Link budget

- Problem evaluation
  - Input parameters
  - Link tools evaluation
  - Eb/No
  - C/N
  - Availability
  - Performance margins
- Link design

Link evaluation

The design of a satellite communications link involve compromisses among several factor with purpose to achieve maximum performance, e.g

- Specified BER In normal conditions of working (digital link) or C/N
- Link availability or % time the BER is better than previously specified as threshold (ex.10^{-3} ou 10^{-4}) or a minimum S / N (analog link)

But at what costs?

Link evaluation

The dominant commitments are:

- Antenna diameter
- Transmission power
- Uplink and downlink frequencies
- Transmission rate, FEC rate, modulation scheme
- Used and consummed bandwith (space segment costs)

Input parameters 1 (transmission theory)

$$F = \frac{P_t}{4 \Pi R^2} \text{ W/m}^2$$ Or with a directivity (G) $$F = \frac{P_t G_t}{4 \Pi R^2} \text{ W/m}^2$$

To a parabolic antenna with $A_e = \eta A_r \rightarrow P_r = F A_e$

$$P_r = \frac{P_t G_t A_e}{4 \Pi R^2} \text{ W/m}^2$$ And from theory of antenna $$G_r = \frac{4 \Pi A_e}{\lambda^2}$$ so

$$P_r = P_t G_t G_r \left[\frac{\lambda}{4 \Pi R} \right]^2 \text{ W}$$ In other way $$P_r = \frac{EIRP \times G_r}{\text{Total Loss*}}$$

into dB

$$P_r\Big|_{dB} = (EIRP + \underbrace{G_r - L_p - L_a - L_{ta} - L_{ra}}_{\text{* >> includ path loss}}) \text{ dBW}$$

Noise temperature 1

- At microwave frequencis all objects with physical temperature T_p greater than 0ºK generate electrical noise which being received by na antenna overcomes - as noise – the signal that shoul receive .
- Being N_0 the spectral noise density and T_A (to the antenna) the temperature (in ºK) the value of that is $N_0 = KT_A$ W/Hz
- The T_A is function of the antenna physical temperature, of the thermal absortion of external sources as well as its gain and its orientation towards those radiant sources

…/…

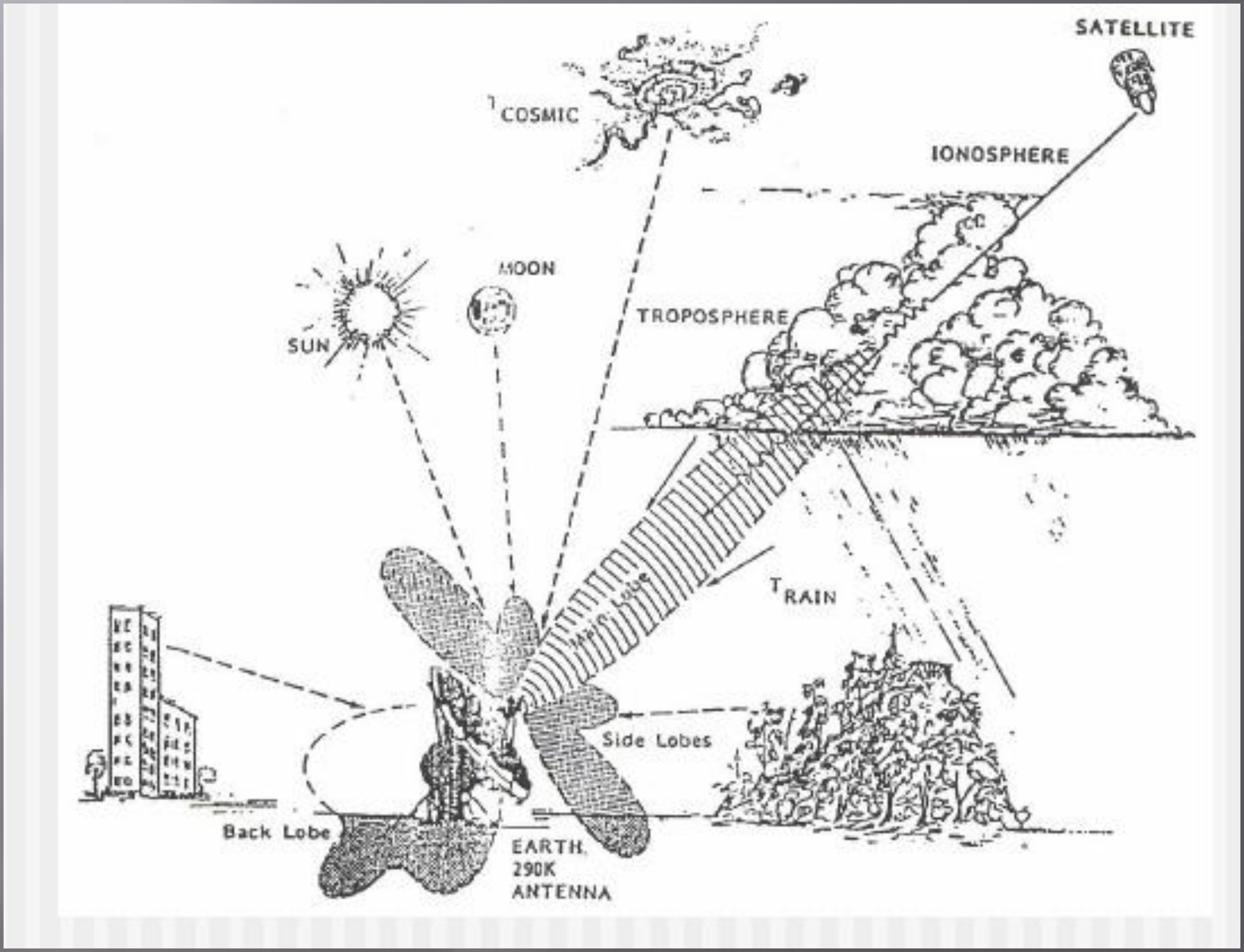
Noise temperature 2

- The antenna once pointed to the satellite is affected by the star noise and terrestrial radiation, in this case function of the antenna elevation and the size of the main and sidelobes.
- There are also other phenomena function of *path lenght* such as - rain absorption and diffusion, refraction or electromagnetic wave depolarization - in the atmospher and ionospher, which contribute for the noise power increase at the antenna either through the signal atenuation or T_A increase

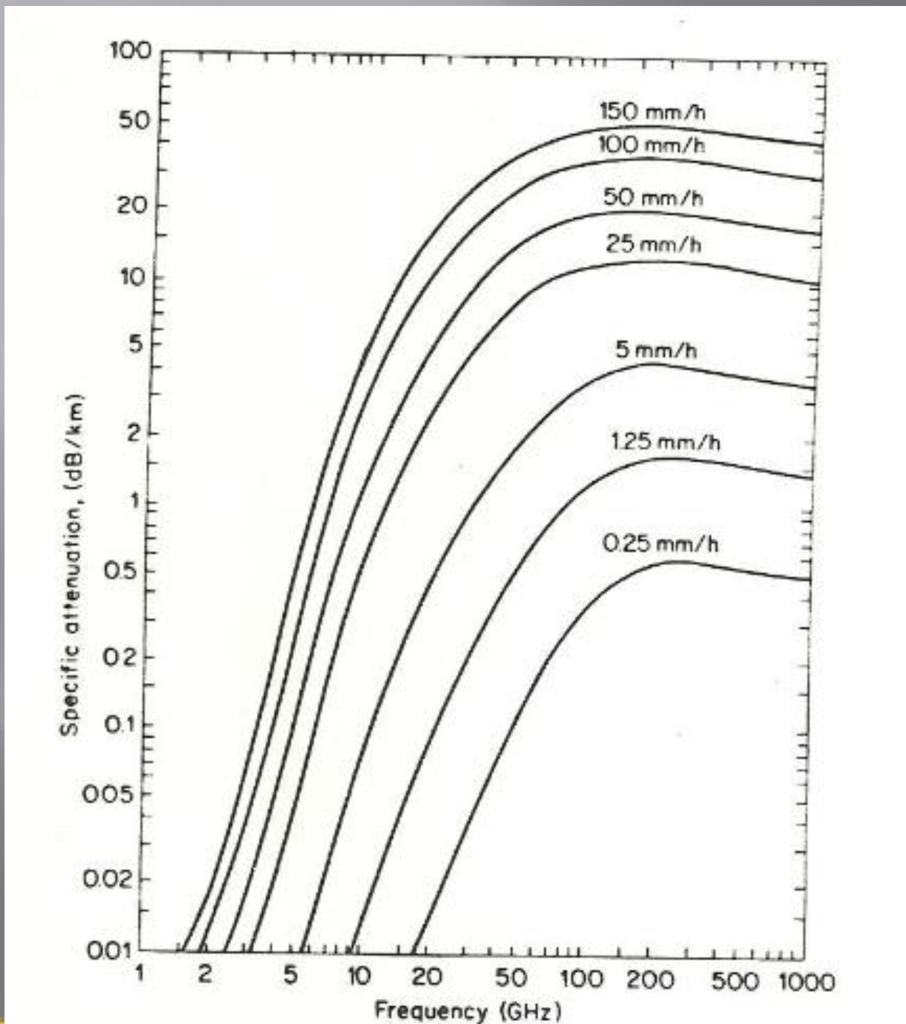
Noise temperature 3

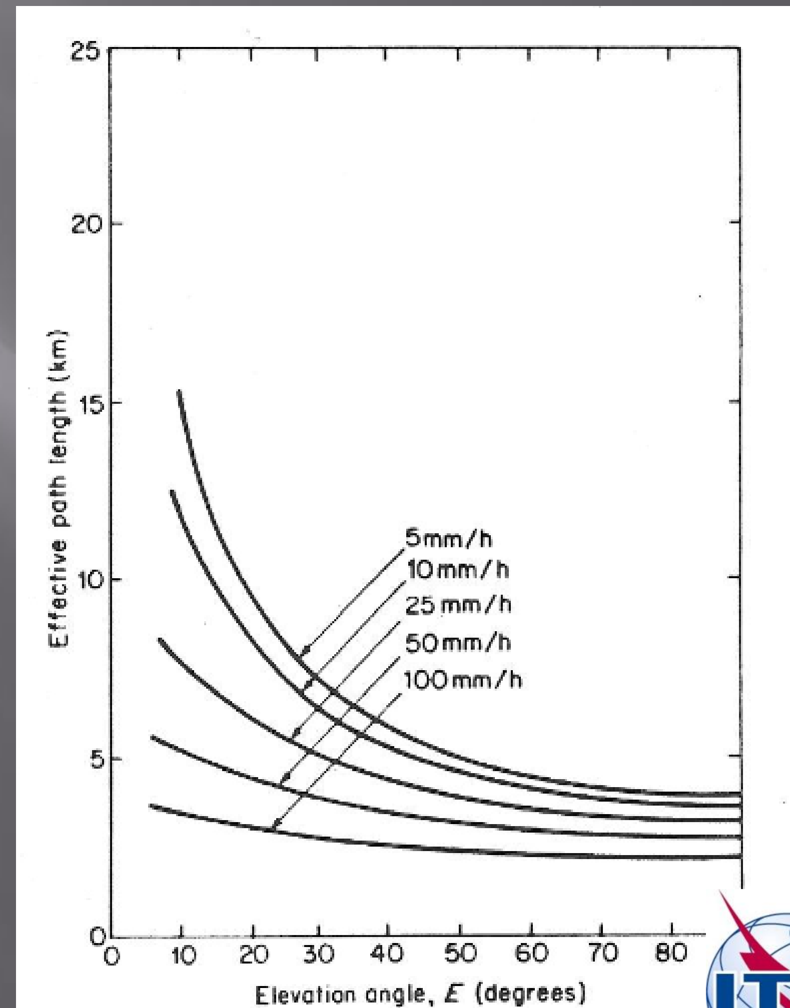
- But also the receiver contribut es significantly to global noise, once at the same time amplifies the original signals, amplifies also the environmental noise and the interference from other equipments.
- More common than noise temperature it is used the **noise figure**, related sith noise temperature by the expression $N_F = 1 + T_R / T_0$, with values from 0,2 dB up to 5 dB depending on the earth station process of cooling the low noise amplifiers.
- To evaluate the receiver noise temperature , rehearse the substituion of LNA , mixer and IF amplifier by noiseless equipments (ideal) and calculate T_s as follow

Noise sources

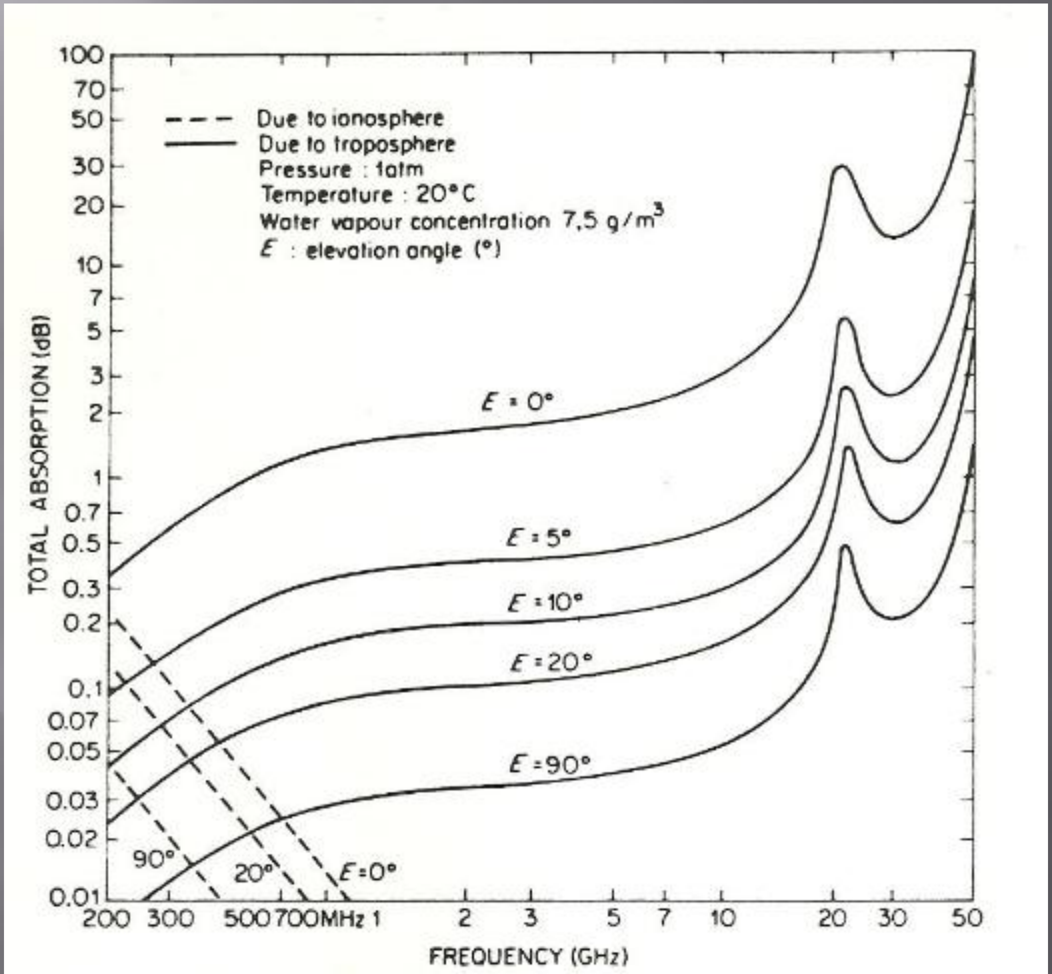


Noise temperature 1B rain attenuation

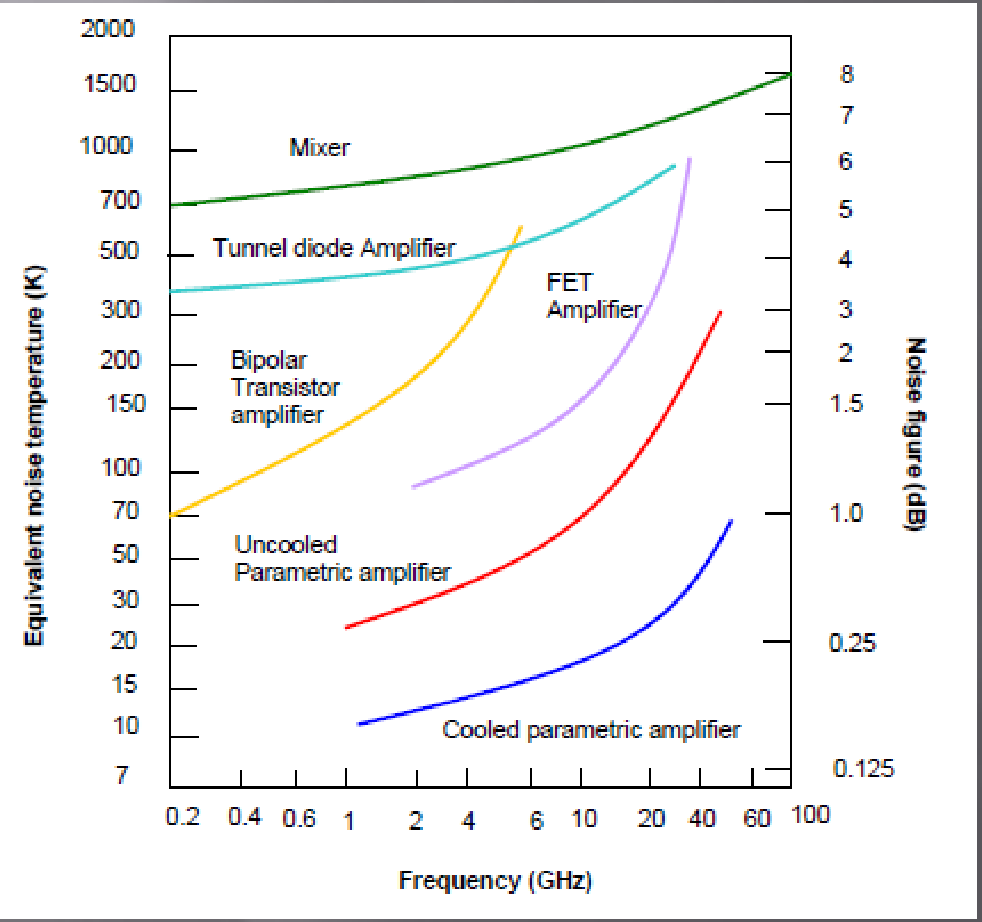




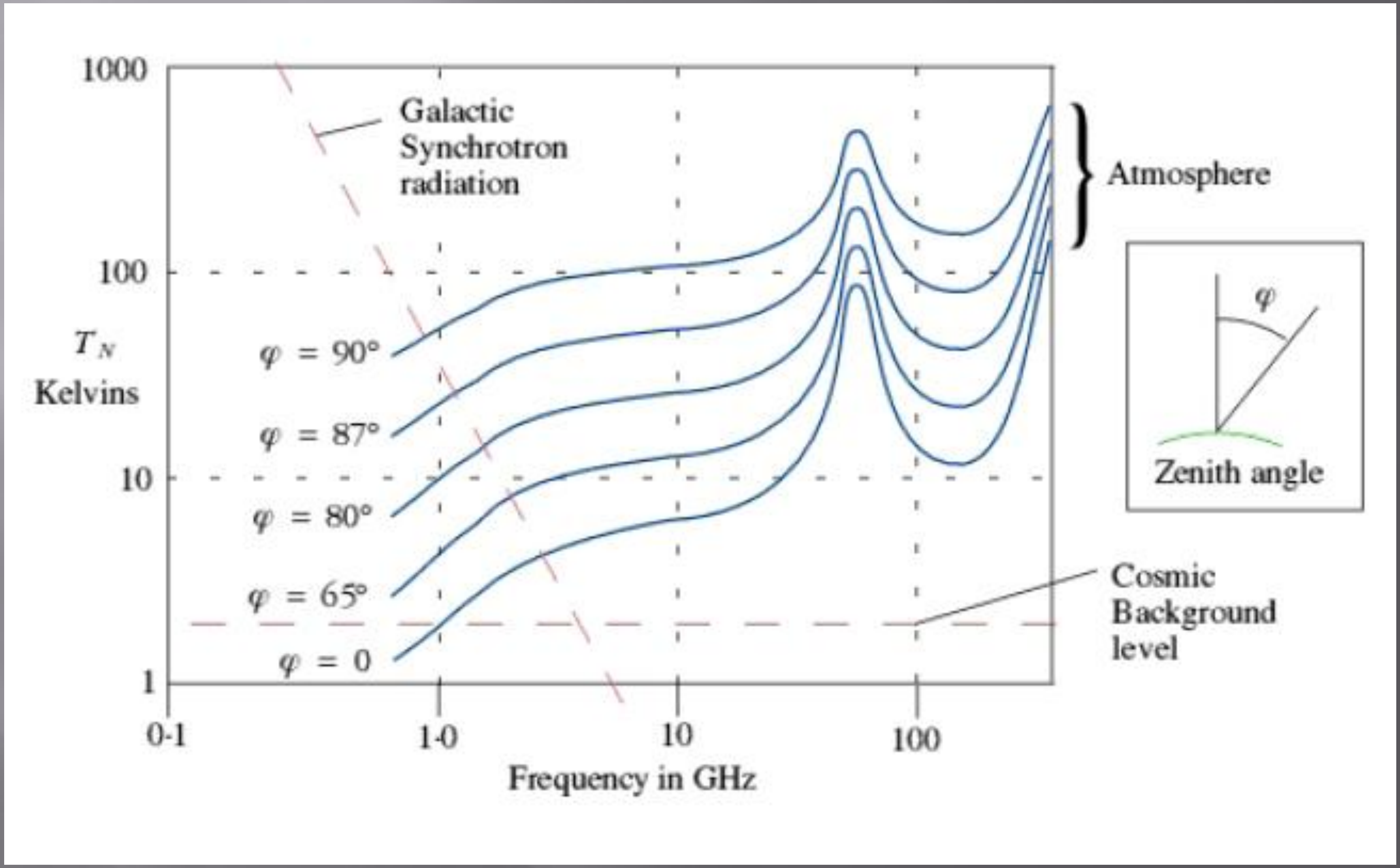
Atmosphere attenuation



Noise temperature 1 C



Noise temperature 1 A

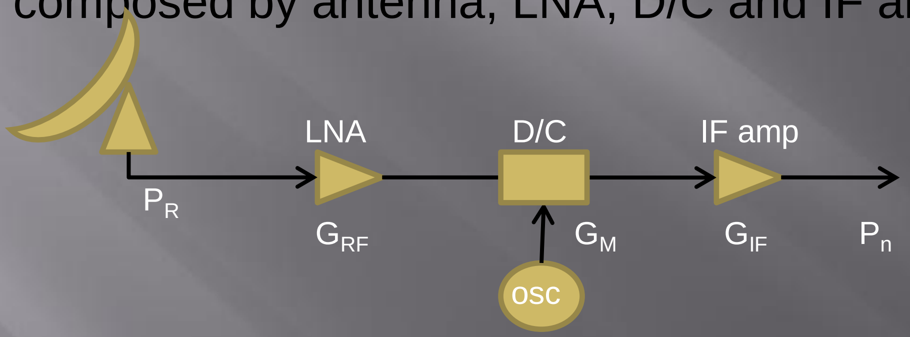


Noise temperature 4

$P_n = KT_nB$

K = Boltzman Constant = 1,38 x10^{-23} J/K
-228, 6 dBW/K/Hz
T_n = noise source temperature ºK
B = bandwith

In a system composed by antenna, LNA, D/C and IF amplifier, P_n



$$P_n = G_{IF}KT_{IF}B + G_{IF}G_MKT_MB + G_{IF}G_MG_{RF}KB\,(T_{RF}+T_{IN})$$

$$T_s = \left[T_{RF}+T_{IN} + \frac{T_M}{G_{RF}} + \frac{T_{IF}}{G_MG_{RF}}\right]$$

Input parameters 2 (G/T)

To calculate the link performance we need C / N, so

$$C / N = \frac{P_t G_t G_r}{K T_s B} \left[\frac{\lambda}{4 \Pi R} \right]^2$$

And in other way

$$C / N = \frac{P_t G_t}{K B} \left[\frac{\lambda}{4 \Pi R} \right]^2 \frac{G_r}{T_s}$$

So the ralation C / N depends on G_r / T_s (known as figure of merit) what is used to determine the performance of a receiving antenna system once G / T improves the global C / N

Input parameters 3 (G/T)

Rewiriting respectively for the up and downlink, and total link

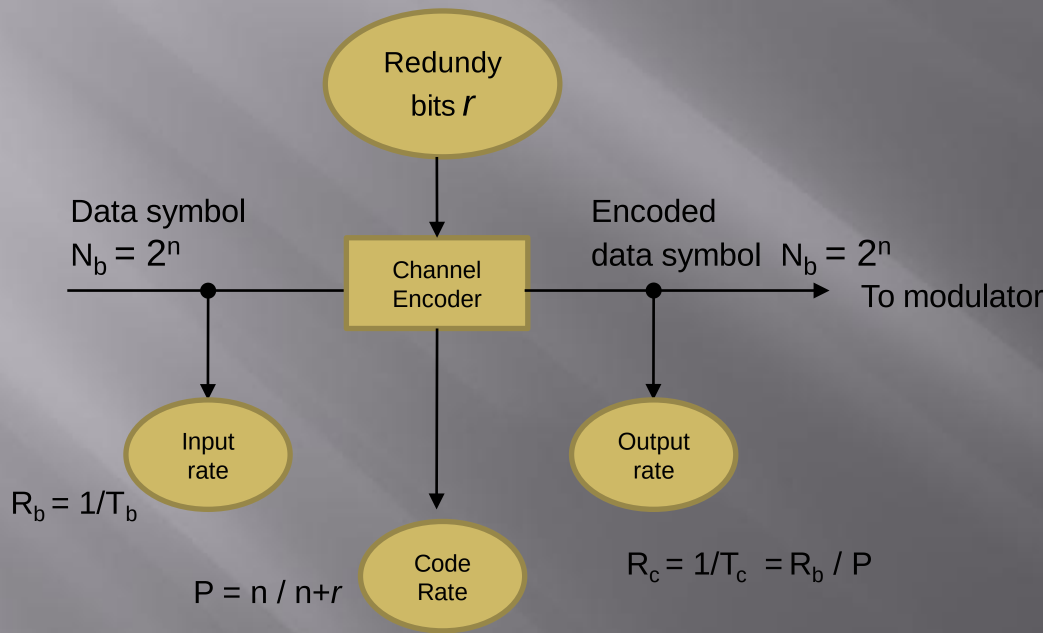
$$C / N\Big|_{UPdB} = EIRP_{TX} - L_{UP} + (G / T)_{SAT} - K - BW$$

$$C / N\Big|_{DNdB} = EIRP_{SAT} - L_{DN} + (G / T)_{RX} - K - BW$$

$$(C / N)^{-1}\Big|_{TdB} = (C / N)^{-1}\Big|_{UPdB} + (C / N)^{-1}\Big|_{DNdB} + (C / I)^{-1}\Big|_{IMdB} + (C / I)^{-1}\Big|_{ADJdB} + (C / I)^{-1}\Big|_{XPdB}$$

Input parameters 4

And for a digital link



If we agree E_b, the energy per bit information, the energy Of the carrier will be:

$E_b \, R_b = C$

and

$E_b / N = (C/N)_T \times (1 / R_b)$

Or to noise spectral density N_0 e como $N = B_{IF} N_0$

$$E_b / N_0 \big|_{dB} = (C/N)_T + B_{IF} - R_b$$

Link analysis tool

- Specific from Intelsat (LST program)
- Specifics from Hispasat
- Specific from others OIS
- Link budget

Link availability

Defined as the **% time , a link is per year operacional,** being responsability of the commercial Manager inform the client what kind of contract Has been purchased or awarded.

5 - 9's   = 99,999 % = inoperative 5 minutes / year

4 - 9's   = 99,99 %   = inoperative 53 minutes / year

3 - 9's = 99,9 %   = inoperative 8,75 hours / year

99,8 %   = inoperative 17,5 horas / year

Performance margins 1

The most important factors that influence the up and downlink are:

1. Atmosphere propagation (rain etc) directly through C/N.
2. Up and downlink frequencies, being that for the frequencies above 8 GHz, the attenuation increases quickly
3. The recpetion carrier level depending on the satellite and the recieve antenna gain
4. Patten radiation and footprint of satellite antenna, namely its edge margin, the pattern advantage, the EIRP, G/T e power flux density

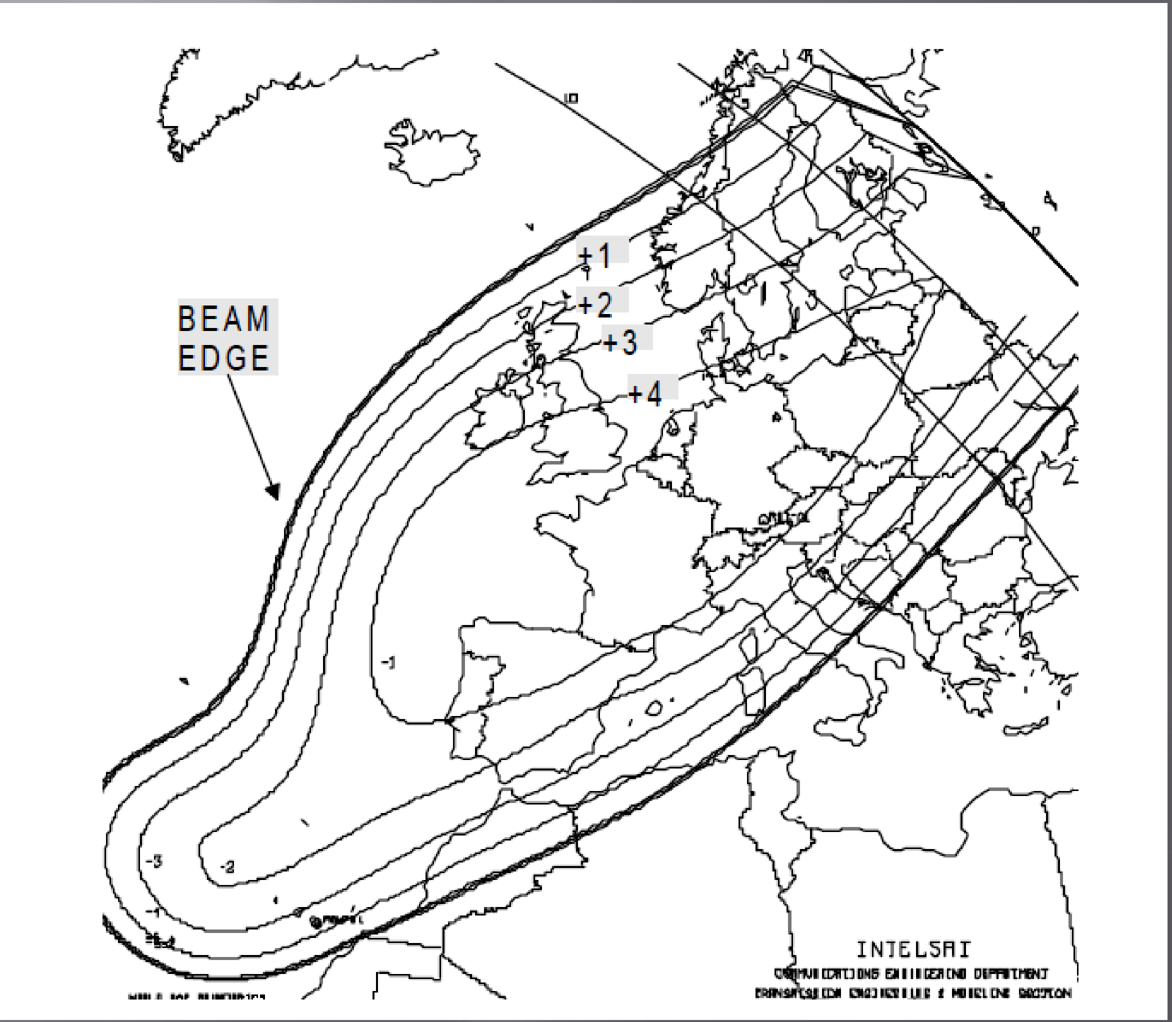
…/…

Performance margins 2

…/…

5. The noise generated in the receive system, depending on the system temperature (noise receiver, waveguide loss and components) eand bandwith used. Particular atention to the sun noise during the equinox of the year, Spring and Autumn.
6. Modulation used and receiver threshold
7. Intersystem interference wahtever would be terrestrial links or other earth stations

Pattern radiation (pattern advantage)



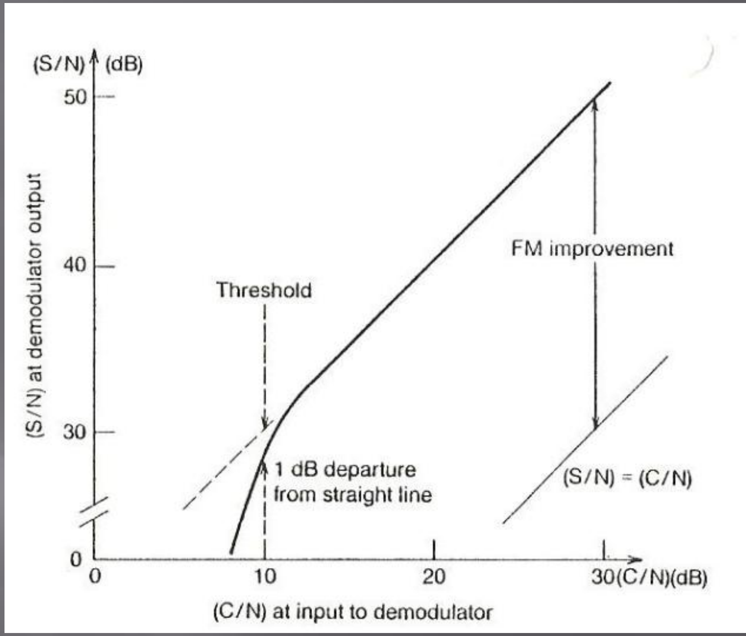
Link Parameters's impact on service quality

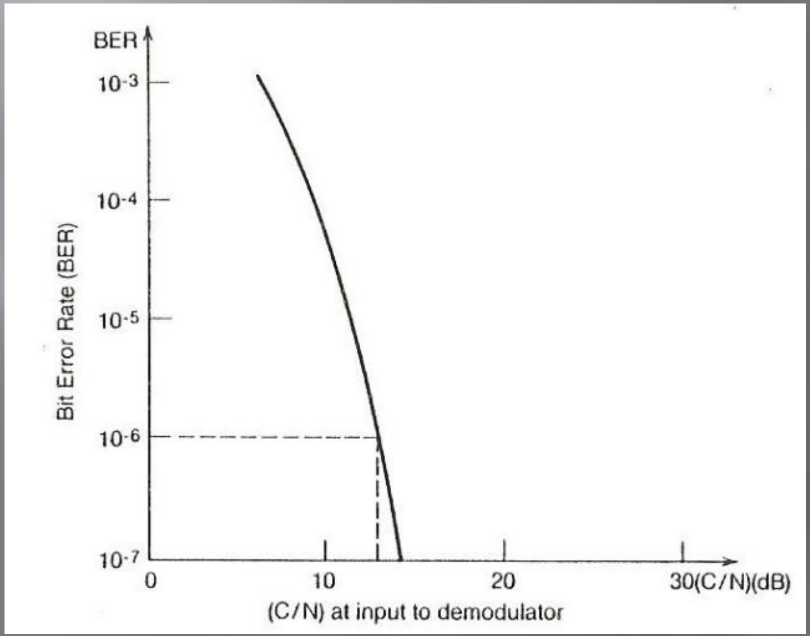
EIRP	$EIRP_{UP}$	+
Uplink pattern advantage	β_{UP}	
Transponder gain step		
Downlink pattern advantage	β_{DN}	
Receive antenna gain	G_{TX}	
Free space loss	L_{UP}, L_{DN}	-
Waveguide losses	L_{WG}	
Atmospheric losses		
Rain attenuation		
Tracking errors		
E/S intermodulation	C/T_{HPAIM}	+
Uplink thermal noise	C/T_{UP}	
Downlink thermal noise	C/T_{DN}	
Transponder intermodulation	C/T_{IMSAT}	
Co-channel interference	C/T_{CCI}	

C / N $\longrightarrow$ **BER**

C / N Specification 1

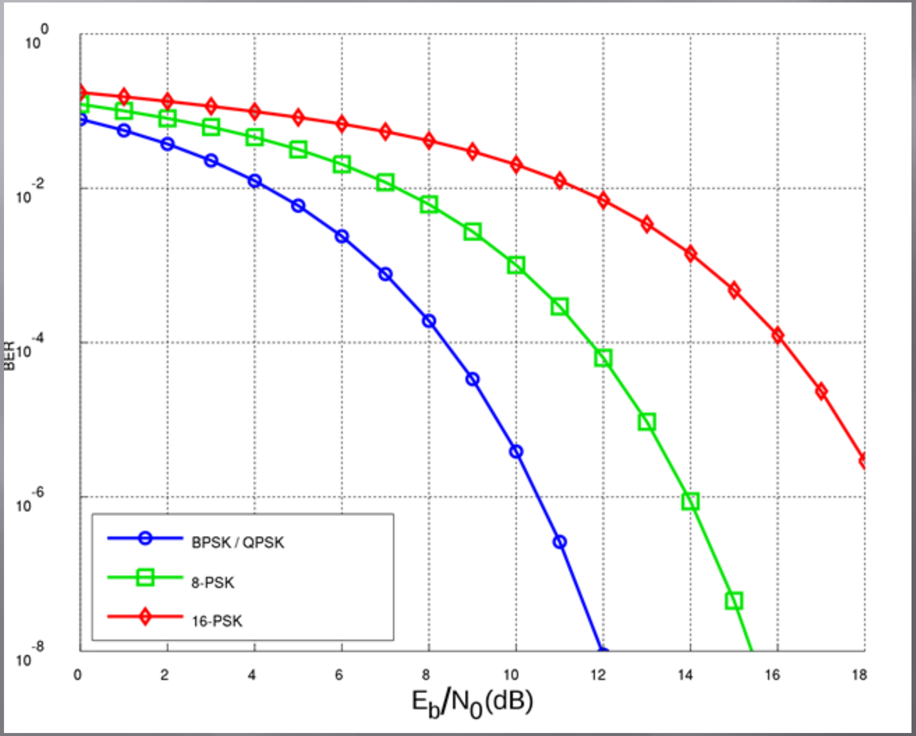
Either for analog systems
or digital there are one ratio for
the Input – output demodulator
Like S/N respectively BER and C/N





For digital carriers where the modulation is PSK, the BER calculation, being specific to the system is still valid the C/N *Threshold* with values between 10^{-3} e os 10^{-8}

C / N Specification 2

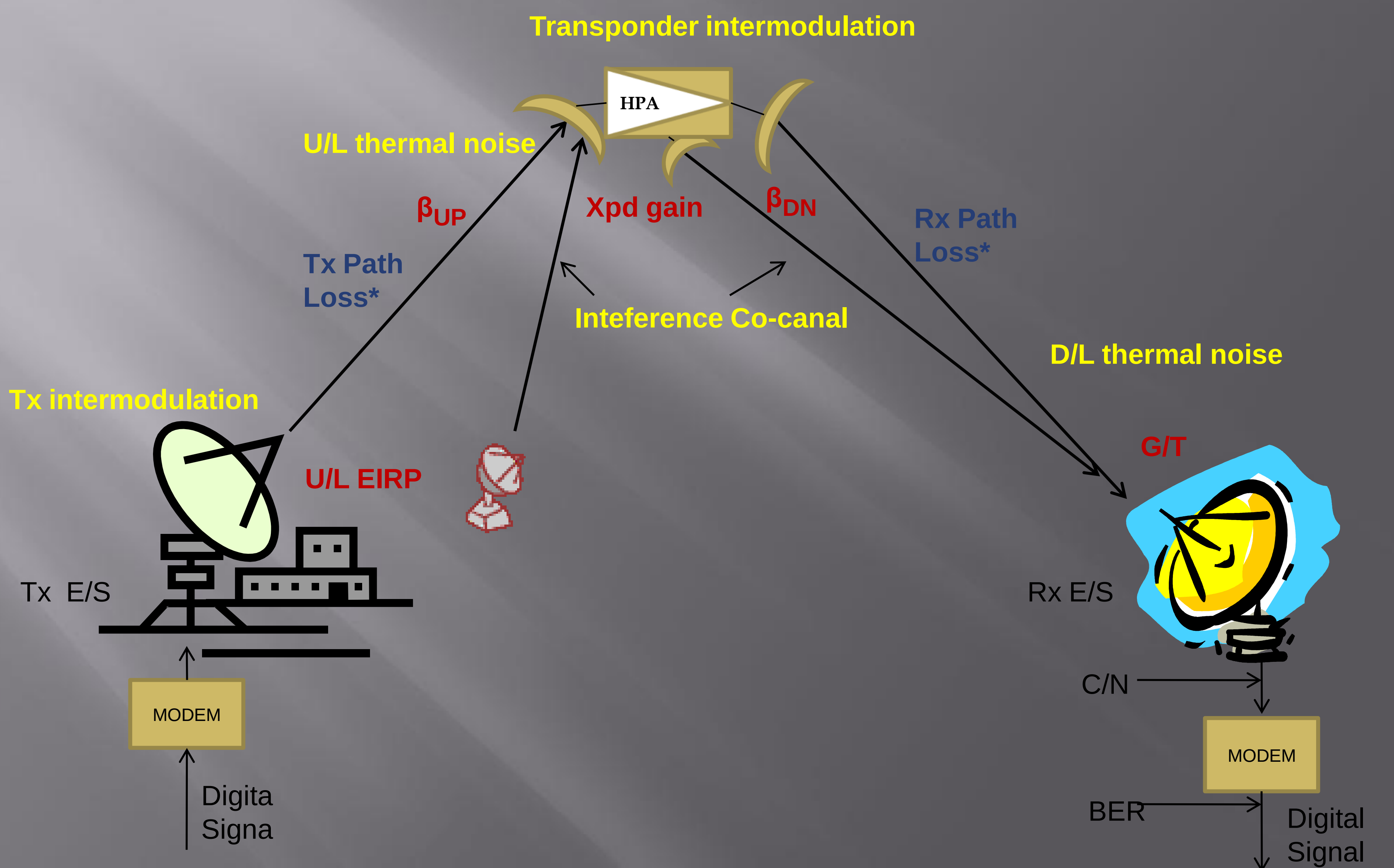


Once defined the performance objectives, S/N or BER or C/N this is specified to a % of time for instance 0,01 of the year ou 0,03 of the month.

In K_u systems more rain sensitive either the margin (8 dB vs 2 dB) or the availability (0,1 % vs 1%) must be considered.

Also the modulation interfere in the performance, as can be seen

Link design


Transponder intermodulation
HPA
U/L thermal noise
βUP
Xpd gain
βDN
Rx Path Loss*
Tx Path Loss*
Inteference Co-canal
D/L thermal noise
Tx intermodulation
U/L EIRP
G/T
Tx E/S
Rx E/S
C/N
MODEM
MODEM
BER
Digita Signa
Digital Signal

Link Design Noise Compont^s

Uplink Thermal Noise – Inherent to the receive noise system prone to rain and tracking errors

E/S HPA intermod. products – Inherent to HPA system with several carriers

Co-Channel Interference – Inherent to exitance of several carriers on the same satélite although diferent beams (frequency reuse) phisically or electrically (polarization) separated

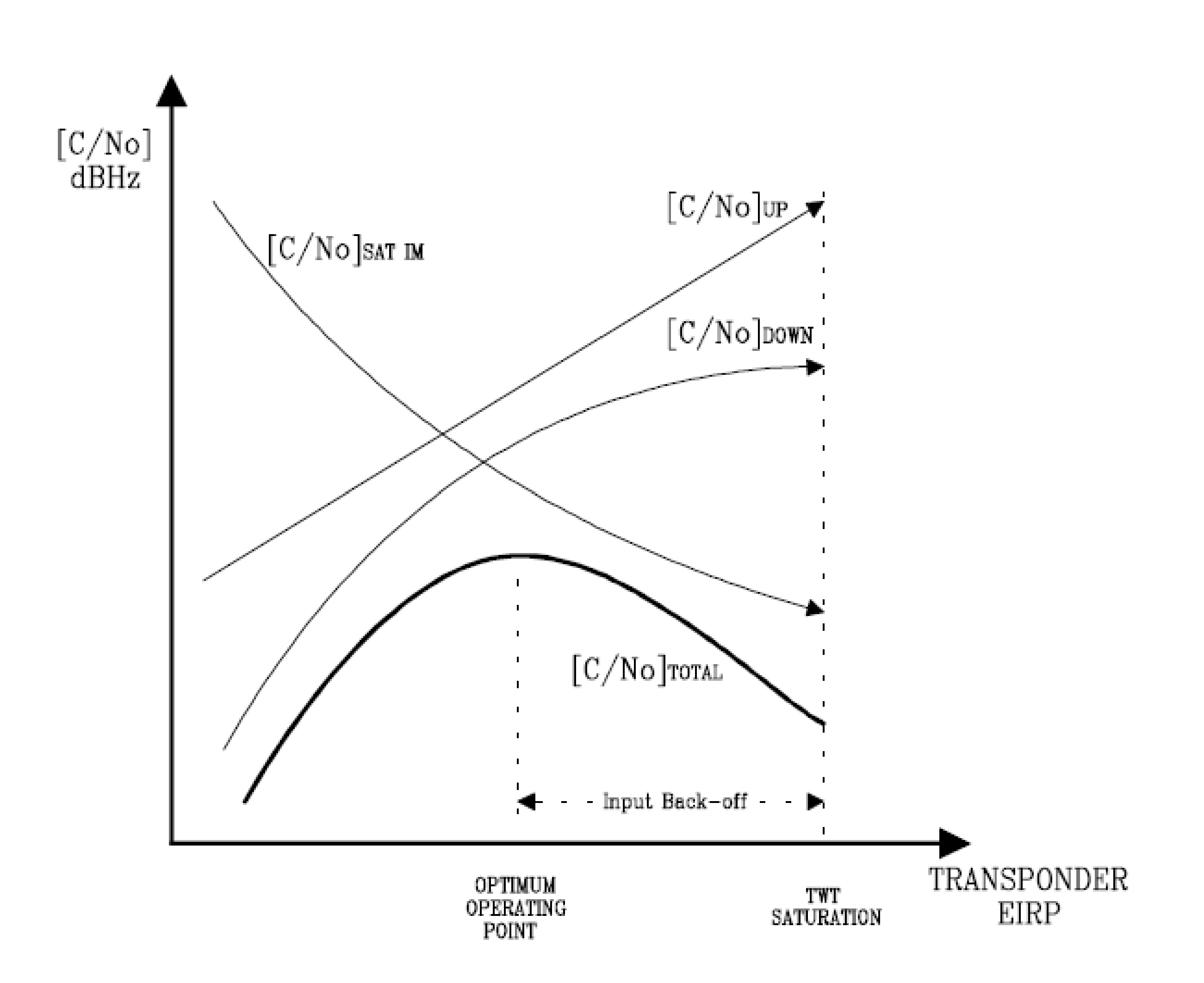
Transponder Intermodulation – It is specified as a limit of EIRP density transmitted by the transponder, in a 4Khz band on the radiation pattern limiar

Link Design Noise Componts

<u>Dnlink Thermal Noise</u> – Inherent to the receive system noise. Similarly to the uplink must be considered the rain margin and tracking errors

<u>Total Link Carrier System Noise</u> – Although in a connection it is mandatory the uplink be kept strictly at its nominal value, and a low EIRP means low C/N, it is proved a higher EIRP doesn't means necessarily better C/N_0

C/N_0 vs EIRP



[C/No] dBHz
[C/No]SAT IM
[C/No]UP
[C/No]DOWN
[C/No]TOTAL
Input Back-off
OPTIMUM OPERATING POINT
TWT SATURATION
TRANSPONDER EIRP

Link Design Assumptions

- $(C / N_0)_{UP} >>> (C / N_0)_{DN}$, about tem's of times. Although C_U being hundred's times > than C_D, the $(C/N_0)_T$ is virtually the $(C / N_0)_{DN}$ what means <u>downlink determines link quality</u>
- The reception antenna gain is not limited in opposition to the satellite one.
- Downlink is designed with the following objectives:
  - Guarantee continuity in % of time (tipically 99,9 %) with a S/N (or BER), what imposes a C/N minimum in the receiver input, what is achieved with modulation and processing appropriated to have a minimum S/N at the output receiver
  - To carry the large number of telephonic (or TV) channel at minimum capital expanditure and operational costs, one has to assume commitments between the antenna cost, the system tracking, the type of earth station management (on site or remote operation) and the multiple access scheme

Link Design parameters 1

- Basic Link
- BER and FEC
- Modulation type
- G/T
- Attenuation margins
- Transponder selection
- Pattern advantage
- Interference
- Downlink power

Link Design parameters 2

- Uplink pattern advantage
- Satellite uplink power
- Uplink losses
- EIRP
- Hardware losses
- HPA
- Intelsat LST calculations
- Other tools sw

Link budget ex. TV sinal

C band sat. Parameters

Transponder sat. Output power	20,0	W
Antenna Gain on axis	20,0	dB
Transponder bw	36	MHz
Down link frequency	3,7-4,2	GHz

Signal FM TV analog sinal

FM TV signal bw	30.0	dB
Mimimum C/N overall receiver	9,5	dB

Receiving C band station

Downlink freq	4	GHz
Antenna gain on axis 4GHz	49,7	dB
Receiver IF bw	27	MHz
Receiver Sistem noise temperature	75	ºK

…./….

Link budget ex. TV signal

Downlink power budget

P_T = Satellite transponder power output	13,0 dBW
B_0 = Transponder output backoff	-2,0 dB
G_T = Satellite antena gain on axis	20,0 dB
G_R =Earth station antenna gain	49,7 dB
L_P =Free space loss 4GHz	-196,5 dB
L_{ANT} = Edge of beam loss for satellite antenna	-3,0 dB
L_A = Clear air atmosphere loss	-0,2 dB
L_M = Other losses	-0,5 dB
P_R = received power at earth station	-119,5 dB

Downlink noise power budget in clear air

K = constante boltzman	-228,6 dBw/K/Hz
T_S=System noise tem 75ºK	-18,8 dBK
B_N=Noise bw 27 MHz	-74,3 dBz
N = receiver noise power	-135,5 dBW

C /N ratio in clear air

C / N = P_R - N =-119,5 dB - (- 135,5 dBW) = 16,0 dB

…/……

Link budget ex. TV Signal

Downlink power budget in rain

P_{RCA}	= Received power in clear air	-119,5 dBW
A	= Rain att	-1,0 dB
P_{RAIN}	= Received power in rain	-120,5 dBW
N_{CA}	= Receiver noise in clear air	-135,5 dBW
ΔN_{RAIN}	= Increase in noise tem. Due to rain	2,3 dB
N_{RAIN}	= Receiver noise power in rain -3,0 dB	-133.2 dBW

C /N ratio in clear air

$C / N = P_{RAIN} - N_{RAIN}$ = -120,5 dB - (- 133,2 dBW) = 12,7 dB

Link Budget ex. DBS link

DBS Satellite

Coverage area 3º x 2º geo orbit (2000Kmx1400Km)

12,2 GHz freq.

Transmitter Output power per channel	200,0 W
Transmit antenna Gain on axis	37,0 dB
Satellite EIRP / channel	60,0 dBW
Path lengh to receive afatio	38000,0 Km
Flux density in coverage center	-102,5 dBW/ m2
Clear air atmospheric loss	0,5 dB
Actual flux density	-103,0 dBW/ m2

Receiving station

Antenna diameter	0,7 m
Efficiency	60,0 %
Effective area of receiveing apperture (Ae)	0,24 m2
Theoretical received power (FAe)	-109,2 dBW

…./….

Link Budget
ex. DBS link

Theoretical received power (FAe)	109,2 dBW
Losses	
Station at edge coverage zone	- 3,0 dB
Polarization loss in receive antenna	- 0,5 dB
Pointing error in receive antenna	- 1,0 dB
Losses in receiver before LN	- 1,0 dB
Actual received power (C)	-114,7 dBW
Noise power budget	
Boltzman Constante	-228,6 dBW / K / Hz
Receiving system noise temperature (700 K)	28,5 dBK
Channel bw IF (27 MHz)	74,8 dB Hz
Noise Power (N)	-125,8 dBW
Worst case design (C/N)	11,1 dB
Margin over 9 dB (C/N) threshold	2,1 dB

Level plan1

The analysis link equations are fundamental to evaluate the systems performance , but besides that allow the equipments auditing for instance antenna acceptance tests, equipments requirements, Network design and costs evaluation

Let us calculate the level plan (potências) for equipaments chain alignement of a E/S such as:

- Antenna Standard A G/T = 35,5 dBºK
- Reception IDR carrier(Intermediate Data Rate) with
- Information rate 2048 Kbps
- FEC ¾
- Overhead 96 Kbps
- C/T = 155 dBW/ºK to BER 10^{-10} (Intelsat VII)

Level plan 2

Being $G / T_{dB/ºK} = C / T – EIRP – L_0$

$EIRP = C / T – G / T_{dB/ºK} + L_0$

The antenna received power will be ($EIRP – L_0$), so

-155 dB/ºK - 35,5 dB/ºK = -190,5 dBW (ou -160,5 dBm)

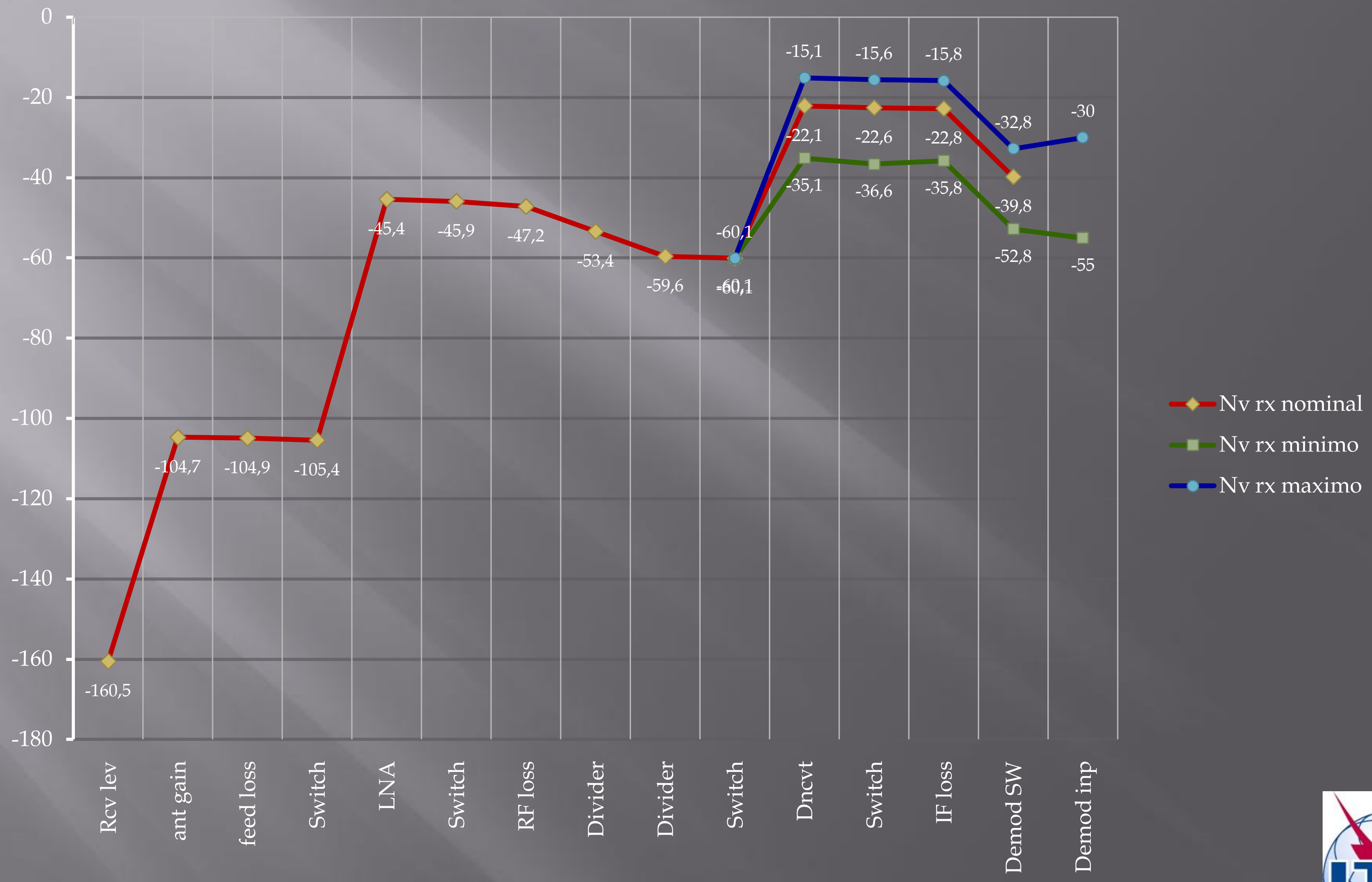
Assuming the following characteristics for the equiptº:

LNA (gain)	60 dB
Downconverter	
Gain	25 a 45 dB
Gain adjustement	20 dB
Demodulator	
Input level	-30 a -55 dBm
(proper operational point)	-40 dBm

Level plan 3

Nº	Equipament	Gain (dB)	Out level (dBm)	Final G	Out level set (dBm)
1	Received level		-160,5		
2	Antenna gain	55,8	-104,7		
3	Free loss	-0,2	-104,9		
4	Switching	-0,5	-105,4		
5	LNA	60	-45,4		
6	Switching	-0,5	-45,9		
7	RF link	-1,3	-47,2		
8	Divider	-6,2	-53,4		
9	Divider	-6,2	-59,6		
10	Switching	-0,5	-60,1		
11	Downconverter	25 a 45	-35,1 a -15,1	38	-22,1
12	Switching	-0,5	-36,6 a -15,6	-0,5	-22,6
13	IF link	-0,2	-35,8 a 15,8	-0,2	-22,8
14	Demod switch	-17	-52,8 a -32,8	-17	-39,8
15	Demod input	-30 a -55			-39,8

Level plan 4


0
-20
-40
-60
-80
-100
-120
-140
-160
-180
Rcv lev
ant gain
feed loss
Switch
LNA
Switch
RF loss
Divider
Divider
Switch
Dncvt
Switch
IF loss
Demod SW
Demod inp
-160,5
-104,7
-104,9
-105,4
-45,4
-45,9
-47,2
-53,4
-59,6
-60,1
-60,1
-22,1
-22,6
-22,8
-39,8
-35,1
-36,6
-35,8
-52,8
-55
-15,1
-15,6
-15,8
-32,8
-30
Nv rx nominal
Nv rx minimo
Nv rx maximo

Homework

- Using the link analysis equations determine the normalized receive station G/T for a F-2 station (diameter 7,5 m) if the following information is provided:

- Normalized frequency 4 GHz
- Satellite EIRP 31 dBW
- Downlink aspect correction 1,85 dB
- C/N_0 measured at receiver 88,4 dBHz
- Downlink slant range 40 586,98 Km
- Atmospheric 0,15 dB
- Operating frequency 4,037 GHz

- Solution G/T = 27,3 dB/ºK a 4 GHz

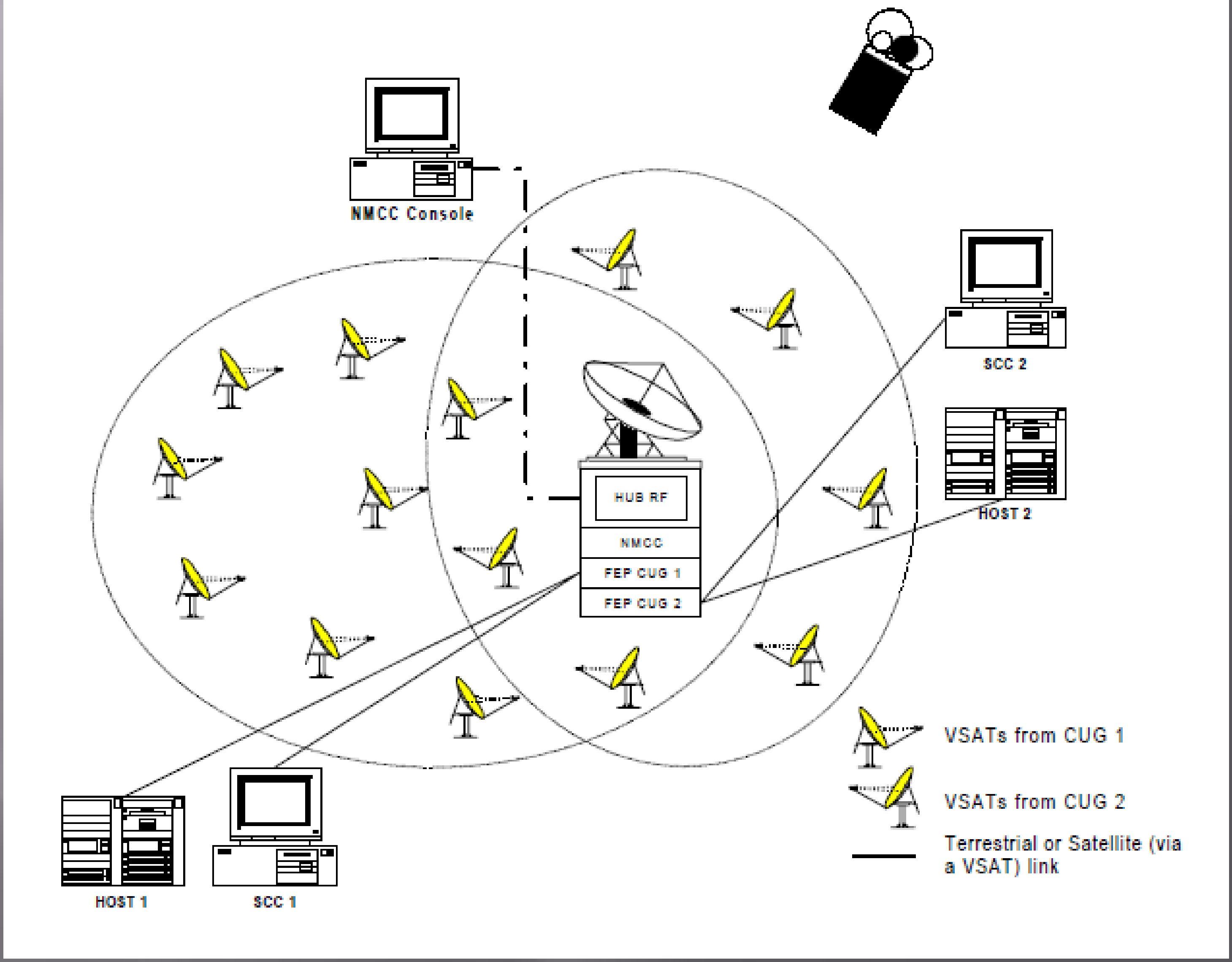
End 4th day (morning)

Courage………….

Vsat Installation & Maintenance

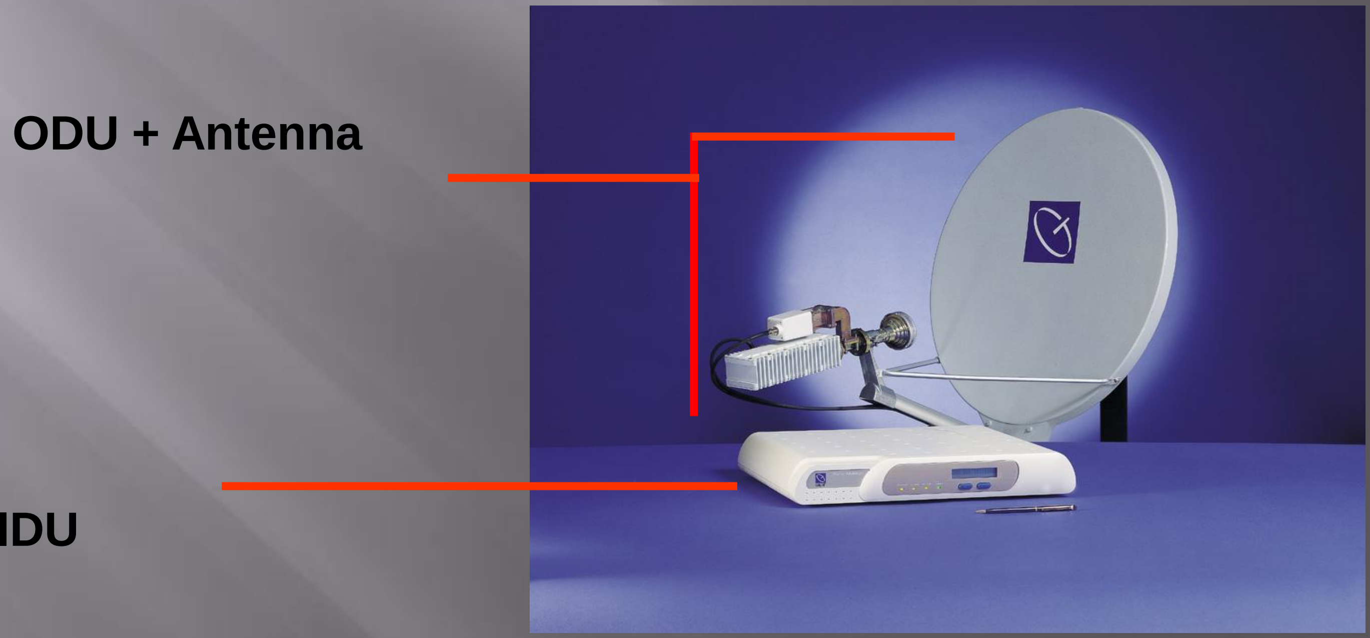
- Installation
  - Site survey
  - Equipment installation (ODU, IDU, IFL)
  - Commissioning, and acceptance tests
  - Installation tools
- Maintenance
  - Remote and on site evaluation
  - ETA
  - ETTR
  - ODU / IDU swap
  - Final tests and RFS

Vsat Network Star

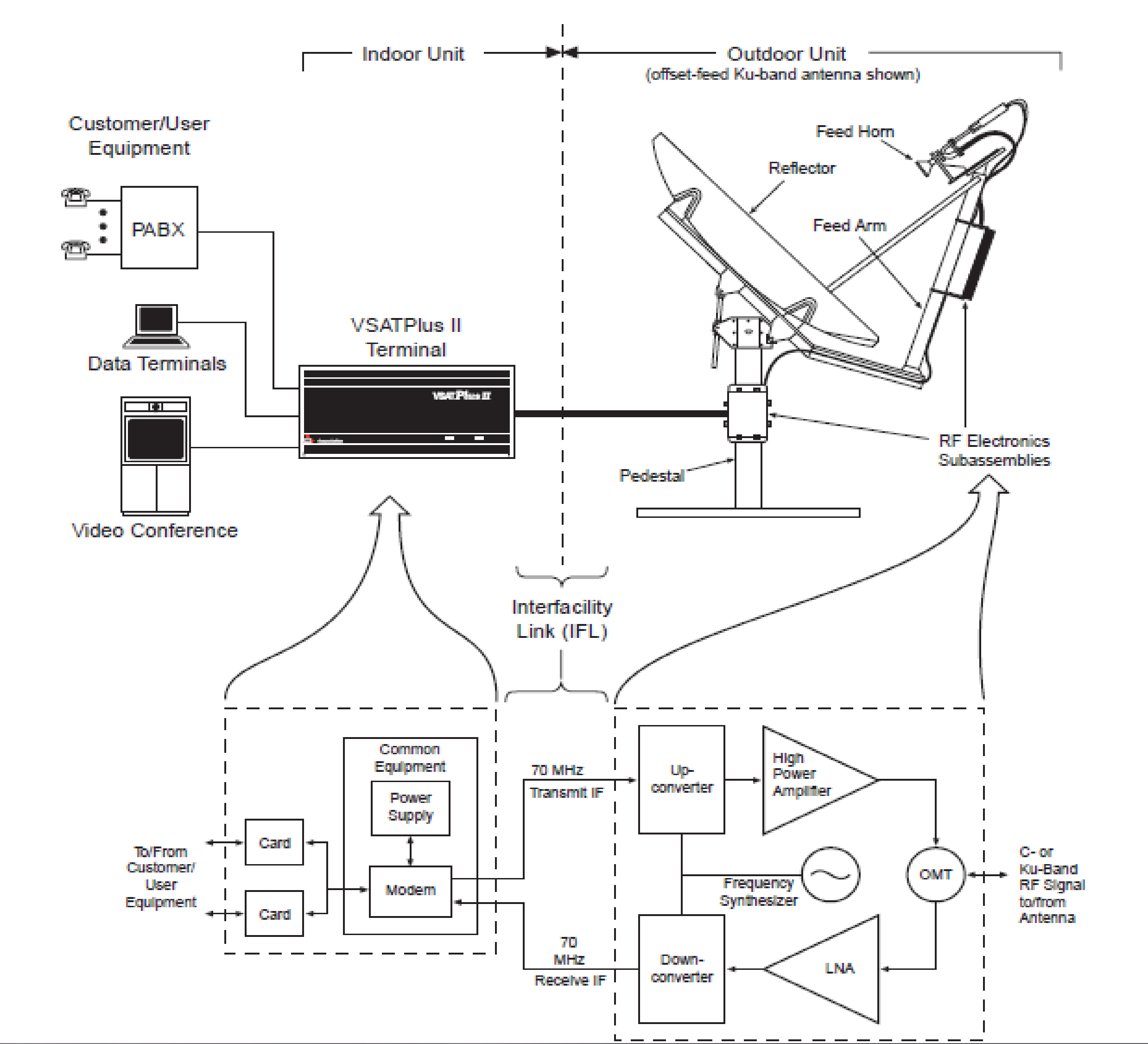


Very Smal Aperture Terminals (Micro terminais)

Working in K_u , C band:



VSAT (ODU, IDU, IFL)



Very Smal Aperture Terminals (Especificações tipo)

Antenna diameter	K_U	0,55 – 1,2 m
	C / XC	1,8 – 2,4 m
Frequency bands	K_U	11,7 - 12,2 GHz
		14,0 - 15,5 GHz
	C / XC	3,7 - 4,2 GHZ
		5,925 - 6,425 GHz
Transmit power	K_U	0,2; 0,5; 1 W
	C / XC	2 ; 5 W
Bit rate	Outbound	256 – 2048 Kbps, QPSK
		64 – 256 Kbps, BPSK
	Inbound	38,4 – 153,6 Kbps MSK
		9,6 – 76,8 Kbps DPSK
LAN		10 Mbps (Ethernet)

Very Smal Aperture Terminals (Aplicações)

- Air Traffic Control
- Internet Access
- ATM Teller Machines
- Point of Sale (POS)
- Corporate Communications
- Corporate Telephony
- Credit Authorization
- E-learning
- E-Voting
- Global Area Networking
- GSM Satellite Backhaul expansion
- Interactive Distance Learning
- Intranet/Extranet
- Inventory Management
- Kyosks / Internet Cafe
- Military
- Oil & Gas
- Post Office
- Prepaid IP
- TWISTER / E- rural
- SCADA Supervisory Control and
- Data Acquisition / Line monitoring
- Transportable Vsat
- Video Surveilance
- Wi-Fi / Wimax hotspot

VSAT Installation

- Technical site survey for gathering information about conditions on the premises to make the installation
- Notice the IFL, namely the length of the installation to decide qhat type of cable to use
- Tools to make the pointing, installation and commissioning

Installation steps 1

- Site survey
  - Identifies installation premises, adress,etc
  - local coordinates
  - IDU ODU and IFL place of installation
  - Client responsability installation items
  - Photos of local and relevant details
- Standard installation (Bidirecional / unidirecional)
  - Assembling Support (penetrating mount, non penetrating mount etc)
  - Post mount
  - Dish assembly
  - Calculating pointing parameters
  - Pointing dish
  - Making coax cables
  - Cable runs – running wire
  - Connecting & waterproofing coax connectors
  - Grounding dish
  - RF equipment installation

Installation step 2

- After previous proccedures
- Energy installation
- IDU installation
- HW/SW Test
- Satellite Pointing
- Commissioning tests
- On service demo to the client
- Final on site report, duly signed by client

Site survey request

Pedido de Site Survey

Data: ____/____/____ Direcção: ____________________ Utilizador: ____________________

Instalador: ________________________________ Fax: ______________________

Data objectivo para realização do serviço: ____/____/____

Rede:__________________NIR:______________Morada:________________________________

Serviço: ____

Cliente: ____

Pessoa para contacto:_______________________Telefone:______________________________

____

Nome e Longitude do Satélite:_________________________Diâmetro da Antena: __________________

UnidadeExterior: _________________________ Unidade Interior: ______________________________

____

Relatório

Localização da Remota LAT / LONG: ______________N / ______________W

Energia: Tem UPS ? ☐ Sim ☐ Não ☐Outro: ____________________

Tem Terra ? ☐ Sim ☐ Não Tem pára-raios ? ☐ Sim ☐ Não

Comprimento de Cabos: _________ (m) Tipo de cabo: ☐ Tipo I ☐ Tipo III RG: _________

Localização da Antena: ☐ Terraço ☐ Jardim ☐ Telhado ☐ Parede ☐ Torre

☐ Outro: ____

Altura da Antena ao Solo: ____________(m)

Tipo de Suporte da Antena: ☐ NPM ☐ Universal ☐ Pedestal ☐ Parede

☐ Mastro de parede ☐ P/ torre ☐ Especial: __________________

Necessidade de Anti-gelo: ☐ Sim ☐ Não

Localização das Unidades Interiores: ☐ Rack ☐ Secretária ☐Outro: ____________________

Sala Climatizada ? ☐ Sim ☐ Não

Cabo em conduta do cliente ? ☐ Sim ☐ Não

Trabalhos Adicionais: ☐ Autorização de condomínio ☐ Construção de maciços

☐Outros:____

Contacto para autorização de acesso à antena (Nome e forma de acesso): ____________________

____

____

Assinatura do Cliente: ____ Data: ____/____/____

Assinatura do Instalador: ______________________________________ Data: ____/____/____

Satellite pointing

- AZ / EL verification and polarization calculations and set
- Magnetic declination verification and the deviation set
- Pointing the antenna and feed polarizer set
- Check satellite beacon frequency (or alternatively RF Carrier e.g. outbound). With a spectrum analyser verify the downling frequency to be seen and check it
- Once configured values and pre-pointing the antenna, start an azimuth scanning for each side of the calculated AZ and repeat it within intervals of 0,5º in elevation. Record each peak where beacon is tunned.
- Start final alignment , previously to the system tests, accordingly OIS instructions and management.

Commisioning test (previous)

- Before starting any satellite transmission the Operator shall receive and confirm the detailed plan of tests procedure (line-up tests) with all technical and operational paramenters to use and instructions to be followed.
- Shall be installed and available one access medium to the NMCC – Network Management & Control Center of the Satellite Operator in case the start up of a satellite service or with the NMCC of the Satellite Hub Operator.

…/…

Commisioning test (previous)

…/…

- To the final alignment of each VSAT it is necessary optimize its cross-polar emissions, using one band slot authorized by the Satellite Operator, which will be preemtible if necessary.
- One method (there is another process, using a spectrum analyser) is using a third HUB to monitor co-polar and cross-polar emissions of the VSAT under test.
- In the end shall sent test to the Satelloite Operatir NMCC, or to the entity that manages the Hub, with pirpose of being approved.

Acceptance procedures 1

1. A Telephone contact is established between the VSAT being aligned and the central monitoring site or Hub.This contact must be maintained at all times
2. The VSAT radiates a continuos unmodulated carrier in the pre-provided test slot under to ensure good measurement accuracy achieved on the spectum analyser.
3. The central site (Hub) monitors the test slot to detect the presence of the carrier originating from the VSAT. If the central site doesn't detect and confirm the carrier in tha assigned transponder and/or if the communications link between VSAT under test and the central site fails **the VSAT under test shall immediatly cease transmissions and re-verify**
   - Correct satellite acquisition
   - Polarization plane alignement
   - Transmit frequency

   re-commencing with step 1
4. Under control of central site adjust carefully the antenna in azimuth and elevation to achieve maximum receive level of the co-polar signal on the spectrum analyser on central site.Ensure that the instrument sweep bandwith and resolution bandwith is optimised .

Acceptance procedures 2

5. Adjust carefully the polariser (or feed) in clockwise and counter clockwise direction until the maximum receive signal is obtained.
6. In the case of a four-port antenna Hub remove the spectrum analyser from the co-polar port and connect the instrument to the cross-polarisation output port of the feed system without changing the previous frequency, sweep bandwidth and resolution bandwidth settings.
7. Re-adjust the instruments sweep bandwidth and resolution bandwidth until the cross-polar component of the VSAT signal can be clearly measured on the spectrum analysers screen.
8. Under control of the central site adjust very carefully the VSAT polariser (or feed) in clockwise and counter clockwise direction until minimum crosspolar signal level has been reached. Mark position and this signal level value. Also note the maximum signal levels obtained clockwise and counterclockwise to this setting..

Acceptance procedures 3

9. At the VSAT terminal compare the polariser (or feed) setting obtained in maximising the co-polar with that obtained in minimising the crosspolarisation (Step 8). It should be the same. In the case of a small difference the VSAT should be aligned at the setting corresponding to the cross-polarisation minimum obtained in Step 8. Important differences in the two settings may indicate problems in the antenna mount (e.g. de-focusing of the feed).
10. Adjust carefully the antenna in azimuth to ensure that the azimuth (and, when necessary elevation) setting is still the same as that of the maximised co-polar signal. If it is not then Steps 4 to 9 should be repeated.
11. Check for each VSAT the carrier off facillity, whenever the outbond transmission is interrupted - manually or automatically - besides the other recommended tests from the manufacturer.

Tools1

Satellite finder

GPS Receiver
for locating Latitude
Longitude of
installation Location ,

Quick Pointing
Application sw

Digital multimeter

compass

Inclinometer

Dielectric Grease

Assorted wrenches

Tools 2

CrossOver Ethernet Cable

Coax Cable Wire Cutter

Snap & Seal coax connectors with nuts

Snap & Seal Crimper

Rubber Tape

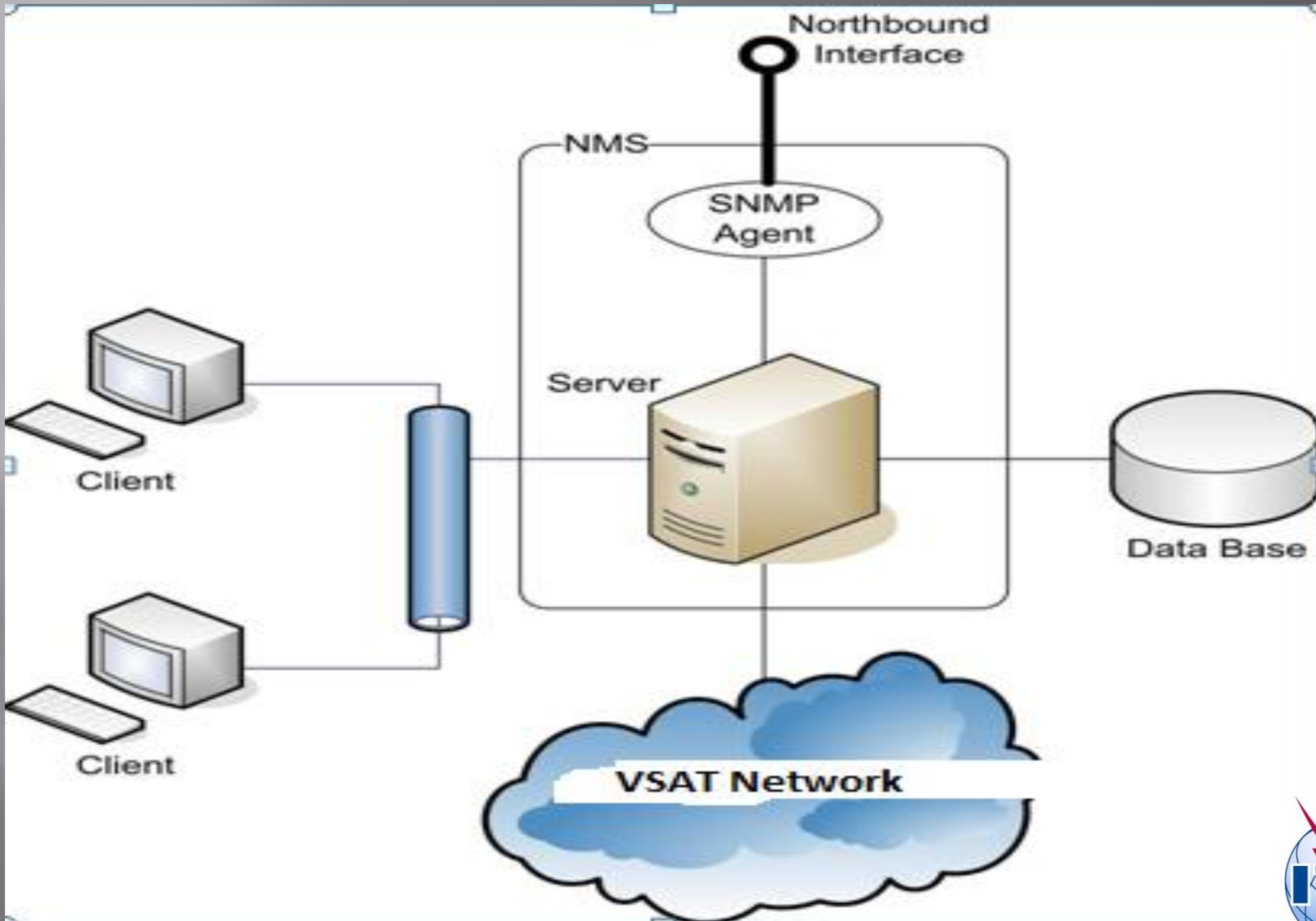
InLine Recieve Side Coax Cable Amplifers

Coax Shielding Grounding Blocks

Maintenance

- Remote
  - All the recent Vsat system have the possibility of remote control from the Hub over remote terminals. This is achieved through a centralized management system, named NMS-Network Management System that with protocol SNMP-Simple Network Management Protocol interact over all remote devices, where previously has been installed MIBS-Managed Information Database. The action is made through special sw installed in the devices that allows this to respond to request of information from the NMS.
- On site
  - Either on consequence of centralized “alarme” through the NMS or at user request, the corrective maintenance onsite involve speciallized teams, that with spare kits, interven to troubleshoot and debug any problems.

NMS



Northbound
Interface
NMS
SNMP
Agent
Server
Client
Client
Data Base
VSAT Network

NMS general overview 1

- NMS GUI enables an operator to monitor and control a Vsat Network
- The NMS supports the following functions:
  - View, modify and download individual configuration and software of the Hub and VSATs
  - View alarms and events from the Hub and VSATs
  - Gather statistics and log events
  - Create real time graphs for network monitoring

NMS general overview 2

Maintenance Request call

- Shall identify the node with problem (NE-Network Element) with the description - if possible - of the unit to debug.
- Shall request information about the ETA-Estimated time of arrival on site, fullfilling the client SLA-Service Level Agreement .
- Shall identify centralized contacts for testing purposes and estimation of time to repair
- Shall foresee specific ID's to record the name of devices or its characteristics that could be damaged or with bugs, for inventory purposes.

Corrective Maintenance

- Diagnostic testing to determine the existence and cause of a malfunction
- Removal and replacement of malfunctioning equipment
- Reorientation of the antenna subsystem to the original satellite
- Provision of Parts from the agreed Parts holding
- Repair or replacement of Remote Terminal interconnecting cables
- Reloading initialising instructions and decommissioning
- Verification of proper operation and completion of service report together with Customer acceptance
- Notification to the Global Technical Assistance Centre that the Remote Terminal has been restored to operational service
- Removal and testing of malfunctioning units and return of malfunctioning units to wharehouse designated repair facility within agreed working days of removal from Customer Location
- Any other task that may be reasonably expected to be undertaken to resolve problems.

End 4th day

Search the guilt??