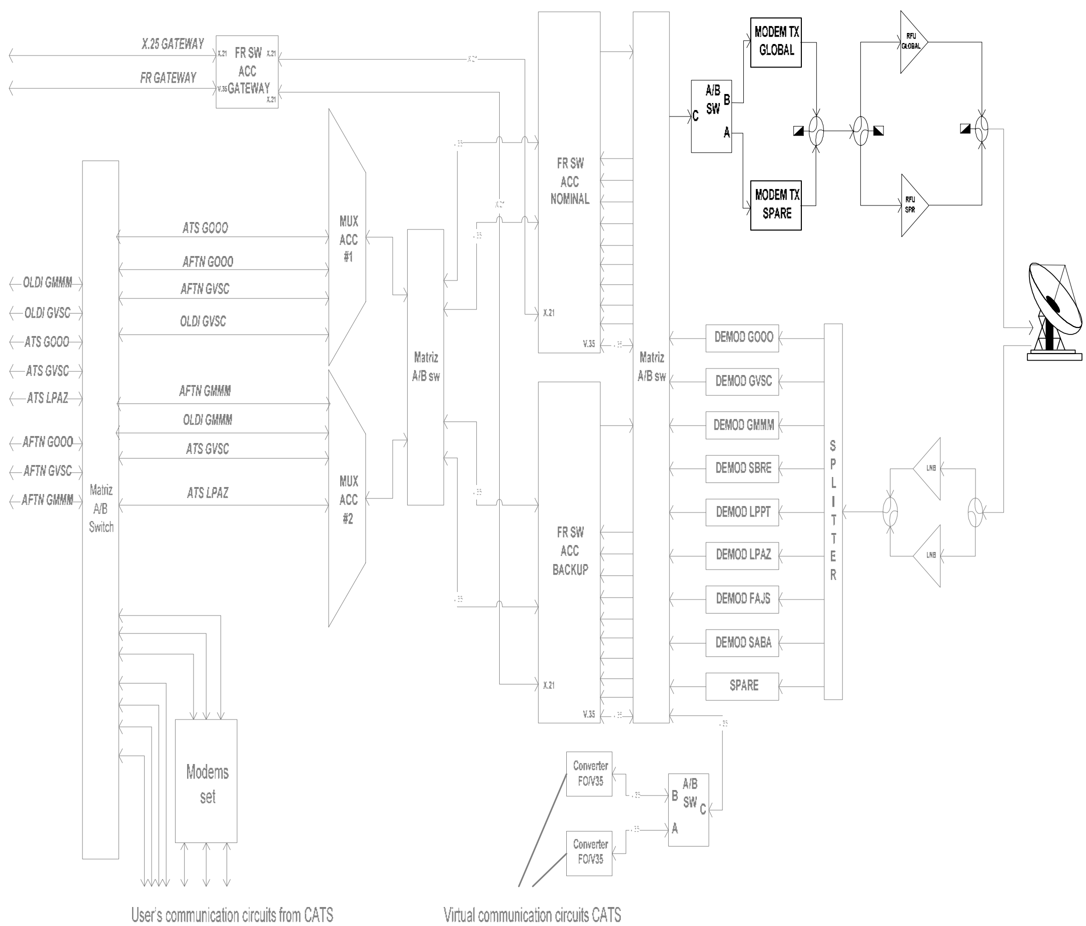


Figure 5-1: LPA-ACC Station Block Diagram

5.2 Las Palmas - CATS (AENA)

- Same considerations than ACC.
- Redesign of the contingency strategy.

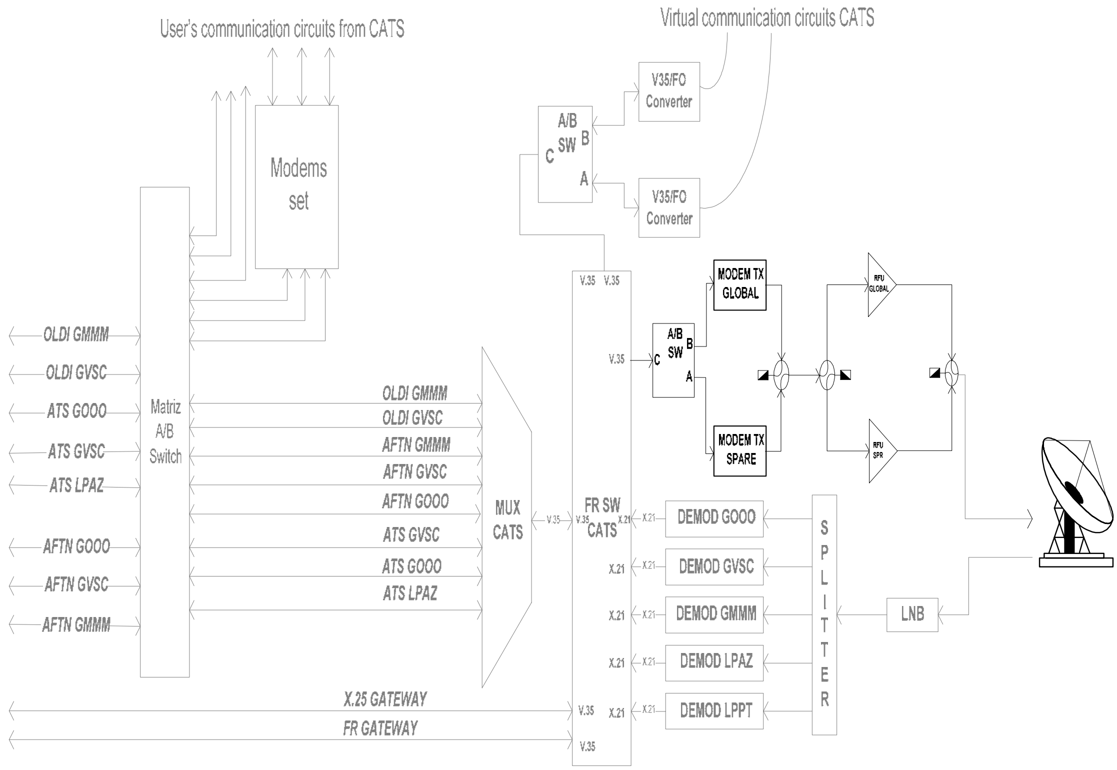


Figure 5-2: LPA-CATS Station Block Diagram

5.3 Dakar (ASECNA)

- Global coverage allows a RF and IF redundant system simplification.
- Less satellite EIRP implies higher Tx amplification capabilities for transceivers.
- Rx chain is not affected by the satellite migration.
- Simpler M&C redundant algorithms.

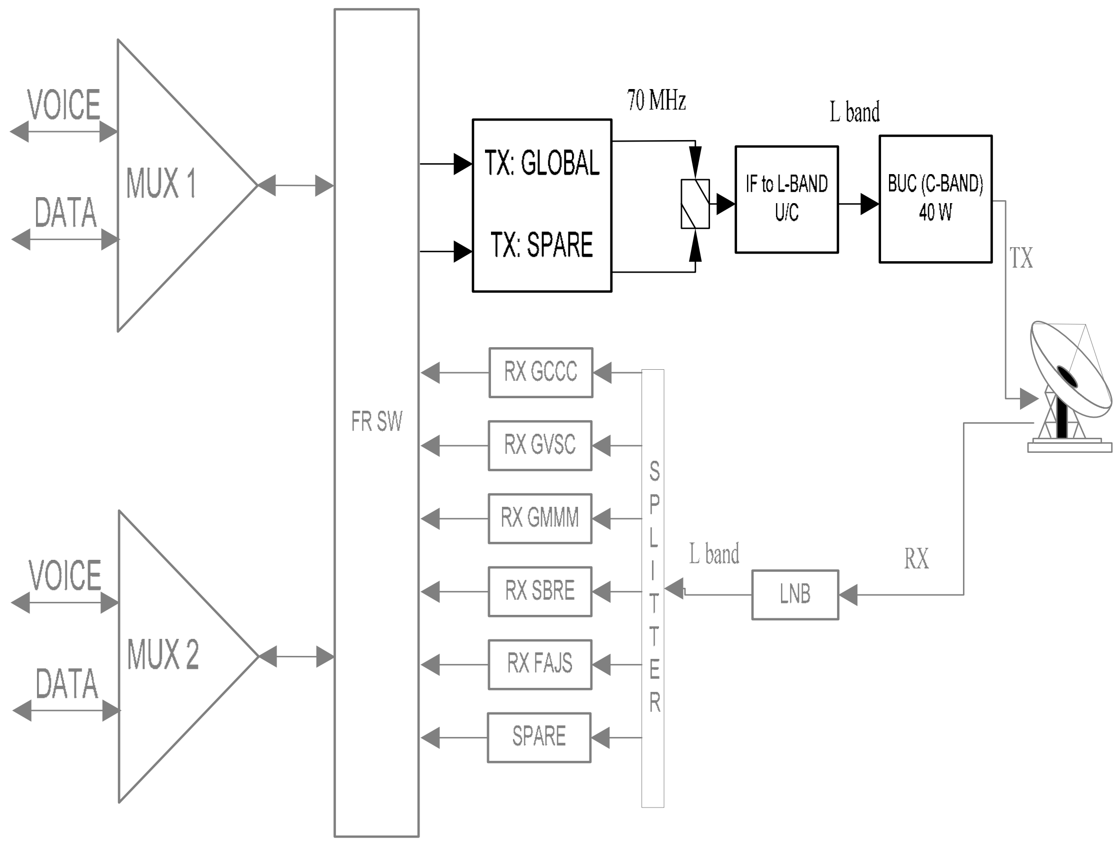


Figure 5-3: DKR Station Block Diagram

5.4 Casablanca (ONDA)

- Less satellite EIRP implies higher Tx amplification capabilities for transceivers.
- Rx chain is not affected by the satellite migration

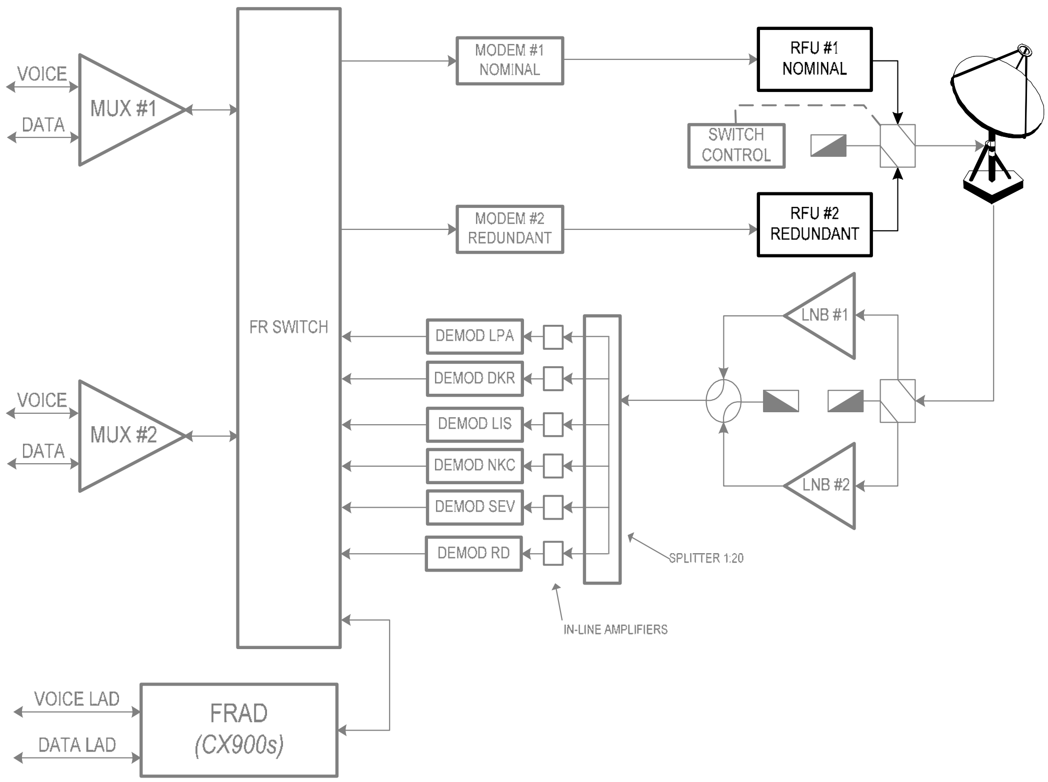


Figure 5-4: CAS Station Block Diagram

5.5 Johannesburg (ATNS)

- Less satellite EIRP implies higher Tx amplification capabilities for transceivers.
- Rx chain is not affected by the satellite migration.

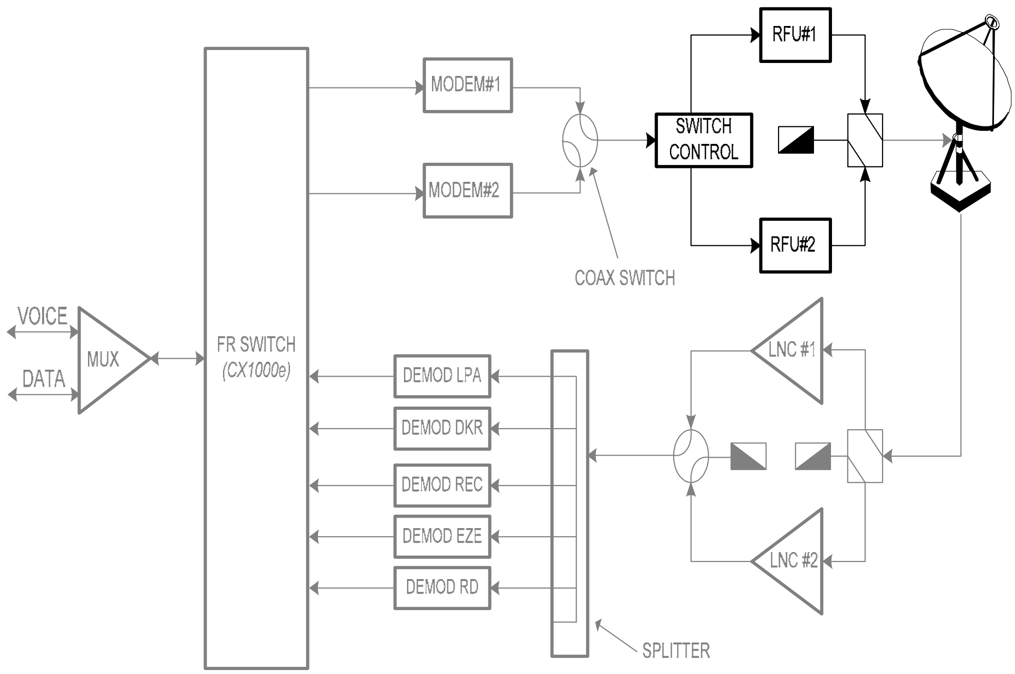


Figure 5-5: JNB Station Block Diagram

5.6 Other CAFSAT Stations

For Lisbon and Santa Maria (NAV), Sal (ANA), Nouakchott (ASECNA), Recife (DECEA) and Buenos Aires (FAA-ANAC) the satellite migration does not affect to present RF, IF or BB equipment.

6 DETAILED MIGRATION TASKS

Since the network is international it would be very difficult to find proper dates to relocate it if any of them have to purchase and wait for new transceivers. Then the idea is to achieve relocation with existing equipment and that each station would upgrade later if required.

Then in this section the impact of the migration at each station is detailing separating the minimum required tasks in order to migrate the whole network with the minor service interruption, from additional later tasks or stations modifications in order to refurbish current service level through stations upgrade, but impacting just at station level not at the network level.

6.1 Previous task common to all nodes: Satellite Clearance Angle

Due to the antenna re-pointing, resulting of the satellite migration, all earth stations have to check that its horizon profile is free from obstacles and possible interfering sources at the new antenna azimuth.

The antenna pointing parameters are showed in the following table:

Tx E/S	Elevation	True azimuth	Azimuth compass bearing
LPA	57,27	185,56	191,44
REC	68,04	65,07	87,37
JNB	30,93	292,87	310,99
DKR	72,67	182	190,52
LIS	44,15	193,98	197,66
SMA	46,47	168,19	177,71
EZE	31,18	56,27	63,45
CMN	49,61	198,47	201,47
NKC	68,63	186,57	193,79
SID	69,54	163,26	173,7

Table 6-1: New satellite pointing angles

The relation between true azimuth (TA) and azimuth compass bearing (ACB) is:

TA = ACB +/- decl.

Where decl. Is the magnetic declination in the E/S geographical location.

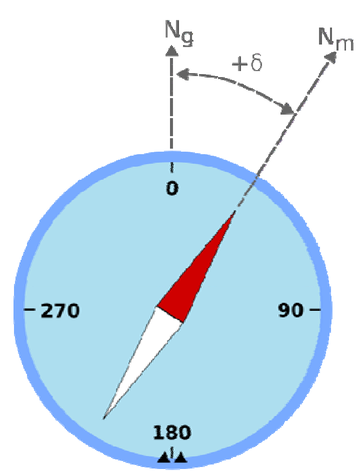


Figure 6-1: Azimuth compass bearing

6.2 Las Palmas (AENA)

The tasks to be carried out in this earth station are the following:

6.2.1 Antenna re-pointing

The equipment and tools needed for this task are:

- Set of spanners
- Spectrum analyzer for L-band
- Inclinometer
- Compass

The following information resumes all the information required to point the antenna towards Intelsat 901 satellite:

POINTING ANGLES		
Satellite longitude	342	**ºE**
Station longitude	-15.39	**ºE**
Station latitude	27.93	**ºN**
BEACON CHARACTERISTICS		
Beacons (C Band)	3952 3952.5	**MHz**
Beacons (L band)	1198 1197.5	**MHz**
Polarization	RHCP	
ANTENNA POINTING		
Elevation	57.27	**º**
Azimuth	185.56	**º**
True Bearing	191.44	**º**

Table 6-2: Antenna pointing information

The steps to be followed in order to get the antenna pointed are:

Step 1: Point the antenna using azimuth and elevation nominal values provided in the table. Use the inclinometer and the compass.

Step 2: Mount the pointing set up.

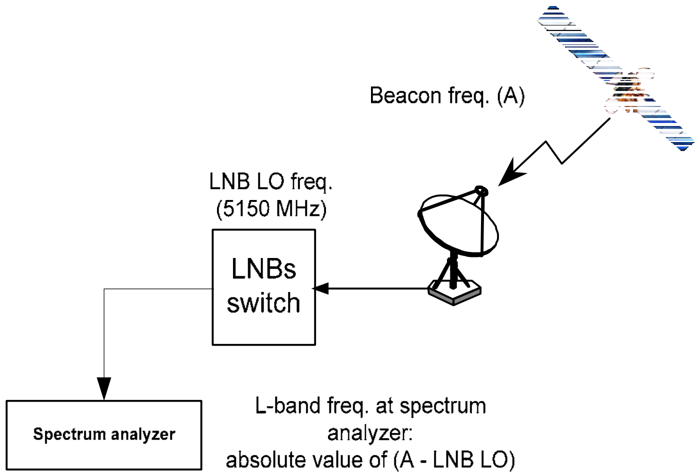


Figure 6-2: Antenna pointing set-up.

Step 3: Find the satellite beacon using the spectrum analyzer. Bear in mind the power level of the beacon (around -80/-70 dBm).
Step 4: Adjust the spectrum analyzer to show the best plot.
Step 5: Perform a slow sweep in both elevation and azimuth in order to maximize the signal strength of the beacon.
Step 6: Fix elevation and azimuth screws of the antenna.

6.2.2 Diplexer removing

The equipment and tools needed for this task are:

- Set of spanners
- Set of screw drivers

These are the steps that should be followed in order to complete this task at ACC antenna:

Step 1: Be sure that the transceivers are off.
Step 2: Remove the diplexer from its support inside the transceivers box.
Step 3: Connect the Tx waveguide switch #2 output port to the flexible waveguide flange -already installed in the box- using a flexible waveguide.
Step 4: Remove the waveguide pieces that connect the Tx waveguide switch #1 to Tx waveguide switch #2. Put a load in the proper Tx waveguide switch #1 port.

6.2.3 Transceivers & modems reconfigurations for new transponders/frequencies

No equipment or tools are needed for this task.

6.2.3.1 Transceivers reconfiguration: SSE-CSTAR.

These are the steps that should be followed in order to complete this task at ACC antenna:

Step 1: Be sure that the transceiver is muted.
Step 2: Using the hand held or a laptop, connect to the transceiver M&C port and send the following commands:

PARAMETER	COMMAND
Transceiver TX status	TX=OFF
Tx Frequency	TFR=6318 (TBC)
Tx Gain	TG=TBD

6.2.3.2 Transceivers reconfiguration: AnaCom C-AnaSat.

These are the steps that should be followed in order to complete this task at ACC antenna:

Step 1: Be sure that the transceiver is muted.
Step 2: Using the hand held or a laptop, connect to the transceiver M&C port and send the following commands:

PARAMETER	COMMAND
Transceiver TX status	TX REC=OFF
Tx Frequency	TX FREQ=6318 (TBC)
Tx Gain	TX GAIN=TBD

6.2.3.3 Modems reconfiguration: CM701.

These are the steps that should be followed in order to complete this task at the ACC equipment rack:

Step 1: Modify the following commands using the front panel controls:

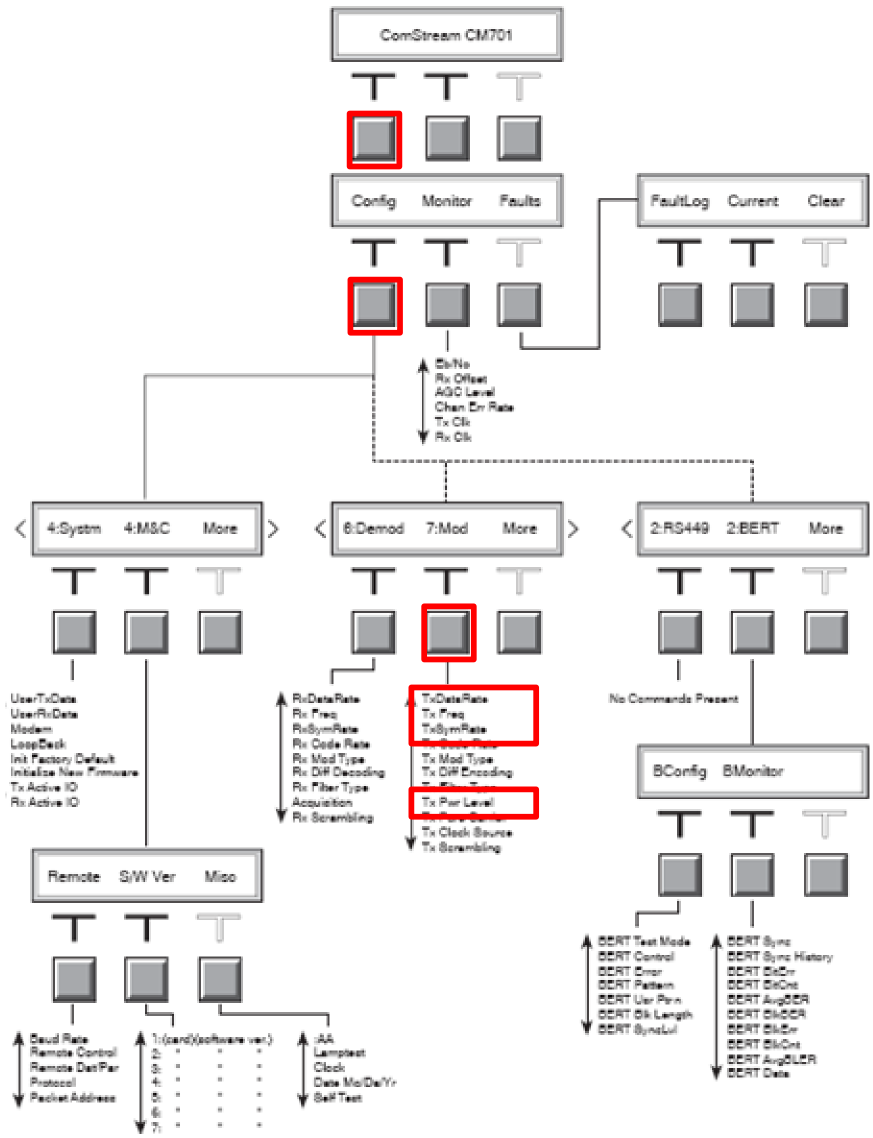


Figure 6-3: Modem front panel commands sequence

5:Mod & 7:Mod	
COMMAND	PARAMETER VALUE
Tx Enable	DISABLE
Tx Freq	70335.000 *(TBC)*
TxDataRate	192000
TxSymRate	192000
Tx Pwr Level	*TBD*

5:Mod & 7:Mod	
COMMAND	PARAMETER VALUE
Tx Enable	ENABLE

6:Mod	
COMMAND	PARAMETER VALUE
Tx Enable	DISABLE

Or using a M&C connection to the CM701 modem. The commands and parameter values to be sent are as follows:

CONFIG: Modulator #1 (Slot # 5) Nominal		
Command	**Parameter Value**	**Description**
5:EM	**0**	Enable Modulator. (0 = disable, 1 = enable).
5:TS	**70335000** *(TBC)*	Transmit Synthesizer frequency
5:TD	**192000**	Data rate
5:PTD	**192000**	Bit Rate
5:TR	**192000**	Symbol Rate
5:TP	*(TBD)*	Transmit Power (range: -25 dBm to –5 dBm).
5:EM	**1**	Enable Modulator. (0 = disable, 1 = enable).

CONFIG: Modulator #2 (Slot # 6)		
Command	**Parameter Value**	**Description**
6:EM	**0**	Enable Modulator. (0 = disable, 1 = enable).

CONFIG: Modulator #3 (Slot # 7) Spare		
Command	**Parameter Value**	**Description**
7:EM	**0**	Enable Modulator. (0 = disable, 1 = enable).
7:TS	**70335000** *(TBC)*	Transmit Synthesizer frequency
7:TD	**192000**	Data rate
7:PTD	**192000**	Bit Rate
7:TR	**192000**	Symbol Rate
7:TP	*(TBD)*	Transmit Power (range: -25 dBm to –5 dBm).

6.2.3.4 Demodulators reconfiguration: DBR 401

These are the steps that should be followed in order to complete this task at the ACC equipment rack:

Step 1: Modify the following commands using a M&C connection to the demodulator. The commands and parameter values to be sent are as follows:

Node	Command	Parameter Value
DKR	LTD	A, 192000, 4093132.5, 1, 1
SID	LTD	A, 64000, 4100535, 1, 1
CAS	LTD	A, 320000, 4100247.5, 1, 1
REC	LTD	A, 64000, 4100760, 1, 1

Parameter explanation:

- Link Table Define (A)
- <date rate> in bps
- <rf freq> in kHz
- <rm> is 1 for QPSK
- <rc> is 1 for rate ½ Sequential.

Step 2: Check that every demodulator locks the carrier that is configured for (the Sync LED should be steady green)

6.2.3.5 Demodulators reconfiguration: IntelliCast 2000

These are the steps that should be followed in order to complete this task at the ACC equipment rack:

Step 1: Modify the following commands using a M&C connection to the demodulator. The commands and parameter values to be sent are as follows:

Node	Command	Parameter Value
LIS	LTD	A, 128000, 4089085, 1, 8
SMA	LTD	A, 128000, 4089287.5, 1, 8
JNB	LTD	A, 192000, 4096555, 1, 8
NKC	LTD	A, 64000, 4077127.5, 1, 8

Parameter explanation:

- Link Table Define (A)
- <date rate> in bps
- <rf freq> in kHz
- <rm> is 1 for QPSK
- <rc> is 8 for rate ½ Sequential.

Step 2: Check that every demodulator locks the carrier that is configured for (the Sync LED should be steady green)

6.2.4 Frame Relay switch reconfiguration

In the new station configuration, all the FR frames have to be sent to the same modem. Therefore, the Memotec CX1000e FR switch has to be reconfigured in order to let all the DLCI associated to this station be sent through the same FR switch port, that is connected to the nominal modem. In the same way, the FR sw port connected to the spare modem should be configured.

These are the steps that should be followed in order to complete this task at the ACC equipment rack:

Step 1: Modify the FR swtch configuration file as indicated in the paragraph above.
Step 2: Send the FR swtch configuration file to the CX1000e using the M&C port.
Step 3: Check that the new configuration has been loaded by the equipment.

6.2.5 Carrier line-up

To establish the Equivalent Isotropic Radiated Power value (E.I.R.P.) of the station, transmitting to the Intelsat satellite with the IOC coordination. The IOC coordinates and controls all carriers activation and transmission.

Step 1: Configure the nominal RF & IF equipment (transceiver and modem) to the nominal Tx frequency according to the Intelsat SSOG. Configure the modem Tx power level 5 dB below the foreseen initial modem output power.
Step 2: With a spectrum analyzer, monitor the assigned Tx frequency in the satellite to make sure that it is free of carriers.
Step 3: Contact the IOC to confirm the authorization to proceed with the line up. With the IOC instructions, transmit a modulated carrier. This carrier will be at the final assigned operation frequency (or frequency indicated by the IOC), and it will be 5 dB below the calculated nominal Tx power level.
Step 4: The IOC will measure all the transmitted carrier parameters, using the communications system monitor (CSM). Following the IOC instructions, adjust the transmitted carrier power level according to the real operation conditions.
Step 5: The transmitted carrier power level should guarantee the necessary power for the down link. The IOC will measure the satellite down link power of the transmitted carrier. If it is possible, it will be checked from our own station and with the spectrum analyzer the received power level of the transmitted carrier (corrected with the Correction Factor). Notify this value to the IOC.
Step 6: Repeat the adjustment with the IOC of the transmitted carrier power level for the redundant modem and transceiver (redundant Tx chain).
Step 7: After the adjustment of the station Tx power level, check that the input level to the transceiver is not exceeding the limits for linear operation, and that the modem Tx power level stays in the center of the dynamic margin. It could be necessary to recalculate the installed attenuator value. In this case, carry out the necessary adjustments and take note of the new values. Repeat for the redundant tx chain.
Step 8: Register the value of the final Tx power level for future reference. Also, register the received power level.

6.2.6 M&C database and redundant functionalities modification

6.2.6.1 Actions for a quick adaptation to the new scenario

There are two options:

- Disable the whole M&C system redundant capabilities
- Make the modifications that are described below to achieve hot 1:1 redundancy, although having continuous transceiver operations.

6.2.6.1.1 Tx modems

No changes in the M&C system are needed to get a 1:1 Tx modem redundant system.
In order to achieve this situation, the following steps should be carried out:

Step 1: Configure all the modems with the same parameters.
Step 2: Re-cable the modems and coax switch connections as showed in the figure below:

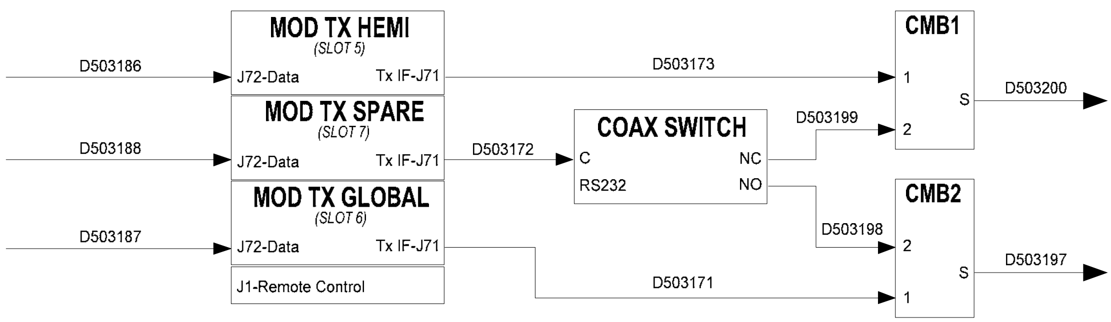


Figure 6-4: ACC modems previous cabling configuration.

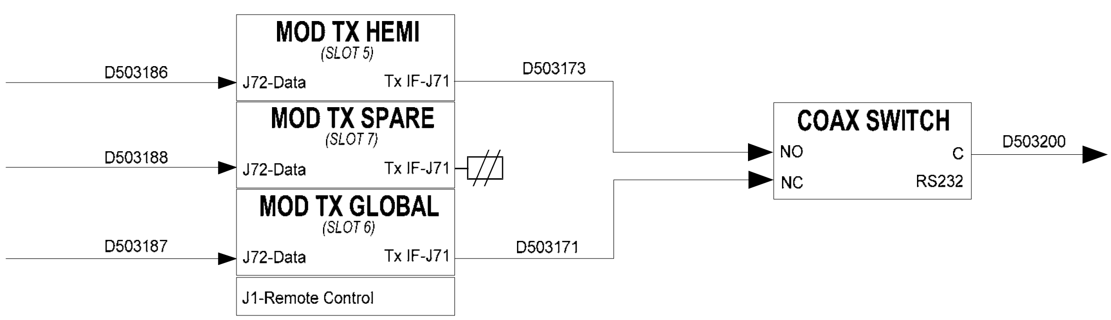


Figure 6-5: ACC modems new cabling configuration.

6.2.6.1.2 *Transceivers*

For the RF Tx system, it is possible to have a 1:1 redundant system by making some cabling changes at the transceivers' box. The following figures show this change:

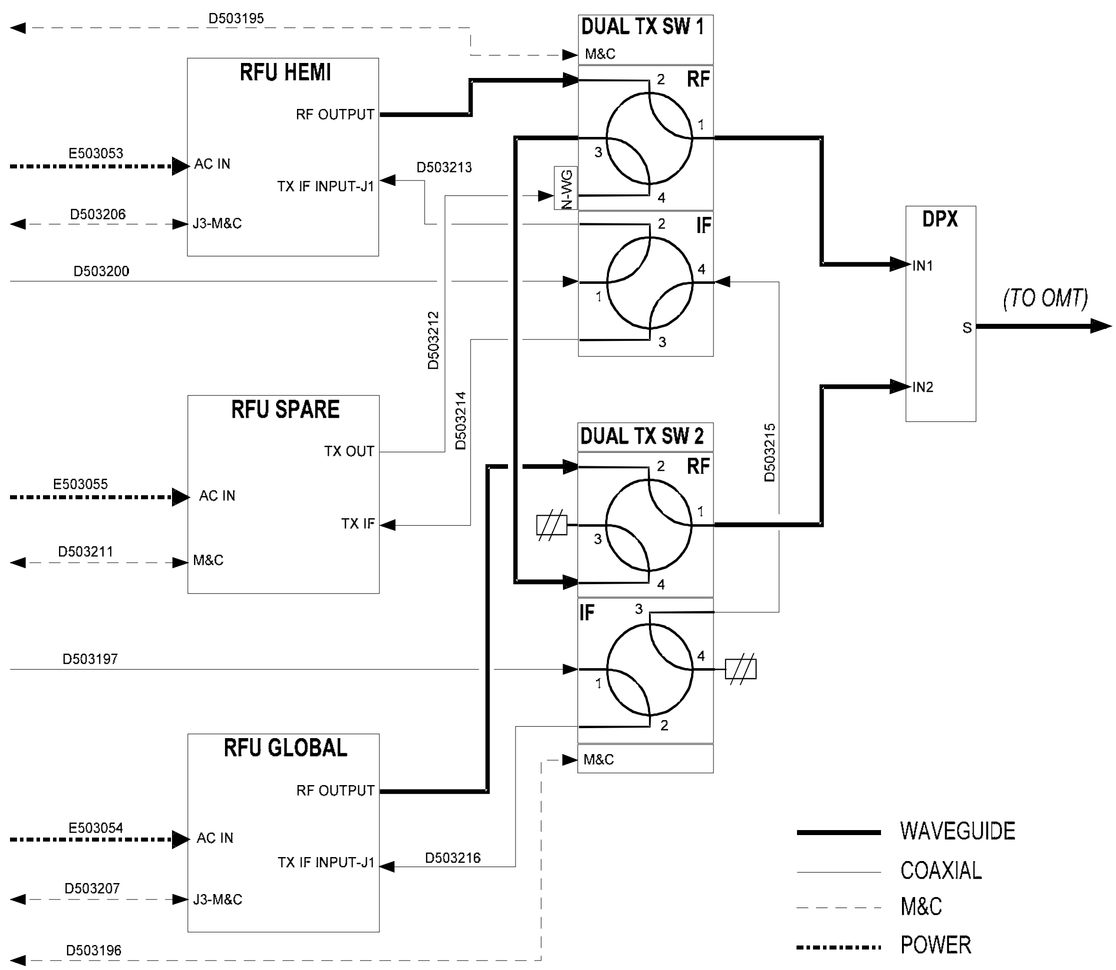
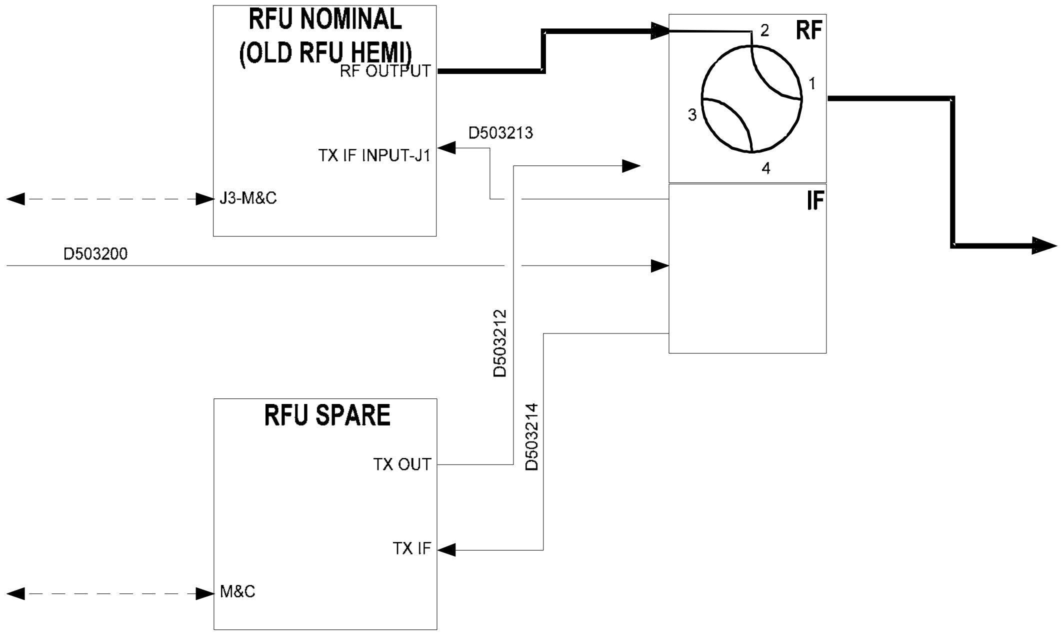


Figure 6-6: ACC Transceivers previous configuration.


RFU NOMINAL
(OLD RFU HEMI)
RF OUTPUT
TX IF INPUT-J1
J3-M&C
D503213
D503200
D503212
D503214
RF
IF
2
1
3
4
RFU SPARE
TX OUT
TX IF
M&C

CAFSAT Migration Plan Working Group Meeting

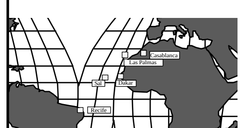
Madrid, Spain
July, 2nd & 3rd 2008

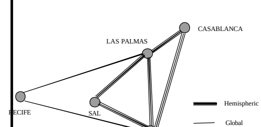
Agenda Item 1:
Satellite Migration Study

Agenda:

- 9:30 - 10:00 Reception & Coffee
- 10:00 – 11:00:
  - Item 1: Satellites Study
  - Item 2: Migration Tasks
- 11:00 – 11:30 Coffee Break
- 11:30 – 12:30:
  - Item 3: Migration Plan
  - Item 4: Future Work Programme
- 12:30 – 13:30 Any Other Business
- 14:00 – 15:00 Lunch
- 15:00 – 16:00 Minutes of Meeting Approval

Background: Network Origin





- Initial INSA's design for CAFSAT Network took place under AENA contract and the first node was deployed on 2000 at Canary Islands (GCCC)
- Initial network design took into account five stations: LPA, SID, DKR, REC and CAS.
- Space segment: IS-801
- Only 1/5 stations was out of IS-801 hemispheric coverage
- Hemispheric vs Global coverage →
  - ✓ Lower MHz recurrent cost
  - ✓ Lower HPA power @ E/S
  - ✗ Network expansion limited by coverage
  - The better solution at this situation was taking advantage of the lower MHz recurrent cost of hemi carriers although making LPA & DKR stations more complex.

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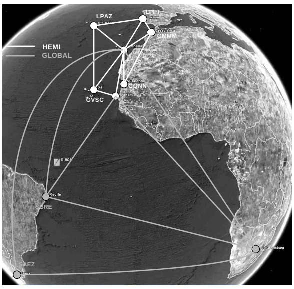
Background: Nowadays



- 10 Stations:
  - 3 operating @ global beam
  - 5 operating @ hemi beam
  - 2 operating @ both beams
- IS-801 (launched 1997) end of life is expected by September 2008 (entering in elliptic orbit)
- Main requirements for new satellite:
  - C-Band
  - Coverage over Europe, Africa and Central and South America (special attention to the Northeast region of Brazil and the archipelagos of Canaries, Cape Verde, Azores and Madeira)
  - Preferably in hemi beams, but at least in global beam with reasonable EIRP and G/T
  - Keep a reasonable price, equaling or improving the present amounts paid to INTELSAT, and offering same price to carriers in Hemi beam and global beam.

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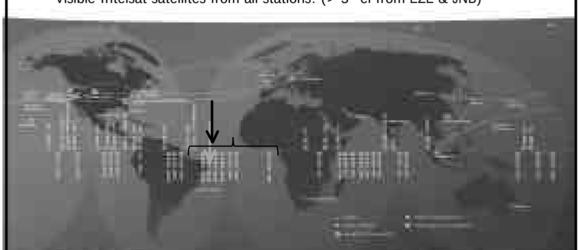
INTELSAT Current Fleet (I)

- Visible Intelsat satellites from all stations: (> 5º el from EZE & JNB)



- Additional requirement: visibility to proposed satellite/s must be confirmed a.s.a.p. to avoid re-allocations of antennas caused by unexpected obstacles and/or interfering radio systems

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INTELSAT Current Fleet (II)

- Revision of current visible spacecrafts from all stations:
  - IS-1R, IS-11, IS-3R: Linear polarization and low elevation (<10º from JNB)
  - IS-903: SMA out of Hemi Beam [16º el @ JNB, 42º el @ EZE]
  - IS-801 [19º el @ JNB, 40º el @ EZE]
  - IS-907: SMA & SAL out of Hemi Beam [22.5º el @ JNB, 38º el @ EZE]
  - IS-905: SMA & SAL out of Hemi Beam [25º el @ JNB, 36º el @ EZE]
  - IS-603: Extended Orbital Maneuver Lifetime
  - IS-901: SMA & SAL out of Hemi Beam [31º el @ JNB, 31º el @ EZE]
  - IS-10-02: SMA & SAL out of Hemi Beam [45.5º el @ JNB, 18º el @ EZE] ¿EZE visibility?
- Same multi-beam solution will lead to:
  - 5 operating @ global beam (REC, EZE, JNB, SMA, SAL)
  - 2 operating @ hemi beam (CAS, NUK)
  - 3 operating @ both beams (LPA, DKR, +LIS)
- Capacity on the EH/EH beam on satellites 901, 903, 905, 907 and 1002 is not currently available
- Intelsat compromise to keep current carriers fares for each station up to contract renovation dates

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Today's Solution: Global coverage

- Present Satellite BW scenario: Similar situation @ other satellite operators for C-Band over Africa
- After revision of current Intelsat visible fleet INSA agrees with Intelsat the best solution is to migrate all stations to a global beam:
  - ✓ Simplification of current stations: no need of future upgrades for new links on different beams. Although LPA & DKR station would require equipment refurbishment but
  - ✓ Simplification of future stations
  - ✓ More network expansion capability:
    - Links not restricted by hemi coverage nor to new nodes neither to new circuits between present nodes
    - Greater coverage
  - × Worse transponder conditions → Higher stations power required
  - × Worse operational (recurrent) costs from scratch → Higher carrier price
  - ✓ Intelsat compromise to keep current carriers fares

New Satellite Proposal

- Taking into account coverage and elevation, recommended satellite is IS-901
- The more centered one for current stations *(CAFSAT center @ 15ºW)*, giving better coverage for network expansion

	IS-801	IS-901
Launch Date	February 28, 1997	June 11, 2001
Degrees East	328.5 – 31.5º W	342ºE – 18ºW
Design Lifetime	10 years	13 years
C-band EIRP	Global 29.0 up to 33.4 dBw Hemi 34.5 up to 40.4 dBw	Global 31.0 up to 35.7 dBw Hemi 36.0 up to 41 dBw
C-band G/T	Global -12.0 up to -7.8 dB/K Hemi -8.0 up to -1.3 dB/K	Global -11.2 up to -6.3 dB/K Hemi -8.0 up to -1.6 dB/K
C-band SFD	-67.0 to -89.0 dBw/m2	67.0 to -89.0 dBw/m2

- Although global beams have similar parameters, proposed transponder is 36/36 with a lower SFD value. Other transponders with better SFD have not BW available
- IS-801 37/37 transponder is near maximum gain right now and JNB is near saturation
- Data rates growths always lead to power upgrades.

Intelsat's First Proposal

- Initial Links budget data provided by Intelsat for the new satellite IS 901:
  - LPA and DKR stations maintain two carriers each
  - The Rx station used does not represent the worst case in all the samples

	Relocate to IS-901/342E						
TX E/S	Transp	Uplink freq.	Downlink freq.	Info Rate	U/L eirp	D/L eirp	(C0+N0)/N0
CAF-01F1	36/36	6318,3350	4093,3350	128	51,9	5,6	8,4
CAF-01F1	36/36	6325,6475	4100,6475	64	51,6	5,4	8,7
RCF-01F1	36/36	6325,7600	4100,7600	64	51,0	5,3	8,7
JHN-05F1	36/36	6321,5550	4096,5550	192	56,5	8,0	8,4
DKR-04F1	36/36	6318,1325	4093,1325	128	53,6	6,3	8,4
DKR-04F1	36/36	6321,7575	4096,7575	64	50,9	5,4	8,7
NVL-02F1	36/36	6314,0850	4089,0850	128	53,3	6,3	8,4
SMI-03F1	36/36	6314,2875	4089,2875	128	53,0	6,3	8,4
BUE-01F1	36/36	6321,3525	4096,3525	64	53,4	5,3	8,7
RAB-04F1	36/36	6325,2475	4100,2475	320	57,0	10,4	8,5
NOU-06F1	36/36	6302,1275	4077,1275	64	49,3	3,7	8,7
EPG-01F1	36/36	6325,5350	4100,5350	64	49,2	3,6	8,5

INSA's Link Budgets Analysis

- Links budget data recalculated for the new satellite IS 901 taking into acount:
  - LPA and DKR stations have a 192 kbps single carrier
  - The Rx station used represents the worst case in all the samples

	Relocate to IS-901/342E				
TX E/S	Transp	Uplink freq.	Downlink freq.	Info Rate	U/L eirp
CAF-01F1	36/36	6318,3350	4093,3350	192	56,2
RCF-01F1	36/36	6325,7600	4100,7600	64	49,0
JHN-05F1	36/36	6321,5550	4096,5550	192	58,7
DKR-04F1	36/36	6318,1325	4093,1325	192	55,8
NVL-02F1	36/36	6314,0850	4089,0850	128	53,4
SMI-03F1	36/36	6314,2875	4089,2875	128	53,3
BUE-01F1	36/36	6321,3525	4096,3525	64	53,6
RAB-04F1	36/36	6325,2475	4100,2475	320	57,2
NOU-06F1	36/36	6302,1275	4077,1275	64	49,2
EPG-01F1	36/36	6325,5350	4100,5350	64	49,2

- LPA (and DKR) U/L eirp to be confirmed by Intelsat
- CAS data rate exceeds current needs

Revised INSA & Intelsat Link Budgets Analysis

- In order to accommodate all CAFSAT services with U/L eirp of 55 dBW or less, the SFD of IS-901 transponder 36/36 will be changed in 3 dB from -79.6 dBW/m^2 to -82.6 dBW/m^2 :

	Relocate to IS-901/342E				
TX E/S	Transp	Uplink freq.	Downlink freq.	Info Rate	U/L eirp
CAF-01F1	36/36	6318,3350	4093,3350	192	53,3
RCF-01F1	36/36	6325,7600	4100,7600	64	48,0
JHN-05F1	36/36	6321,5550	4096,5550	192	53,5
DKR-04F1	36/36	6318,1325	4093,1325	192	52,6
NVL-02F1	36/36	6314,0850	4089,0850	128	50,3
SMI-03F1	36/36	6314,2875	4089,2875	128	50,0
BUE-01F1	36/36	6321,3525	4096,3525	64	50,4
RAB-04F1	36/36	6325,2475	4100,2475	320	54,0
NOU-06F1	36/36	6302,1275	4077,1275	64	46,3
EPG-01F1	36/36	6325,5350	4100,5350	64	46,2

- LPA and DKR stations 192 kbps single carrier center frequencies assignment to be provided/confirmed by Intelsat, instead of the previous separated 128+64 kbps frequencies

Satellite & Radiofrequency Conclusions

- Intelsat 901 satellite. Transponder 36/36. Global coverage
- The use of Global beam for all CAFSAT station simplifies the earth station architecture.
- No need of further upgrades independently of future links
- New stations in CAFSAT network will reduce initial investment cost
- Easier stations upgrade to L-band intermediate frequency tx & rx
- Good chance to change used scrambler to avoid future modems incompatibilities

Agenda Item 2: Migration Tasks

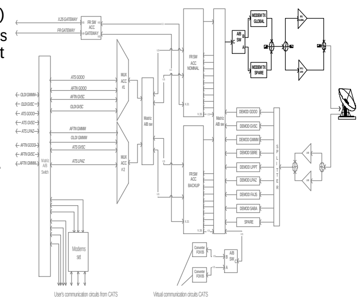
LPA Station Analysis & Impact (I)

Las Palmas (AENA) (ACC)

- Global coverage allows a RF and IF redundant system simplification.
- Rx chain is not affected by the satellite migration.
- Simpler M&C redundant algorithms.

[Future/Optional]

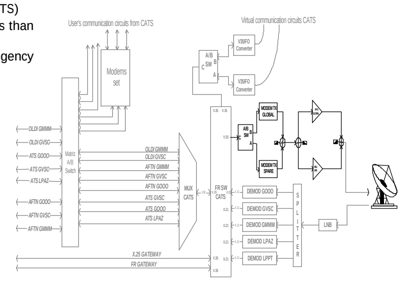
- New circuits could lead to increase the transceivers Tx power



LPA Station Analysis & Impact (II)

Las Palmas (AENA) (CATS)

- Same considerations than ACC.
- Redesign the contingency strategy.



LPA Station Migration Tasks

- Antenna repointing.
- Diplexer removing.
- Transceivers & modems reconfigurations for new transponders/frequencies.
- M&C database and redundant functionalities update.
- *Recommended:* RF transmission 2:1 redundant system replacing for a 1:1 or 1:2 redundant one.
- *Recommended:* IF transmission 2:1 redundant system replacing for a 1:1 redundant one.

Station DKR Migration Tasks

- Antenna repointing.
- Diplexer removing.
- IF transmission 2:1 redundant system replacing for a 1:1 redundant one.
- BUC & modems reconfigurations for new transponders/frequencies.
- M&C database and redundant functionalities update.
- *Optional:* new BUC and Up-converter installation (already purchased by ASECNA).

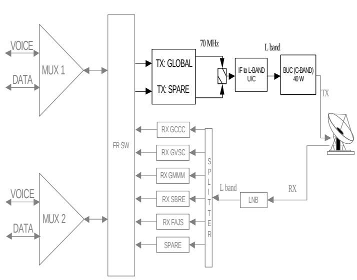
Station DKR Analysis & Impact

Dakar (ASECNA)

- Global coverage allows a RF and IF redundant system simplification.
- Rx chain is not affected by the satellite migration.
- Simpler M&C redundant algorithms.

[Future/Optional]

- Take advantage of migration to change TX chain? - TBC



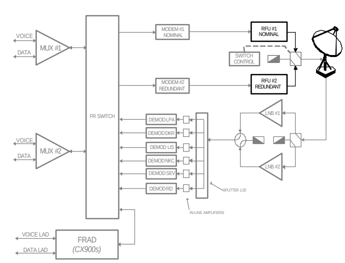
Station CMN Analysis & Impact

Casablanca (ONDA)

- Rx chain is not affected by the satellite migration.
- No need for higher power @ Tx chain according to last SFD reported by Intelsat

[Future/Optional]

- Revision of required data rate (320 kbps vs 192 kbps)
- Circuits growing will require transceivers replacement (redundant 1:1)



Station CMN Migration Tasks

- Antenna repointing.
- Transceivers & modems reconfigurations for new transponders/frequencies.
- *Optional:* M&C database update.

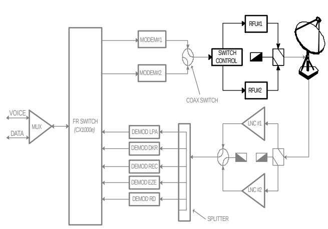
Station JNB Migration Tasks

- Antenna repointing.
- Transceivers & modems reconfigurations for new transponders/frequencies.
- *Optional:* M&C database update.

Station JNB Analysis & Impact

Johannesburg (ATNS)

- Rx chain is not affected by the satellite migration.
- No need for higher power @ Tx chain according to last SFD reported by Intelsat



Other CAFSAT stations Analysis & Impact

Lisbon and Santa Maria (NAV), Sal (ANA), Nouakchott (ASECNA), Recife (DECEA) and Buenos Aires (FAA):

- Satellite migration does not affect to present RF, IF or BB equipment.

Other CAFSAT stations Migration Tasks:

- Antenna repointing.
- Transceivers & modems reconfigurations for new transponders/frequencies.

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Stations Conclusions (I)

- LPA:
  - Increase to 192 kbps single carrier
  - No Tx power lever increment needed but few margin to increase the total data rate
- JNB:
  - Adjust the carrier BW to the total data rate actually used
  - No Tx power lever increment needed but few margin to increase the total data rate
- DKR:
  - Increase to 192 kbps single carrier
  - No Tx power lever increment needed (new 40W BUC to be installed at this earth station)
- CAS:
  - Adjust the carrier BW to the total data rate actually used
  - No Tx power lever increment needed but few margin to increase the total data rate
- *Recommendation:* Detail study of current stations circuits data rate.

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Stations Previous Tasks

- All sites should confirm the new satellite clearance :

	IS 901		
TX E/S	Elevación	Azimut	True Bearing
CAF-01F1	57,3	185,6	191,4
RCF-01F1	68,0	65,1	87,4
JHN-05F1	30,9	292,9	311,0
DKR-04F1	72,7	182,0	190,5
NVL-02F1	44,2	194,0	197,7
SMI-03F1	46,5	168,2	177,7
BUE-01F1	31,2	56,3	63,5
RAB-04F1	49,6	198,5	201,5
NOU-06F1	68,6	186,6	193,8
EPG-01F1	69,5	163,3	173,7

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Impact Summary

- Satellite: IS-901
- Global beam transponder 36/36

- None station needs tx power increase
- LPA & DKR stations “simplification” upgrades:
  - 1:1 redundancy
  - Good chance for L-band intermediate frequency tx & rx

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Agenda Item 3: Migration Plan

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Migration Plan (I)

- One-step migration plan:
  - All the station change to the new satellite at the same time
  - Too much human resources to carry out this plan
- Two-step migration plan:
  - Premise: ATS circuits have priority over the other types.
  - 1st step: migration of Global stations than share ATS circuits
  - 2nd step: rest of the stations at the same time
  - Too much human resources to carry out this plan

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Required Resources

- Tools to be used for migration tasks:
  - Spectrum analyzer for L-band frequency
  - Compass
  - Clinometer
  - L-band splitter allowing LNB feeding
  - Common tools
- Personnel to carry out migration tasks:
  - RF technician for antenna re-pointing
  - Earth station operator with CAFSAT system management knowlegde

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Migration Plan (II)

  - Intermediate optional step: migrate LPA global circuits using CATS earth station
- Alternative migration plan:
  - CAFSAT members should recommend priority circuits to be migrate.
  - Consider the availability of terrestrial back up circuits in all the stations to optimize the migration plan

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Agenda Item 4:
Future Work Programme

Appointment of a “Coordination Team” of 3 members is suggested cuadernillo

Agenda Item 5:
Any Other Business

- INSA adds some thoughts about CAFSAT Network future

LIST OF COORDINATION TEAM

Administration:	ICAO/Nairobi	
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Earth Station:	Las Palmas/ Las Palmas Contingency	
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Administration:	ASECNA	
Earth Station:	Senegal	
Contact person	**Management level**	**Technical level**
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FORM FOR COORDINATION TEAM

Administration:		
Earth Station:		
Contact person	**Management level**	**Technical level**
Full name		
Telephone		
Fax:		
Email:		