Surveillance Data Sharing

VSAT Sizing Training

CDM625 Modem Application

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Niamey, Niger

Training Program

What we will discuss

- VSAT sizing
- VSAT architectures
- IP protocols
- VSAT Network maintenance

What you will do

- VSAT sizing of a network
- VSAT network configuration
- Satellite modem configuration
- Routers configuration

How do we do ?

- 45 to 60 minutes of theory followed by cofee breaks
- About 60% of the time will be practice
- Non stop or with lunch break

- Ask questions when you want
- If it’s too slow, say it
- If it’s too fast, say it
- Adaptative training, let’s discuss about your needs

Who are you? Why are you here?

Present yourself and tell us what you want at the end of this training

Does the program fits your needs ? Is there a particular theme you want to see more than others ?

Basics

- Our need is simple: COMMUNICATE
- With :
  - A media
  - A language
  - Rules
  - A Quality of Service (QoS)
- The actual training is a good example :
  - The media is: The air (Pressions and depressions)
  - The language: English! Commom between us (standard?)
  - Rules: One speak, others listen and can speak at their time (token ring ?)
  - QoS: Voice above the average noise

Basic Ground to Ground link

- Draw your synoptic here:

Ground to Ground link with obstacle

- Draw your synoptic here:

Satellite link

- Draw your synoptic here:

VSAT Architectures

- The architecture of a network will depend on the needs
- A solution can be the best on your case and becomes the worst in another
- The aim of a telecom engineer is to determine the needs to draw the corresponding architecture
- The end user usually does not care about the architecture
- Managers usually does not have a clue on what you do and just want to save money
- You are the expert, yours choices have to be motivated by technical arguments

Needs

- Most of cases are dealing with multi-sites data exchange
- Considering these needs will allow to define the following:
  - The architecture
  - Communication protocols
  - Needed bandwidth
  - Equipment selection
- Most of the cases, a loop will be done by changing some parameters in order to get the best configuration considering the needs, the budget and the scalability of the future network

- Lets work with examples

Real cases

- We will work on real examples to see multiples architectures
- 3 cases will be seen, and one will be fully developped
- If you want to talk about a special architecture, feel free to ask

Case 1

- Your needs are the followings :

Site A	Site B	Services
Dakar	Niamey	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Nouakchott	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Douala	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Lomé	ATS, Tel maintenance, AMHS, RADAR, Supervision
Niamey	Dakar	ATS, Tel maintenance, AMHS, Supervision
Nouakchott	Dakar	ATS, Tel maintenance, AMHS, Supervision
Douala	Dakar	ATS, Tel maintenance, AMHS, Supervision
Lomé	Dakar	ATS, Tel maintenance, AMHS, Supervision

Case 1 possible architecture

- Draw a matching architecture :

Case 2

- Your needs are updated with the followings :

Site A	Site B	Service
Dakar	Niamey	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Nouakchott	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Douala	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Lomé	ATS, Tel maintenance, AMHS, RADAR, Supervision
Niamey	Dakar	ATS, Tel maintenance, AMHS, Supervision
Nouakchott	Dakar	ATS, Tel maintenance, AMHS, Supervision
Douala	Dakar	ATS, Tel maintenance, AMHS, Supervision
Lomé	Dakar	ATS, Tel maintenance, AMHS, Supervision
Niamey	Nouakchott	ATS, Tel maintenance
Nouakchott	Douala	ATS, Tel maintenance
Douala	Lomé	ATS, Tel maintenance
Lomé	Niamey	ATS, Tel maintenance

Case 2 possible architecture

- Draw a matching architecture :

Case 3

- New update :

Site A	Site B	Service
Dakar	Niamey	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Nouakchott	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Douala	ATS, Tel maintenance, AMHS, RADAR, Supervision
Dakar	Lomé	ATS, Tel maintenance, AMHS, RADAR, Supervision
Niamey	Dakar	ATS, Tel maintenance, AMHS, Supervision
Nouakchott	Dakar	ATS, Tel maintenance, AMHS, Supervision
Douala	Dakar	ATS, Tel maintenance, AMHS, Supervision
Lomé	Dakar	ATS, Tel maintenance, AMHS, Supervision
Niamey	Nouakchott	ATS, Tel maintenance
Nouakchott	Douala	ATS, Tel maintenance
Douala	Lomé	ATS, Tel maintenance
Lomé	Niamey	ATS, Tel maintenance
Niamey	Douala	ATS, Tel maintenance
Niamey	Lomé	ATS, Tel maintenance
Nouakchott	Lomé	ATS, Tel maintenance

Case 3 possible architecture

- Draw a matching architecture :

Any questions so far ?

Case 1 study

- Following the drawing of the architecture, the idea if to determine the bandwidth size of each link
- For that, you have to collaborate with the technical team which is managing the service, they may help you to know the needed dedicated bandwidth
- For ours examples, we will use the following data:

	Services				
	Tel	MNT	Radar	AMHS	Sup
Débit unitaire kbps	10	10	64	32	12
Débits réels kbps	12	12	76,8	38,4	14,4

- When we speak about data rates, be carefull with encapsulation and its impact on the bandwidth, considering chosen protocols it can be uge

Links statistics

Site A	Site B	ATS	Tel Maintenance	AMHS	Radar	Supervision	Débits	Débit hub
Dakar	Niamey	2	2	1	1	1	177,6	710,4
Dakar	Nouakchott	2	2	1	1	1	177,6	
Dakar	Douala	2	2	1	1	1	177,6	
Dakar	Lomé	2	2	1	1	1	177,6	
Niamey	Dakar	2	2	1	0	1	100,8	
Nouakchott	Dakar	2	2	1	0	1	100,8	
Douala	Dakar	2	2	1	0	1	100,8	
Lomé	Dakar	2	2	1	0	1	100,8	
Débit unitaire (kbps)		10	10	32	64	12		
Débit réel (kbps)		12	12	38,4	76,8	14,4		

- Results without optimization

Voice links optimization

- Erlang's law optimization
- What is it? And why is it usefull for us ?
- If a traffic A is spread on N channels, the probability to get X occupied channels is:

$$P_x = \frac{\frac{A^X}{X!}}{1 + \frac{A}{1!} + \frac{A^2}{2!} + \ \dots \ + \frac{A^N}{N!}}$$

O.K… aaaaaand ?

Bandwidth optimization

- Parameters actually needed to use Erlang's law are:
  - Number of users
  - Active time in one day
  - Active time in one hour
  - Pic factor
  - Number of channels
- Aaaaand, the result of the Erlang Law is :
  - The blocking probability of the considerated service, or the disponibility of the considerated service
- That is a huge concern when we are dealing with critical services like we do

Bandwidth opminization

- Actually we are using Erlang's law in order to determine the number of channels to reach the needed availability of the service
- The minimal availability is generaly fixed by ICAO in our case
- In our case :
  - Calculation sheet introduction
  - For Dakar ?
  - For an other station ?
- Do you understand the interest of that law ?
- What can we do more to optimize the used bandwith ? For IP services ? For M&C traffic ?

Priotirization of services

- Be careful, if we optimize the bandwidth, we have to implement a way to prioritize services in case of traffic congession to ensure critical services like ATS/DS in our case (other services will be slowed in the best case, and stopped in the worst)
- With those mechanism, an ATS/DS call will not be blocked because of M&C traffic for example
- This mechanism can be configured directly on satellite modems (PAMA vs DAMA traffic) or has to be configured on multiplexors or networks éléments (Switch or routers)

Any questions before we go further?

RF Sizing

- Once we know the needed bandwidth, we have to think about the RF block
- Weactually have all the data needed to size BUCs, LNBs and Antennas
- LST5 tool introduction

- Case study

- Taking a look in MCPC case
- Taking a look in TDMA case

One slide resume

- VSAT sizing steps:
  - Needs definition: the more important, everything will follow from this
  - Drawing the architecture: Every story start with a drawing
  - Make a list of shared services
  - Determine needed bandwitch for each services
  - Optimize if you can (but do not forget to prioritize services if ones are more criticals than others)
  - Go for RF sizing considering needed availability, scalability of your network, direct costs and also annual costs (do not forget that satellite bandwidth is expensive, in some cases, direct costs can be higher but it can be worth it if annual costs allow to cover the delta in few years only)
  - Scalability is also an important parameter to consider

Good to know

- After all this work, your satellite profider can tell you that your needs cannot be reached because the chosen transponder is not available
- The best, when you know the position of all stations and the global bandwidth needed, is to include the service provider in the loop
- You will find the best solution considering all parameters
- Experience sharing can also create wonderful things you never expected

Any questions ? Sharings ?

Satellite Modems

- During the VSAT sizing we had to make choices in equipment type and features, between others we had to choose the satellite modem
- In our case we choose the CDM625 from Comtech
- Before working directly on the modem, we will deal with main parameters

Main parameters

- In order to set up a link, you will have to pass through these parameters at least:
  - TX and RX frequencies
  - Data rate (determined with VSAT sizing)
  - Modulation (determined with VSAT sizing)
  - FEC code (determined with VSAT sizing)
  - Code rate (determined with VSAT sizing)
  - Transmit and received level
  - Roll-off factor

Modulation and noise level

- Noise level effect on modulation, visual example:

BPSK Modulation

16 QAM Modulation

Modulation

- A high modulation is less strong to noise than lowest ones
- In other words, the Eb/N0 needed to reach a BER of 10-6 using BPSK, will be lower than the one needed to reach the same BER using 8PSK
- So, the modulation choice is a compromise between availability and budget because of course we can always oversize and get very hih performances but it has a cost

What is FEC code?

- FEC stand for Forward Error Correction
- The FEC allows the system to delete potential transmission errors
- The FEC is basically an algorithm that add control data to the payload
- As a result, using a FEC code is affecting the end user data rate
- Each FEC code is capable of deleting a limited number of errors in the payload
- FEC code choice is a compromise between the maximum BER and the link data rate

And the code rate?

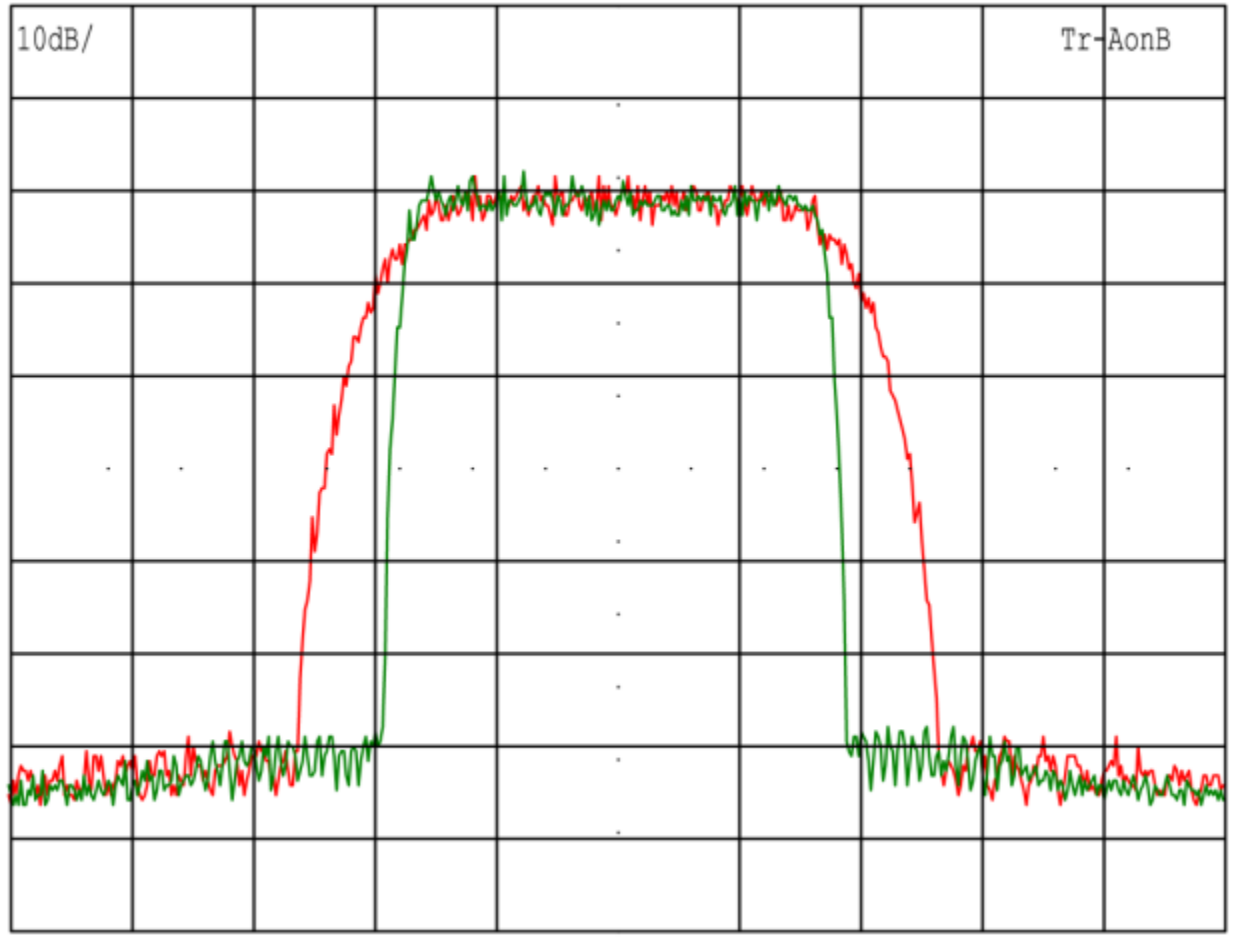
- The code rate, linked to the FEC code, is the proportion of usefull payload comsidering the full transmitted data (including control data)
- For example, a code rate of ½ correspond to 50% of usefull data, so for 1 sended bit, another is sended to correct potential errors
- So this code rate will be used if the link is really noisy
- If the transmission is good, it will be possible to use a better code rate that will use less bandwidth but will be able to correct less errors
- This intruduce the idea of link adaptation to the transmission quality

Link control

- Do you know Automatic Gain Control ?
- This parameter will increase the transmitted power if the receiving station is asking for it
- We can also think about a FEC code change when the transmission is really getting bad and affecting data integrity
- If we go further, we can think about a modulation change as well
- But do not forget that these changes will affect multiples parameters like data rates, transmitted power, needed bandwidth, …

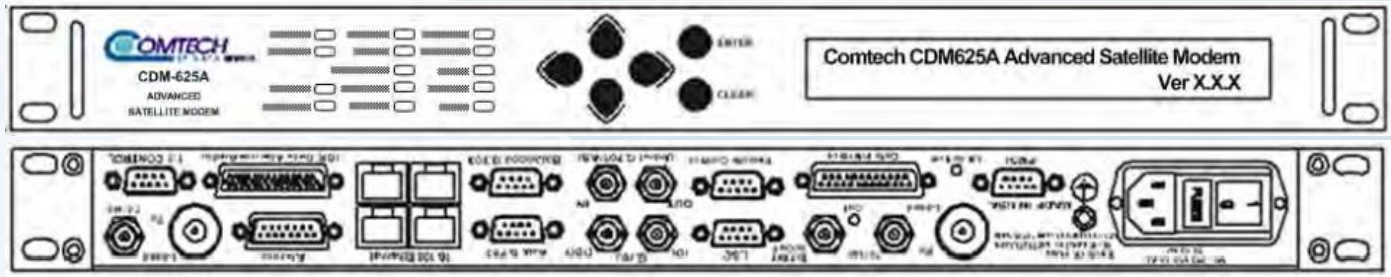
Roll-off factor

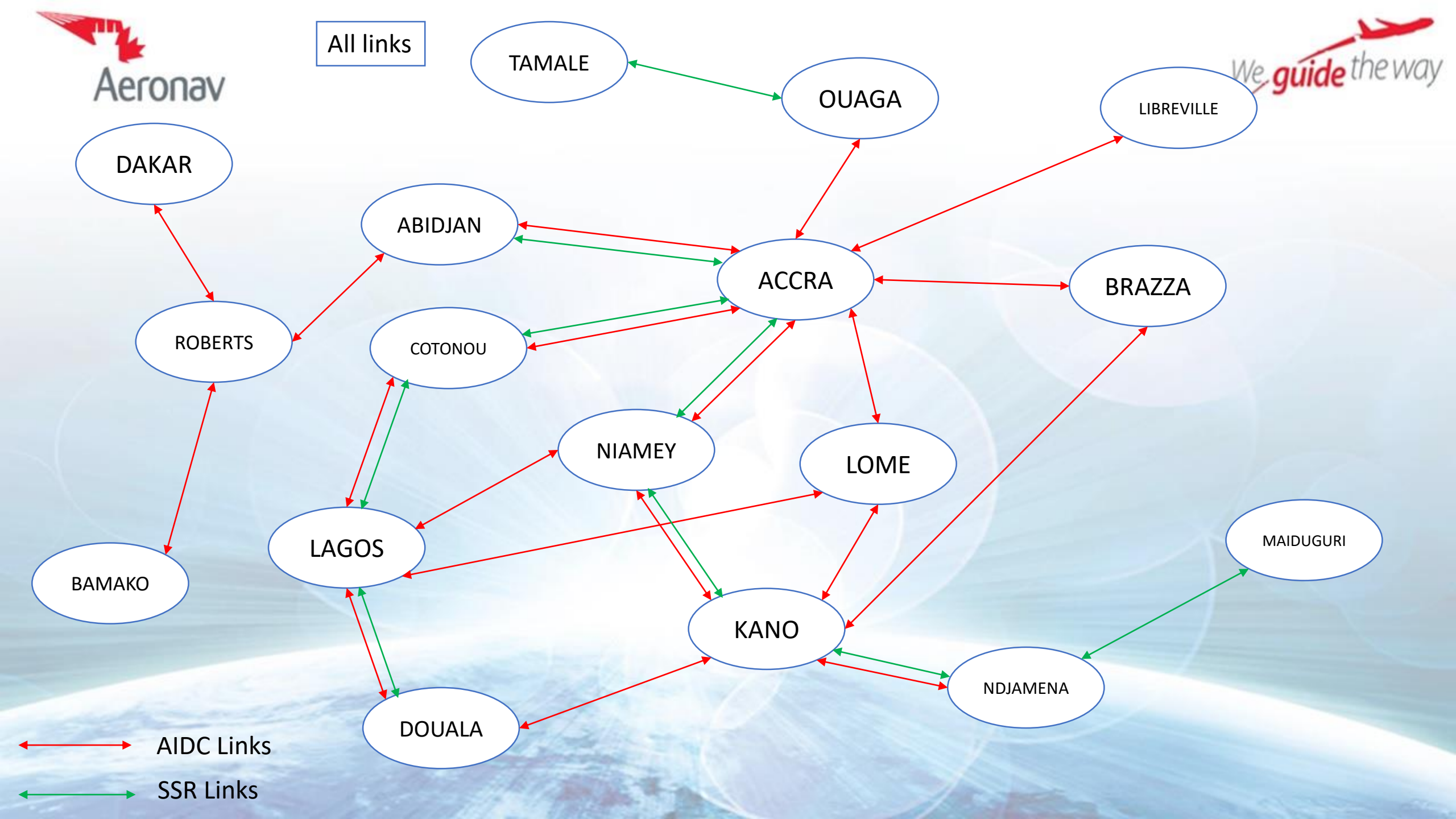
- This parameter is linked to the sharpness of the pass band filter
- The pass band filter will be closest from the ideal as the factor goes down
- The graph shows a pass band filter with a 0,35 roll off factor in red, and a 0,08 factor in green



CDM625 modem

- L band or 140 band
- 5 Mbps max
- Modulations:
  - BPSK, QPSK, OQPSK, 8 ARY
- FEC code:
  - Viterbi, Sequential, RS
- Interfaces IP, E1 or serials
- Used architecture :
  - SCPC

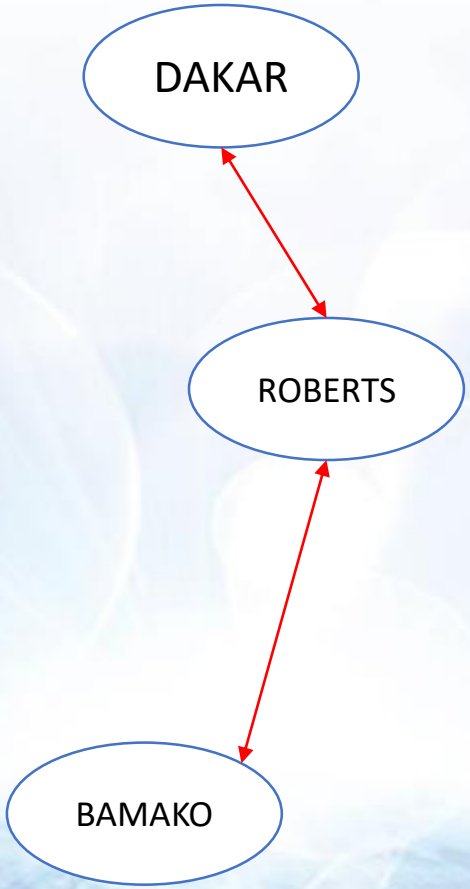



All links
TAMALE
OUAGA
LIBREVILLE
DAKAR
ABIDJAN
ACCRA
BRAZZA
ROBERTS
COTONOU
NIAMEY
LOME
LAGOS
MAIDUGURI
BAMAKO
KANO
NDJAMENA
DOUALA
AIDC Links
SSR Links

Aeronav

We guide the way

Links to configure



Time to work

Make 2 groups and two groups in each group

Each group will have to build a satellite link. You will configure one modem

To build the link, you will have to determine main parameters with the corresponding team

Exercise 1

- Configure a simple SCPC link
- Modify some parameters (modulation, FEC code, …) to see what happen to the used spectrum for example
- Watch alarms
- Get familiar with the datasheet
- Ask questions

To do list

- Use the front pannel
- Change IP address
- Use the web config tool
- Play with parameters
- Try to transmit data to your corresponding team

Training architecture