



INEO
GDF SVEZ

REDDIG MEMBERS COURSE 2010

October 2010 | REDDIG Members training 2010

Presentation summary

- INEO E&S aeronautical export department
- ATC communications
- REDDIG and Peruvian network examples
- Anticipating the future

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INEO E&S Aeronautical Export Department

→ INEO E&S designs, builds, installs and maintain
Information and Communication Systems

Presentation summary

- **INEO E&S aeronautical export department**
 - INEO E&S at a glance
 - Telecommunication systems
 - Air Traffic Control Project
 - Infrastructure projects
- **ATC communications**
- **REDDIG and Peruvian network examples**
- **Anticipating the future**

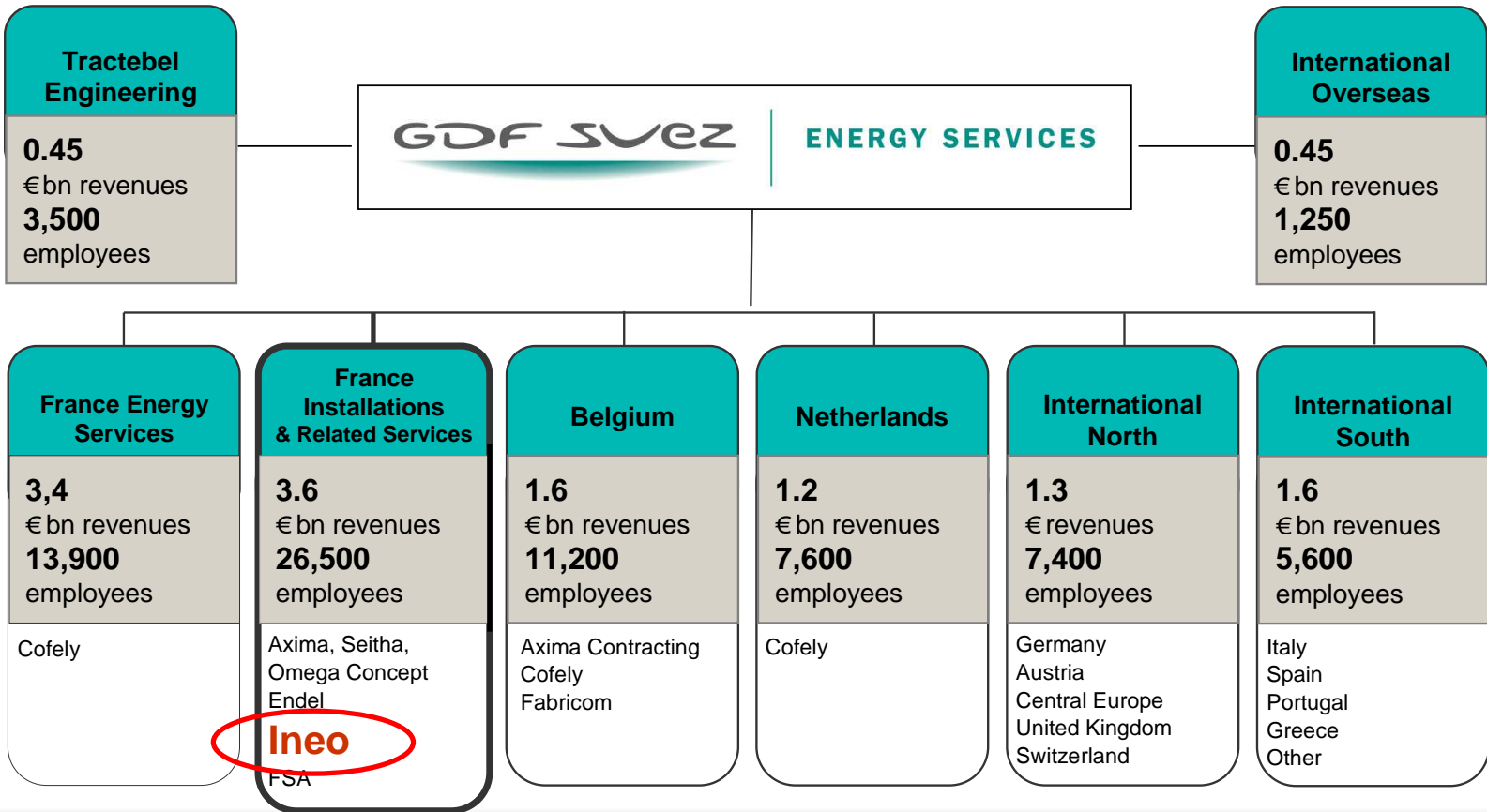
INEO E&S

At a glance

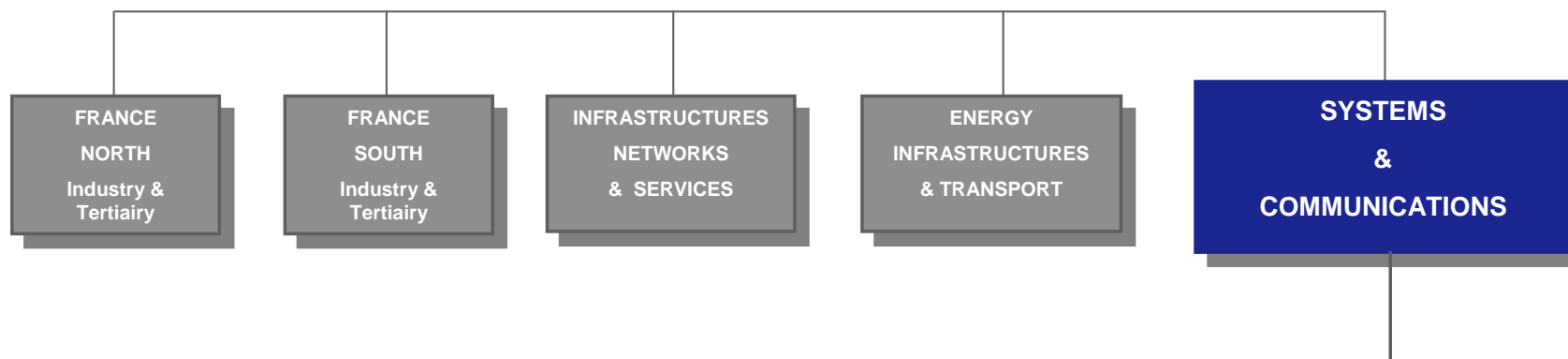
INEO E&S: a sub-branch of GDF Suez



GDF SUEZ Turnover : 79,91 billion €
more than 200 000 employees



BUSINESS UNITS SYSTEMS & COMMUNICATIONS



<p>380 € million turnover</p> <p>1500 employees</p> <p>500 engineers</p> <p>15 locations</p>						
	Aeronautic Transportation systems	Information Systems	Homeland Security	Telecommunications	Defense	Energy networks Export Oil & Gas

235

Employees

105

Engineers

€ 49.5 million

Turnover 2009

60 %

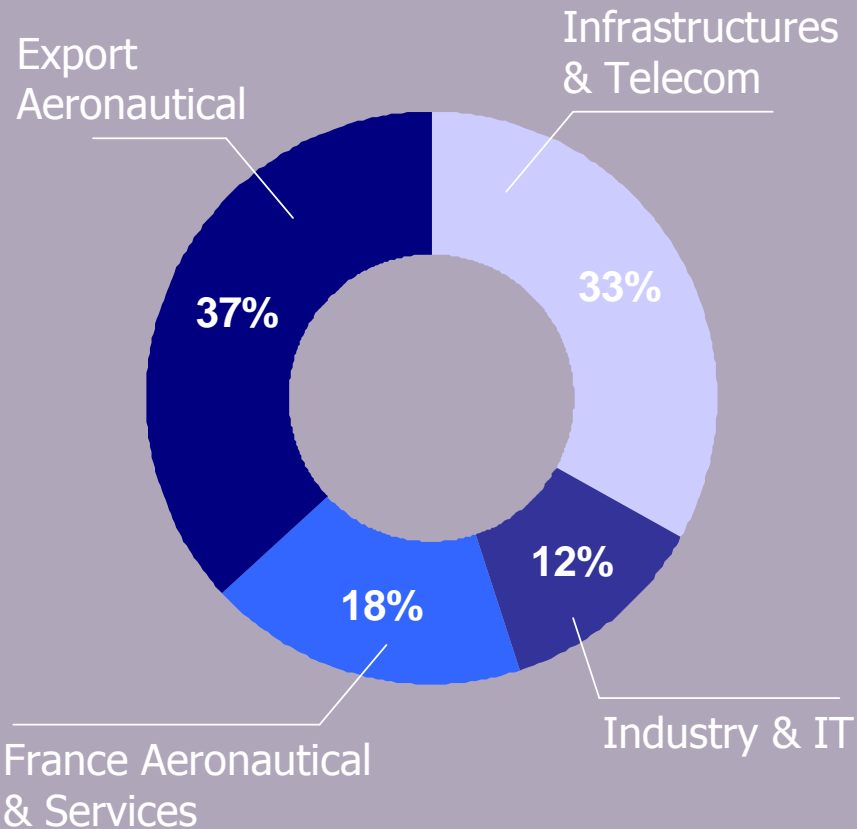
Export

THE POWER OF EXPERTISE DEDICATED TO CUSTOMER'S PROJECT

- > **Specialized teams**
- > **Integration platforms**
- > **Development of Solutions/Products**
- > **Industrial Partnerships**

Multi-skilled technical expertise used by the Operational Departments for their customers.

INEO E&S was created in 2005 by the merge of the civil activities of **CORIS** and **SEEE-IS** (in charge of **REDDIG project**)



MARKET SECTORS

- > Aeronautical
- > Oil and Gas Energy
- > Telecom
- > Industry
- > Infrastructures
- > Homeland Security

Skills – Fields of activities

Infrastructures

- Power stations
- Solar power systems
- Secured electrical distribution
- Airfield lighting
- Monitoring & Control
- Navigational Aids (VOR-ILS-DME-NDB-DF)



Air Traffic Control

- Voice Communication Switching System (VCSS)
- Meteorological Systems
- AFTN / AMHS switch
- Aeronautical Information Systems (AIS)
- Time Synchronisation
- Recording Systems
- ATIS / D-ATIS
- Integrated Consoles
- 3D tower simulators

Communication Systems

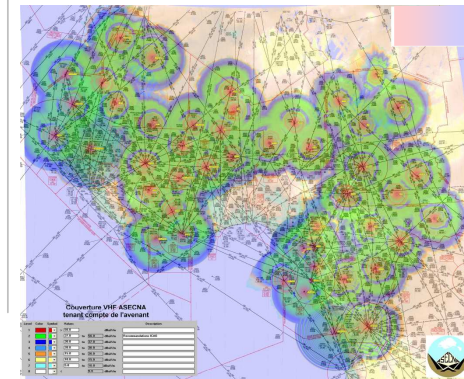
- VHF, HF, MW, V-Sat Communications
- LAN / WAN Networks
- Secured optical fiber networks (data collection around the runway)
- Remote VHF stations
- Monitoring & Control



Scope of work

Aeronautical System Integrator

- > Project Management
- > Engineering / Detailed design
- > Equipment procurement
 - > Integration
 - > Overseas Transport
 - > Installation and Commissioning
- > Training
- > Maintenance



The strength of an expertise dedicated to the customer



A multidisciplinary technical expertise for the benefits of the customer:

- Pool of Aeronautical Experts
- Pool of Telecommunications Experts
- Software development engineers
- Design department
- Integration facilities
- Partnerships with strategic suppliers



INEO E&S Products



INEO E&S develops its own products dedicated to the Air Traffic Control world:



**Concerto Voice
Communication Switch**



3D Tower simulator



**Voice@net Voice
Communication Switch
Simulator**

REFERENCES

Telecommunication systems

INAC network



TDMA based solution using SkyWAN modem

- > Meshed network
- > Low bandwidth consumption

Frame Relay network with Memotec product

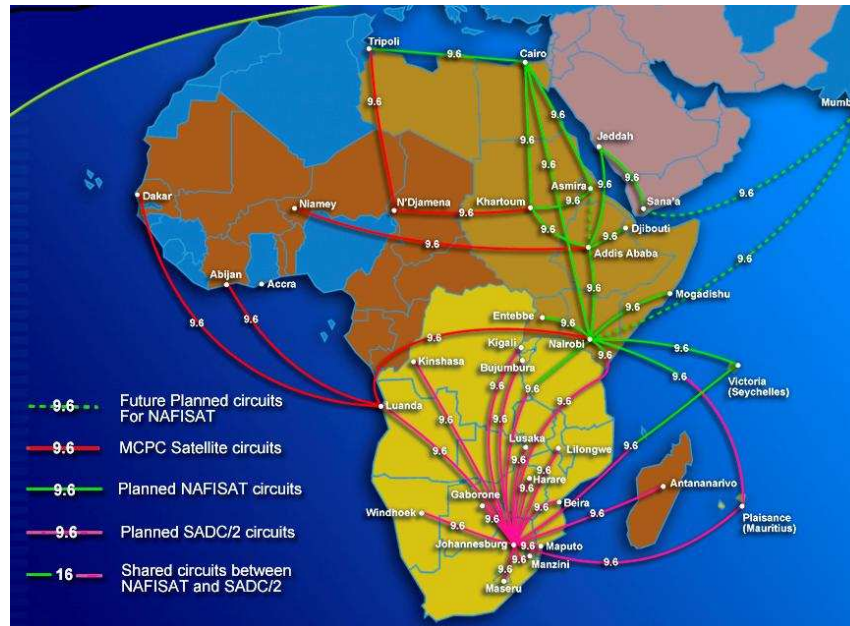
- > Reliable product
- > Well suited to Aeronautical networks

An evolutive network:

- > Upgrade to 31 stations in 2008
- > RADAR Broadcast
- > Integration of AMHS in 2010



Reference – Telecommunication Project



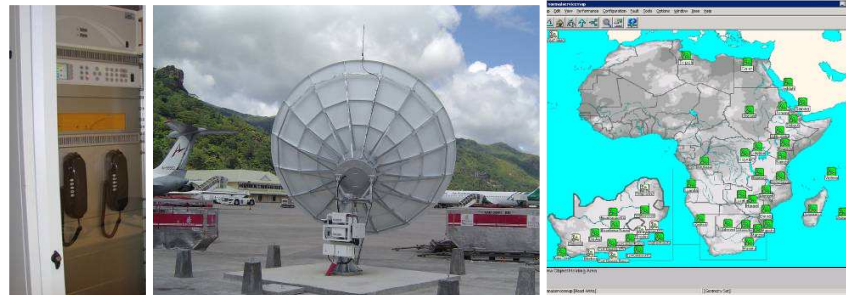
Aeronautical VSAT networks in Africa: SADC-2 / NAFISAT / IVSAT

ATNS

Date: 2006 - 2008

Renewal of the VSAT network for SADC and NAFISAT countries as well as ATNS domestic network (IVSAT)

- Turnkey VSAT network including 43 stations in 28 countries for fixed services (SADC and NAFISAT) as well as mobile services (IVSAT)
- Interconnection with AFISNET (ASECNA)
- On demand bandwidth allocation
- Monitoring and control on each site with two centralized centers (Nairobi and Johannesburg)
- Seamless integration with the Radar system, VHF, AFTN, ATN and ATS/DS



Reference – Telecommunication Project



ASECNA VHF Coverage

ASECNA

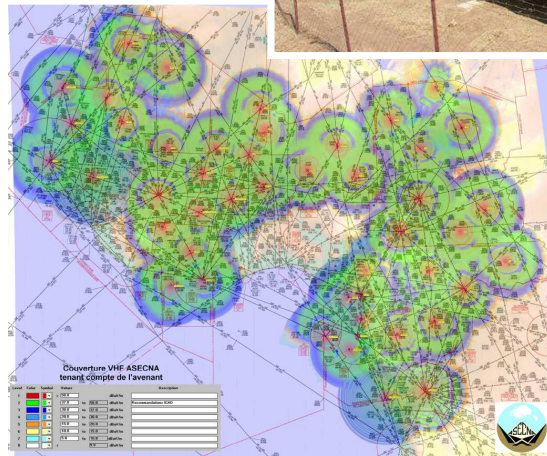
Date: 2008 - 2010

Customer objective

- VHF coverage of the ASECNA airspace
- 12 hubs, 13 new stations, upgrade of 12 existing stations spread out in 13 countries

INEO Solutions

- VHF coverage studies
- Turnkey solution including civil work, solar panels, VSAT stations and VHF systems
- Innovating monitoring and control solution (information gathered locally to optimize space segment)
- INEO is ASECNA remote VHF provider since 1996.



Reference – Telecommunication Project



REFERENCES

Air Traffic Control Projects

Reference – ATC Project



Malabo International Airport (Equatorial Guinea)



ASECNA

Date: 2006 - 2008



Customer objective :

Transfer and installation of the operational systems from the existing TWR to the New Control Tower

INEO Solutions

Study, supply, integration, installation, commissioning and training on :

- Power distribution
- Main Distribution Frame
- VHF Communication system
- GPS Time synchronisation
- TWR Consoles
- Uninterruptible Power System
- Remote Control Monitoring System
- Satellite communication system (ATS/DS, AFTN, MET)
- Microwave link
- Voice recorder
- Concerto VCSS
- Meteorological equipment

Reference – ATC Project



Tripoli Tower (LIBYA)

OEA (Vinci)

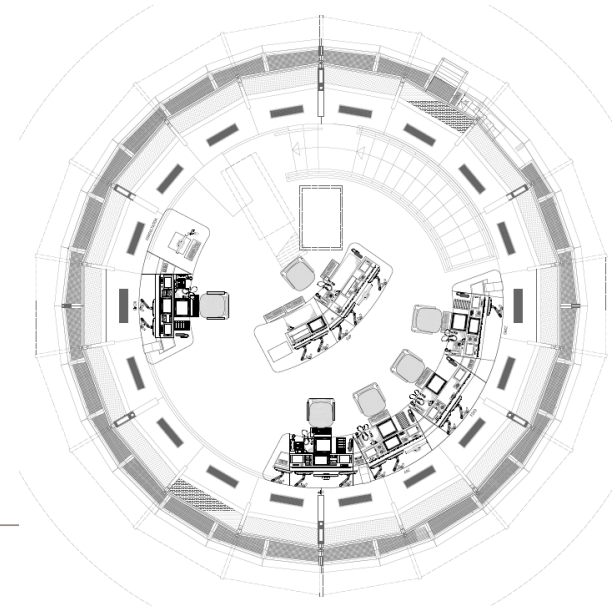
Date: 2009

Customer objective :

- Aeronautical and telecommunication equipment for the new Tripoli tower
- Voice communication switch, VHF, Consoles, Monitoring & Control, Recorder, e-stripping, etc.
- End customer: LCAA. Consultant: ADPI

INEO Solutions

- Engineering on heterogeneous systems
- Very last technology used (e-stripping, IP systems)
- Factory integration in France



Reference – ATC Project

Dakar ACC (Senegal)

ASECNA



Date: 2010

Customer objective :

ASECNA's objective is to build a new ACC close to Dakar Airport in order to control Dakar Terrestrial and Dakar Ocean FIRs

INEO Solutions

- Electrical substations
- 5,5 kV network
- 2 x 100 kVA Uninterruptible Power System
- Power distribution for the whole ACC
- Integration in the existing telecom network
- Duplicated Microwave system
- Consoles
- Concerto VCS and recorder
- Time distribution
- Optical fibre network

REFERENCES

Infrastructures Projects

Reference – Infrastructures Project



Pointe Noire Airport (CONGO)

ASECNA

Date: 2006 - 2007

Customer objective :

Revamping of electrical equipment and airfield lighting

INEO Solutions

- Airfield lighting
- 20 kV power station
- 2 x 200 kVA power generators
- Electric equipment for the power stations and the technical room

Reference – Infrastructures Project



Brazzaville Airport

- Direction des Grands Travaux de la Présidence
- ASECNA

Date: 2009 - 2010

Customer objective :

- Renovation of existing runway
- New runway
- New power station
- New ACC
- New tower

INEO Solutions

- Airfield lighting for both runways, including approach ramp
- Power generators (2 X 600KVA)
- Monitoring and Control of the Power distribution and airfield lighting
- Nav aids
- Optical fiber network
- Consoles, recorder, time distribution

Presentation summary

- INEO E&S aeronautical export department
- **ATC communications**
- REDDIG and Peruvian network examples
- Anticipating the future



ATC communications

Several operational communications are likely to be transported via satellite:

- Aeronautical Fixed Service
- Aeronautical Mobile Service
- Airspace surveillance system
- Meteorological Systems



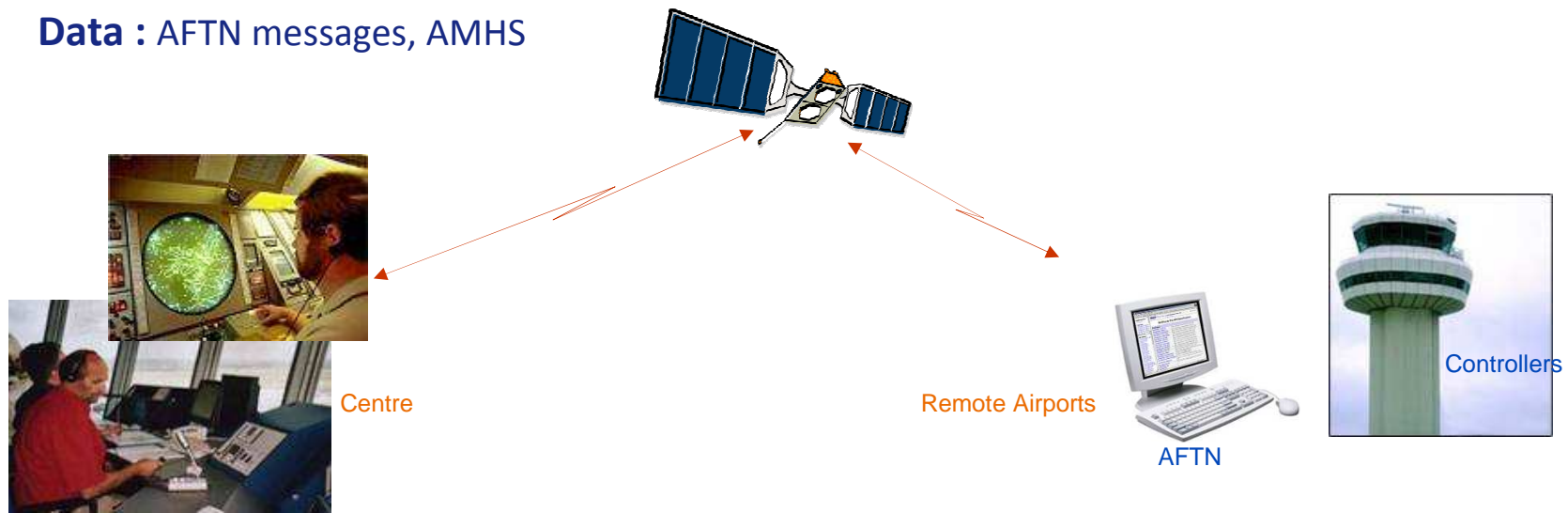
Aeronautical Fixed Services

INEO E&S ensure high QOS for sensitive fixed services

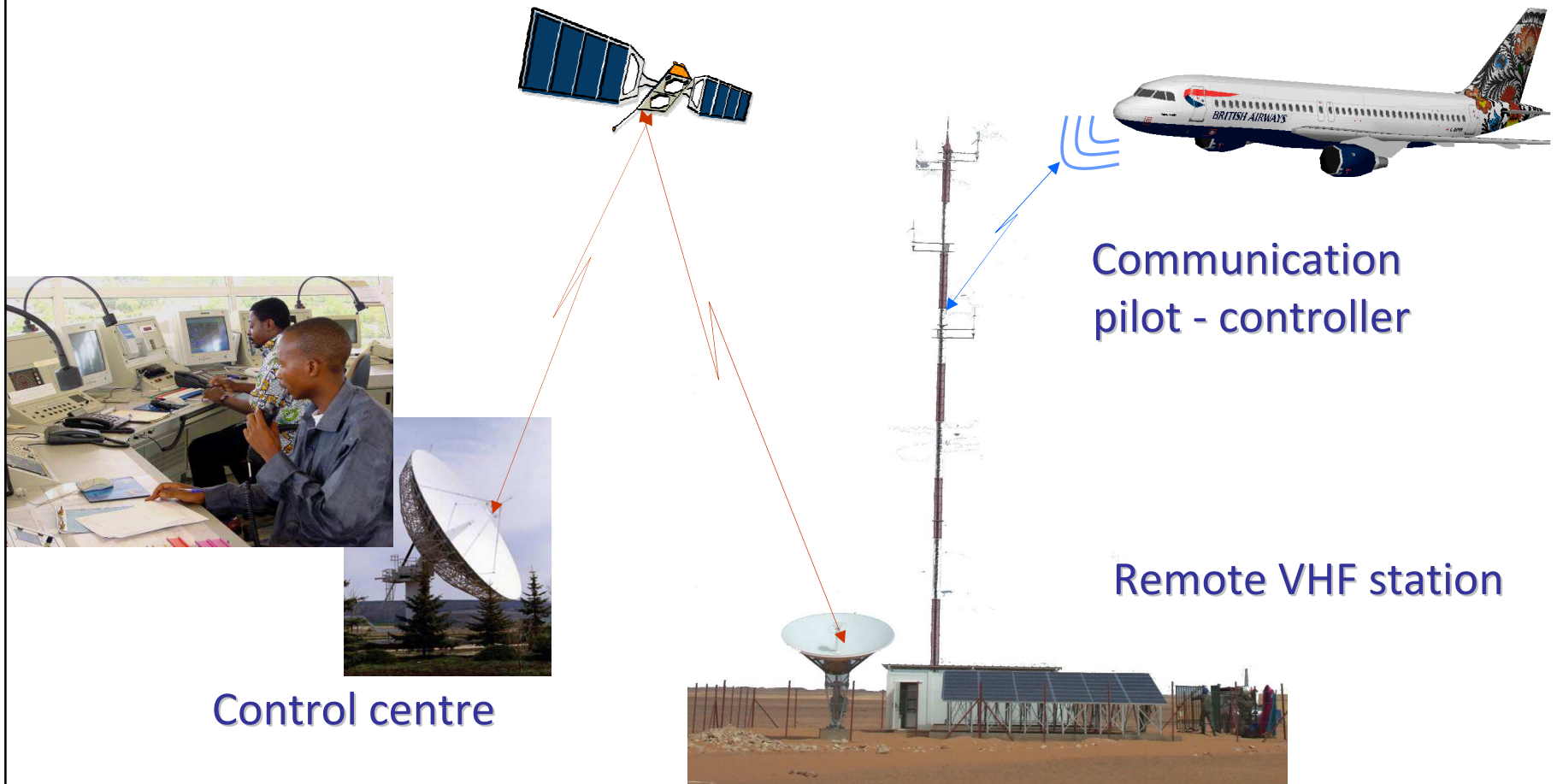
Voice : Communications between Air Traffic controllers (ATS/DS)

- Low delay (300ms)
- Low jitter

Data : AFTN messages, AMHS



Aeronautical Mobile Services



Aeronautical Mobile Services

Aeronautical Mobile Services (AMS) is a critical data:

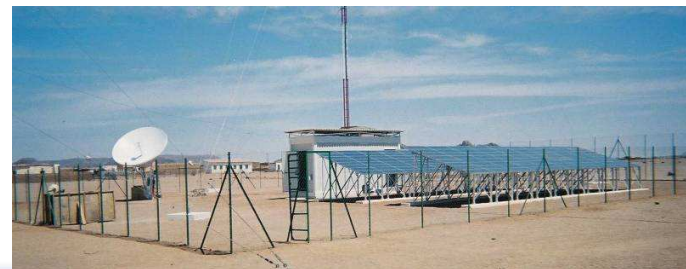
- **Low jitter and low delay (< 300 ms)**
- **Transport of analogical signal for transmitters (PTT)**
- **No call establishment procedure (open channel)**

VHF/UHF (Voice): TWR, APP, ACC. HF (Voice): Mainly for ACC.

VHF-VDL: Data (VDL-M2, to M4)

CPDLC (data communications between pilot and controller).

→ **INEO E&S** has a long term experience to ensure high-quality and high-reliability transport of the AMS service



Airspace Surveillance

Radar traffic (SSR or PSR) requires network-wide synchronism and low jitter
INEO E&S has already installed networks carrying **RADAR data** (Venezuela, ATNS...) and **Multilateration**

Next generation systems such as **ADS-B (UAT, 1090ES and VDL mode 4)** or **ADS-C** are already being implemented in some countries, and here again delay control is a key feature.



Meteorological systems

Meteorological systems:

- Automated weather observing system (AWOS)
- ATIS (Automatic Terminal Information Service)

Those services are likely to be centralized in order to have a global view of the network.
This class of service is not affected by jitter.



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REDDIG and Peruvian network examples

Presentation summary

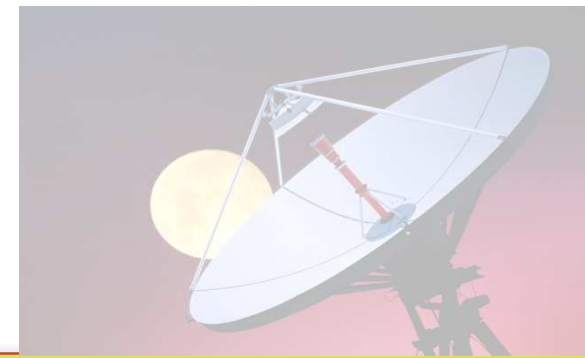
- INEO E&S aeronautical export department
- ATC communications
- REDDIG and Peruvian network examples
 - A continental success: REDDIG
 - The new Peruvian VSAT network
- Anticipating the future

A continental success:

REDDIG

REDDIG at a glance

- **Reddig** (“Red Digital”) is a **private network** that ensure the communications between all the Civil Aviation Authorities in South America. This project was carried out by **SEEE** (now **INEO E&S**).
- The nodes are located in **Argentina, Bolivia, Brazil** (3 stations), **Chile, Colombia, Ecuador, Guyana, French Guyana, Paraguay, Peru, Surinam, Trinidad and Tobago** (2006), **Uruguay** and **Venezuela**.
- One of the **best example of ATC cooperation** in the world that underlined the benefits of such a project:
 - > **Economy**: scale-cost saving
 - > **Safety**



Implantation of the REDDIG system

- Argentina
Buenos Aires
- Bolivia
La Paz
- Brazil
Curitiba
Manaus
Recife
- Chile
Santiago
- Colombia
Bogota
- Ecuador
Guayaquil
- Guyana
Georgetown
- French Guyana
Cayenne
- Paraguay
Asunción



- Peru
Lima
- Suriname
Paramaribo
- Trinidad and Tobago
Piarco
- Uruguay
Montevideo
- Venezuela
Caracas

REDDIG devices



Rack Lima



VSAT Antena Buenos Aires



Management Center



TDMA Management software

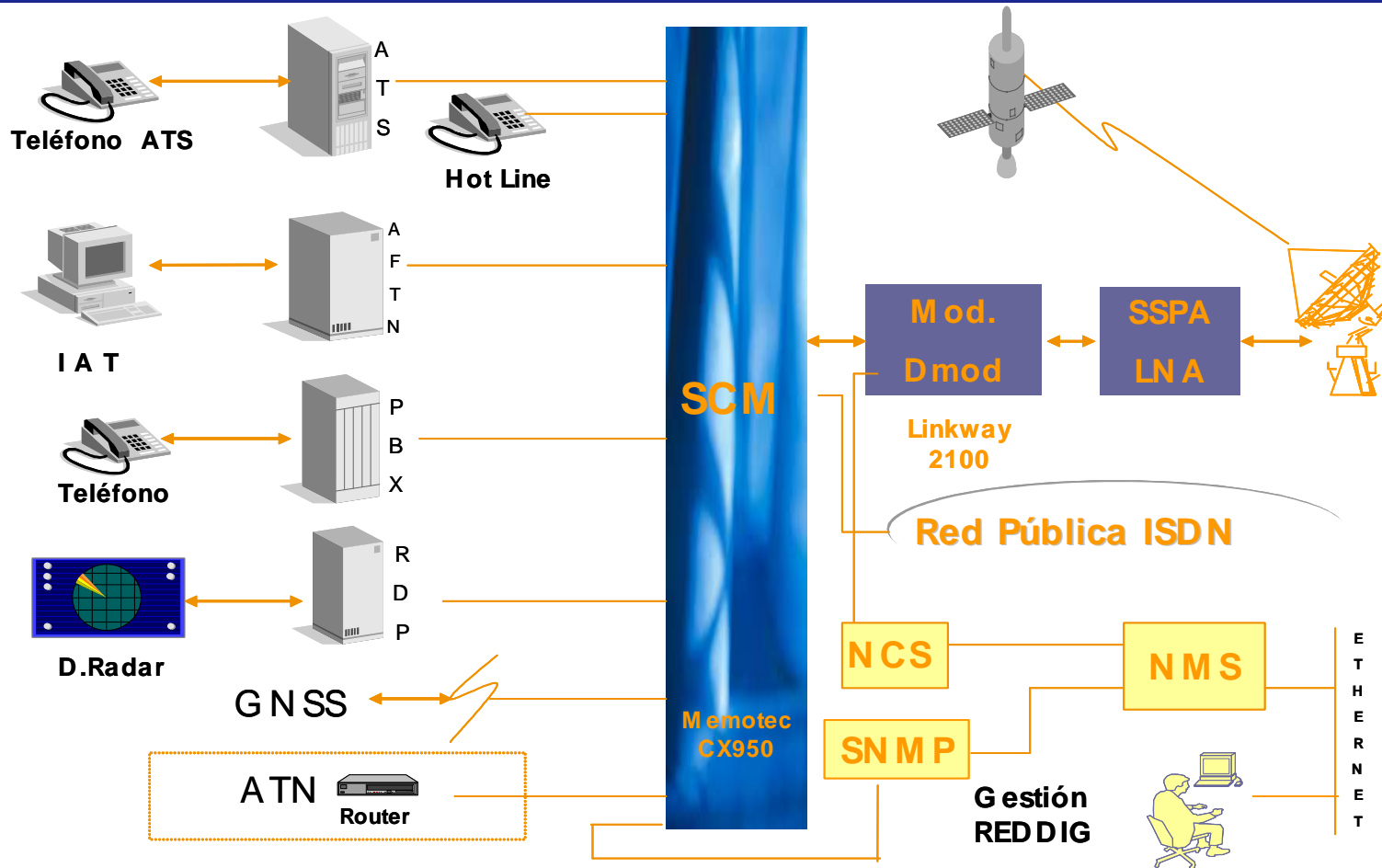
REDDIG : services and properties

- Air traffic control data: flight plans (Departure, transit, Arrival), RADAR display
- Meteorological data and AFTN from every airport
- Service messages
- ATS communications between air-traffic controllers for continental-wide flight following
- Local and National network interconnection
- Communications between administrative and technical authorities from the whole South America

- Compatibility with ATN and GNSS
- Digital and analogical interfaces (E1 y ISDN)
- Bandwidth optimization through TDMA
- Expansible and dynamic network



REDDIG : Typical station layout



REDDIG : Aeronautical VSAT network in South America



TDMA and **Frame Relay** System with **redundancy** and flexible interconnection capabilities.

Full remote controlled Network Management System (NMS).

Geographical redundancy for bandwidth management through Network Control Centers.

Flexible expansion capabilities without new hardware implementation.



Equipment Status Summary - Microsoft Internet Explorer

Address: | C:\WINDOWS\LOCAL_MACHINE\SOFTWARE\INETSOFT\...

< SSIPA Control > < Chain Control > < Automatic Mode Control >

Status Summary as on Mon Sep 30 11:25:21 GMT 2002

Redundancy: Auto mode is DISABLED

SSIPA units:

UNIT A: SSIPA No. 1 Status: Attenuation = 17.7 dB, External Mute = OFF, Internal Mute = ON, RF Power <= 0 dBm, No Alarm

UNIT B: SSIPA No. 1 Status: Attenuation = 20.0 dB, External Mute = OFF, Internal Mute = ON, RF Power <= 0 dBm, No Alarm

Switches: Waveguide switches are in position A, Baseband switch is in position A

Link Management: Modem link on FRAD-MPS-A is UP, Modem link on FRAD-MPS-B is DOWN

COLOR LEGEND: OIE / On-line Down / Critical Alarm Lightdown / Secondary Alarm

The new Peruvian VSAT network

The new VSAT network will be **CORPAC's new backbone.**

- **Fully-meshed** network with state of the art **MF-TDMA modem**
- Full redundancy of the devices for maximum availability
- **Security** and **availability** oriented architecture to ensure **two independent communication links** for the new RADAR (IP) service
- Backup link through the existing REDAP network



The 7 new remote sites



Lima: Master site

Cerro Rayado

Cerro Collpayoc

Cerro Tocto

Cerro Acopia

Pucallpa

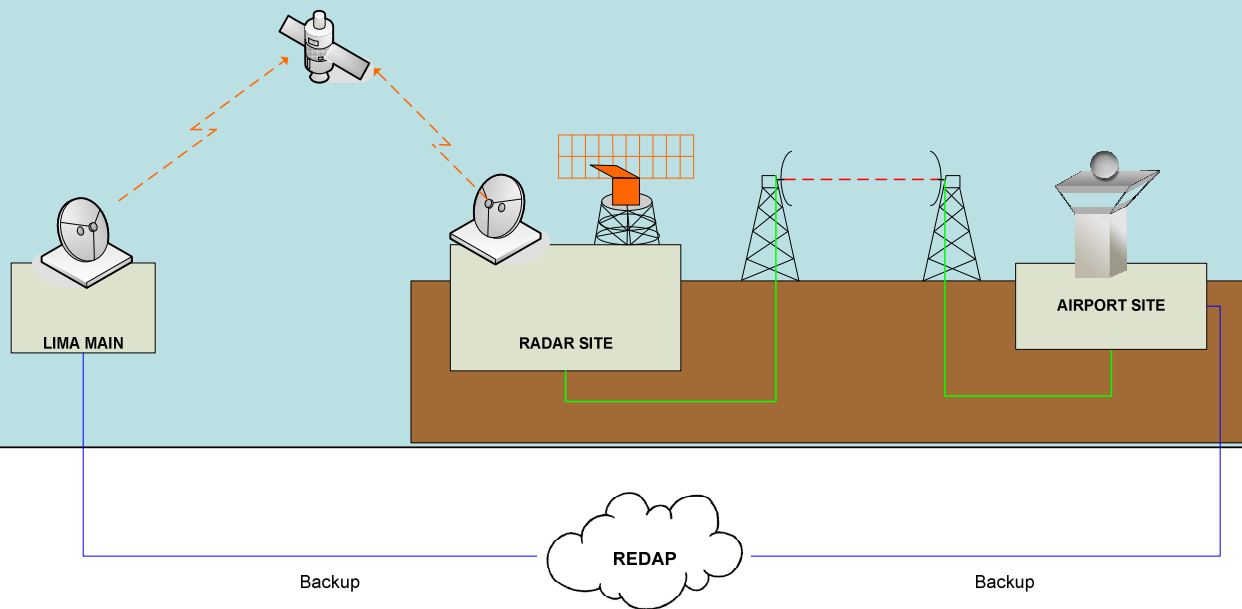
Talara

Iquitos: Backup Master

-> **Hubless** topology

-> **Geographic diversity** for
Satellite backup master

Dual link architecture

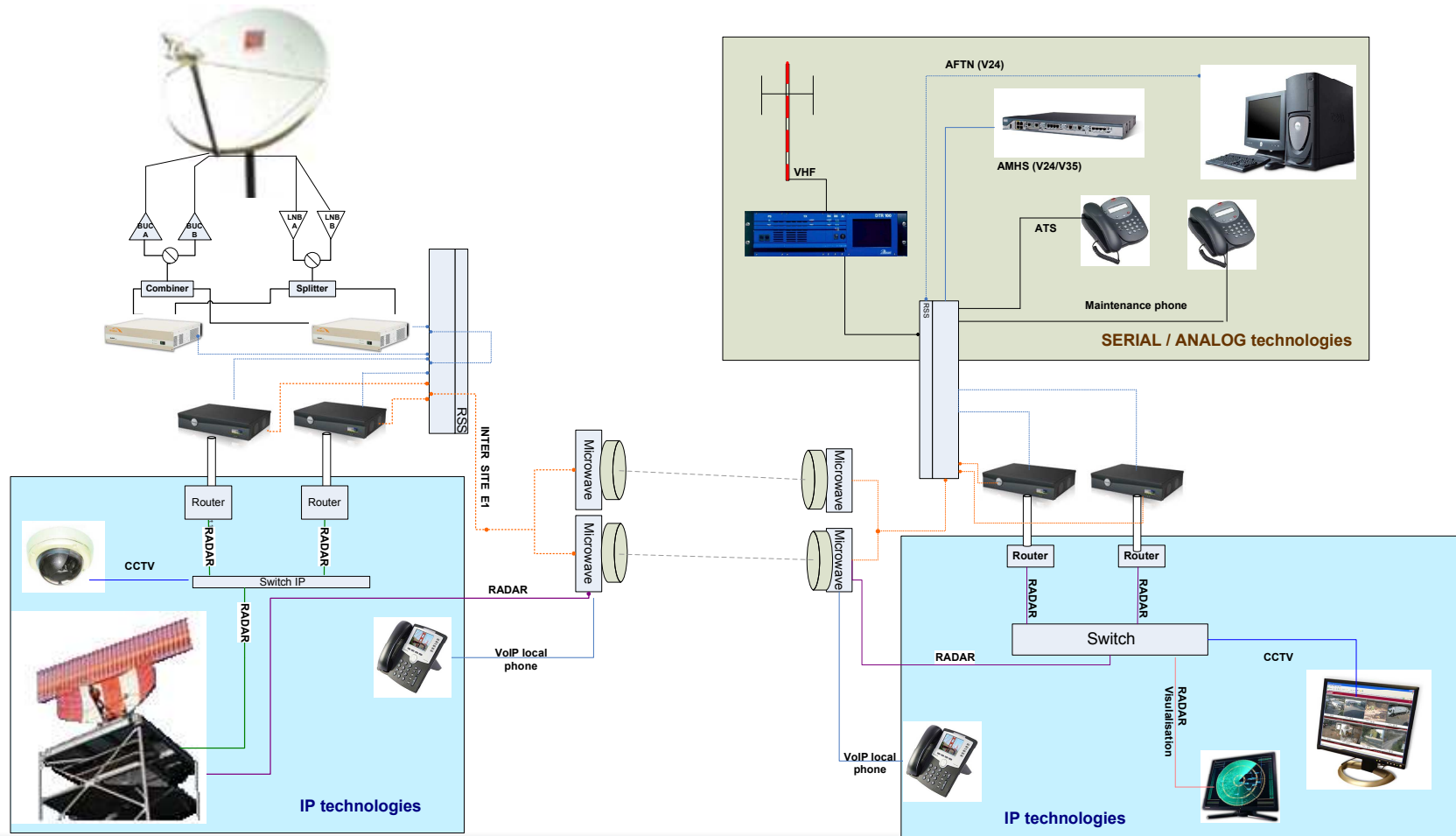


- Main link through Satellite link
- Backup link through REDAP network
- RADAR flows are transmitted **simultaneously on both links**



IMPROVED SAFETY

REDUNDANCY ON THE INSIDE



CORPAC network features

- **Hardware redundancy**
- **Communication link redundancy**
 - Improved safety



- **Dual technology support: IP and Serial/Analog interfaces**
 - First step to the IP convergence

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- **Anticipating the future**



Anticipating the future

→ Satellite technologies & IP features

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- **Anticipating the future**
 - Satellite communications: a future technology ?
 - Satellite access: the TDMA hegemony ?
 - The IP convergence

**Satellite communications :
a future technology ?**

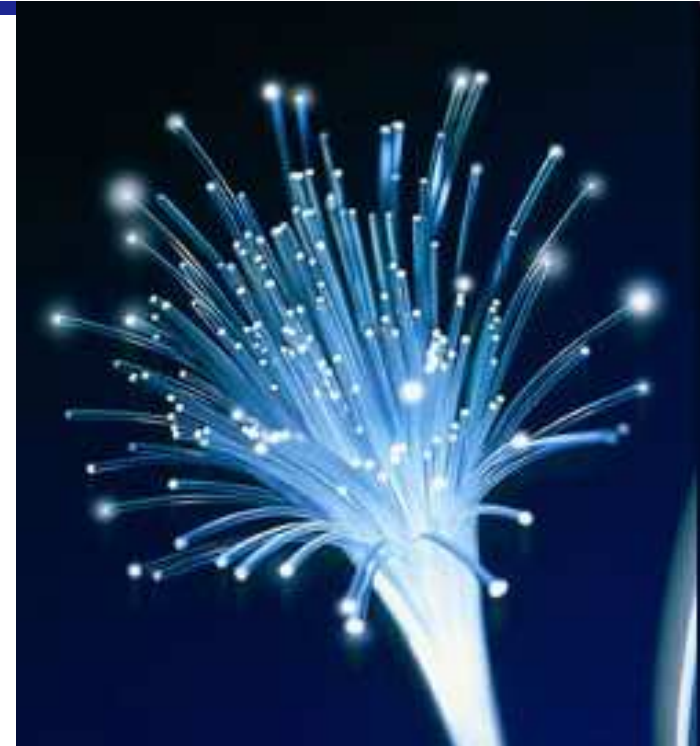
The Optical fiber age ?

Optical fiber advantages

- Huge bandwidth
- Low maintenance
- Low delay

Optical fiber drawback

- High installation cost (civil work)
- Physical weakness
- Shared resource (if purchased to a provider)



The key features of VSAT networks

- **Satellite bandwidth allocated by 100kHz**
 - > NO SHARED CAPACITY

➔ **Independent network**

- **Robust network configuration**
 - > Hubless
 - > Master backup functionality

➔ **No single point of failure**

- **Easily deployed**
 - > Low infrastructural needs
 - > Autonomous solutions (solar panels)

➔ **Low density area installation possible**



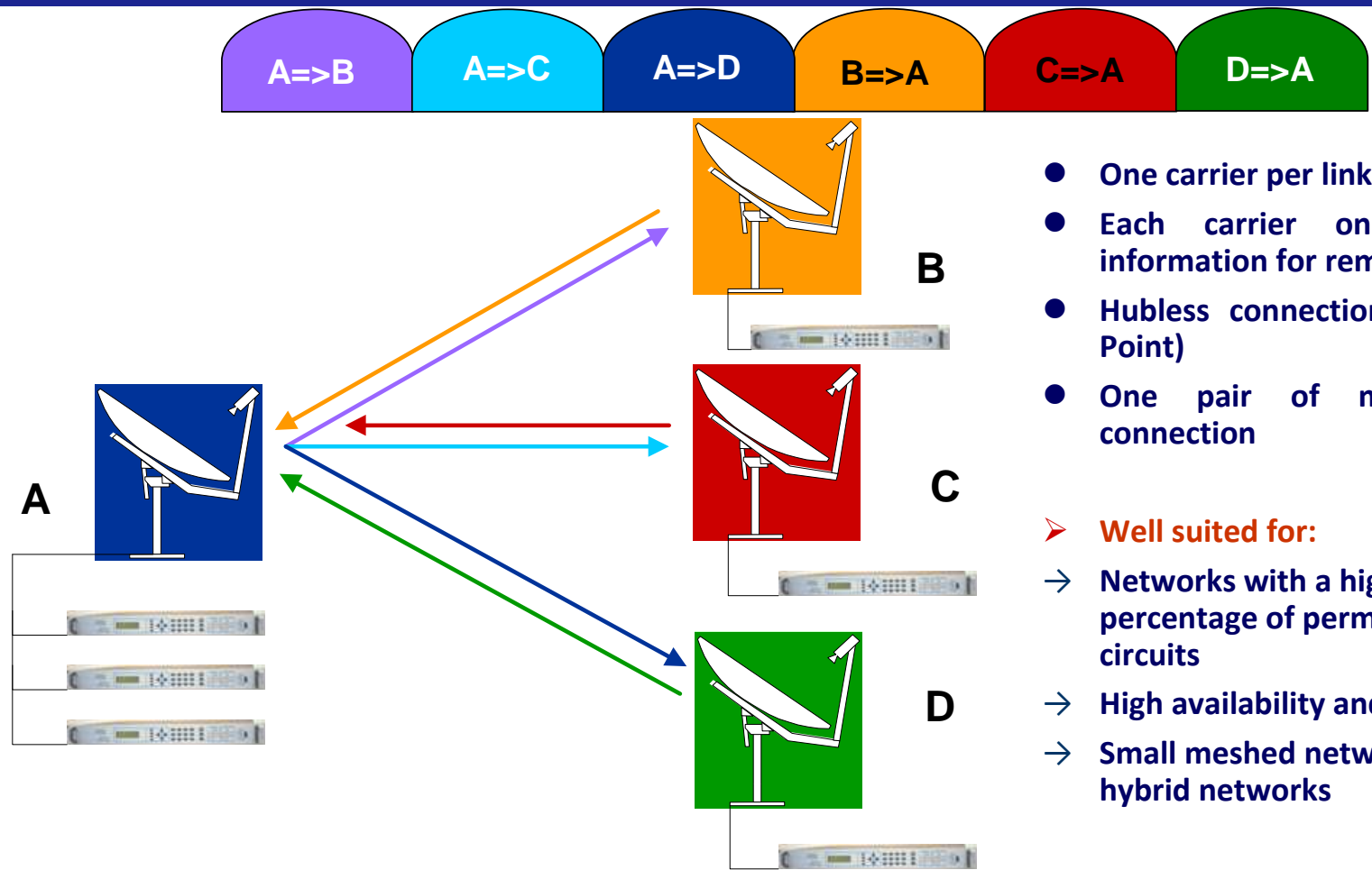
Faster disaster reaction

- Optical fiber is vulnerable to earthquakes
- Unlooped OF network → loss of most part of the communications
- Satellite network: lower damage to outdoor equipment
- Loss of one station doesn't impact the others
 - faster recovery of communications
 - faster help organization in the heart of the tragedy
 - Possible use of SNG (small news gathering)



**Satellite access :
the TDMA hegemony ?**

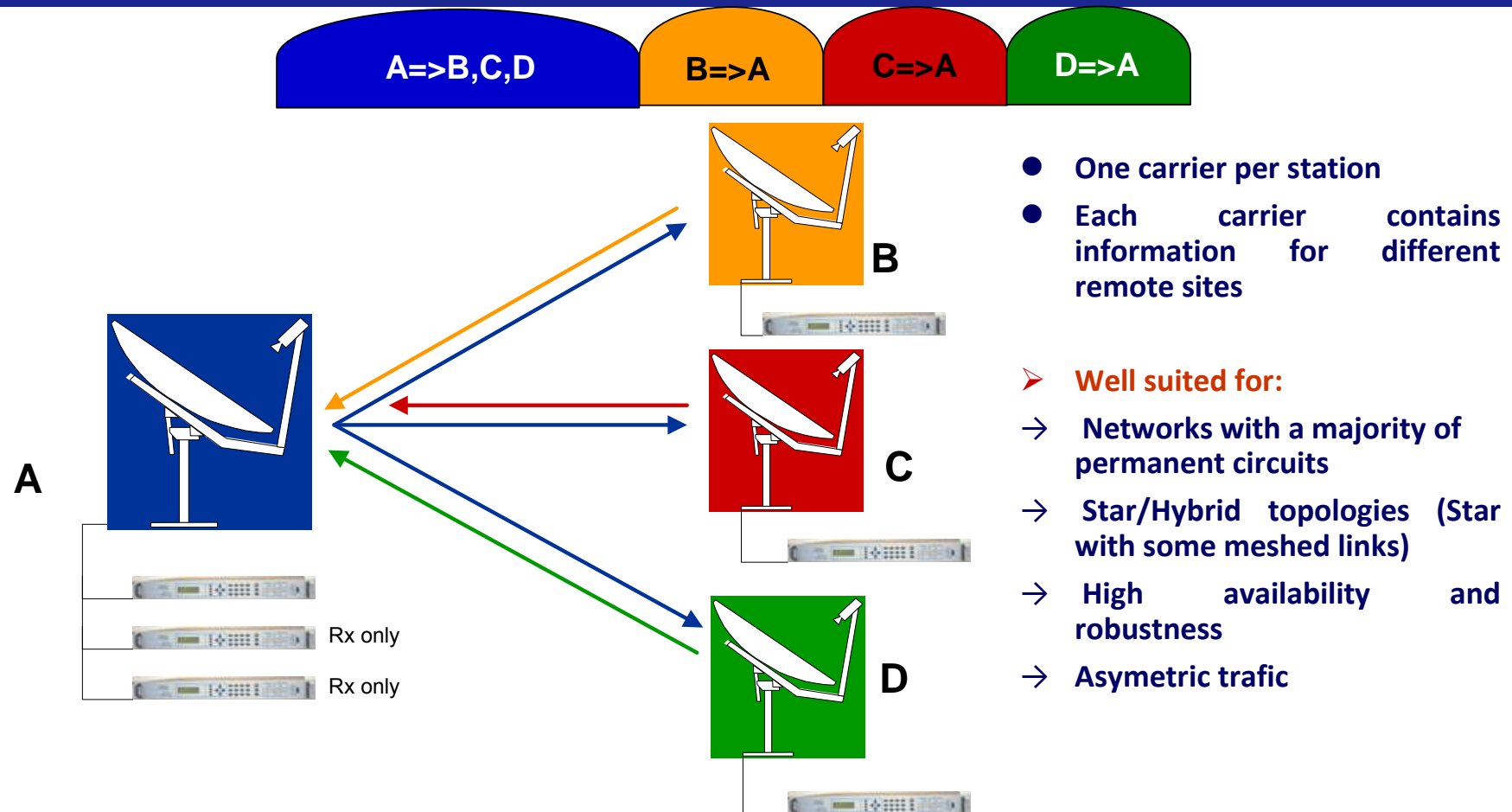
Point to Point - SCPC



- One carrier per link
- Each carrier only contains information for remote site
- Hubless connections (Point to Point)
- One pair of modem per connection

- **Well suited for:**
- ➔ Networks with a high percentage of permanent circuits
 - ➔ High availability and robustness
 - ➔ Small meshed networks or large hybrid networks

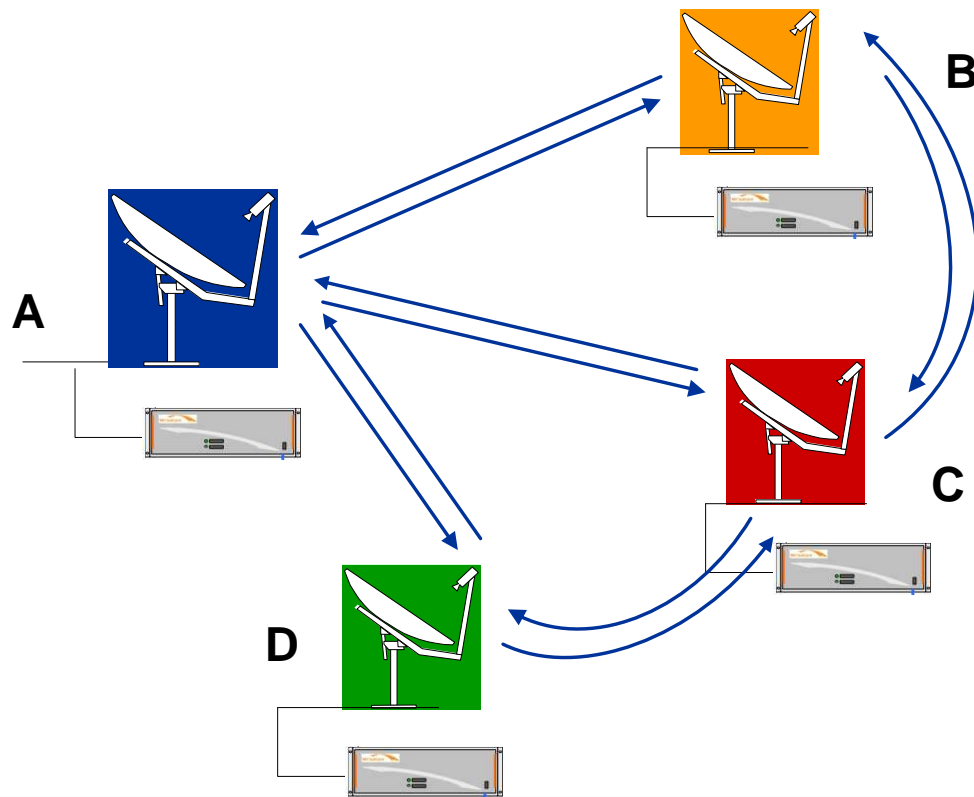
Point to Multipoint - MCPC



TDMA



A,B,C,D=>A,B,C,D



- One carrier shared by a large number of stations
 - Frequency hopping : Multi Carrier
 - Time divided in slots.
 - Synchronisation stations (one main, one stand by)
- **Well suited for:**
- Networks with a high percentage of DAMA circuits
 - Full Mesh topologies with a large number of sites
 - Flexibility

Bandwidth Allocation

Bandwidth can be allocated permanently (**PAMA**) or on demand (**DAMA**)

PAMA Services:

- Radar
- VHF



Low JITTER
No BW request

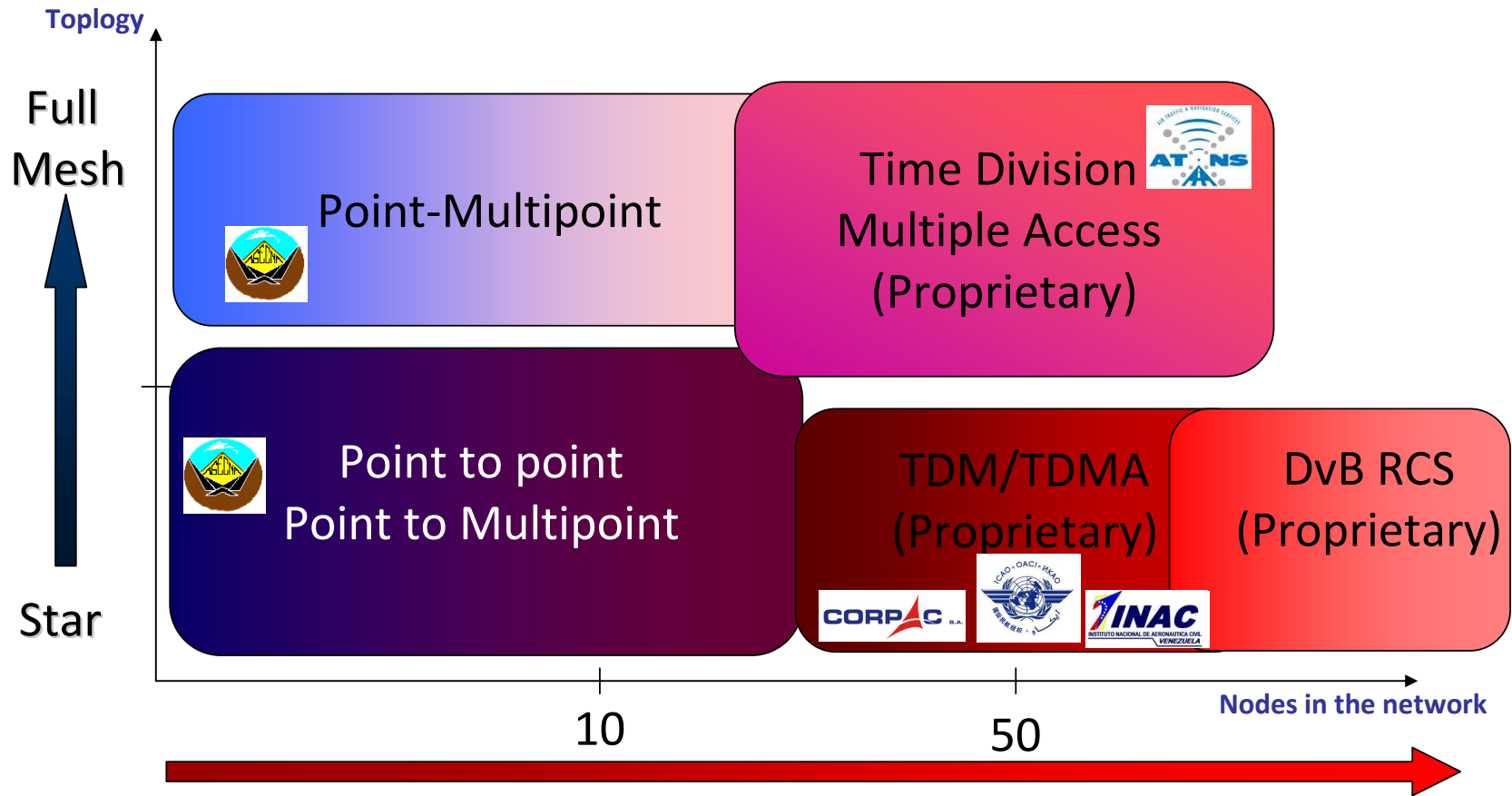
DAMA Services

- AFTN, AMHS
- ATS/DS
- RCMS (VOR, Radar, VHF, etc)
- M&C



BW on demand
PAMA on demand for real time
(low jitter)

VSAT Technologies



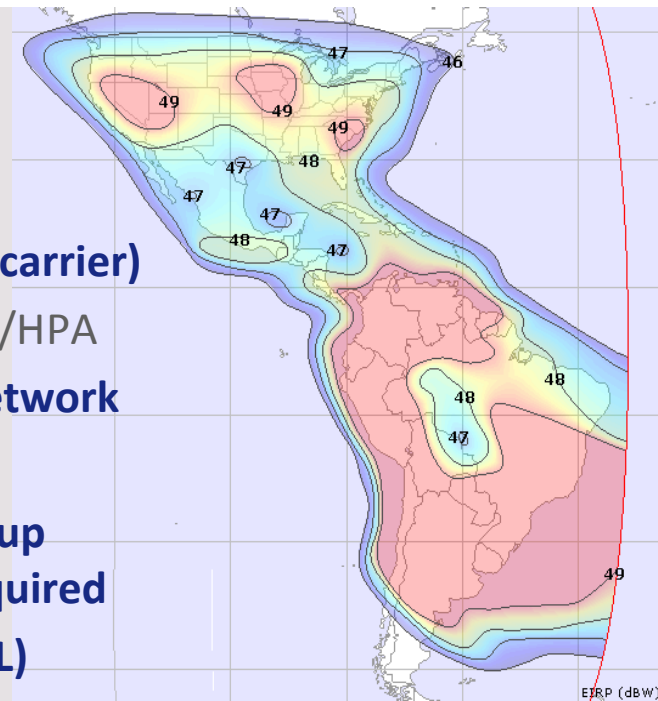
TDMA analysis

Advantages

- Bandwidth on demand
- Tighter frequential spectrum
- Network flexibility:
 - Add station
 - Add circuits / services
- Powerfull in meshed network
- Less hardware

Drawbacks

- Modem cost
- Big RF part (large carrier)
 - Larger Antena/HPA
- Same RF in the network
- Master (and backup master) station required
- TDMA header (SLL)



Satmex6 - Ku

MCPC/SCPC analysis



Advantages

- PAMA oriented connection
- Cheaper RF part on the remote site
 - Well suited for desartic area
 - Low upload traffic
- Cheap unit price
- Star topology

- MCPC :
 - Well suited for asymmetric traffic
 - Cheaper hardware (less modulators)

Drawbacks

- No bandwidth on demand
- Higher frequential spectrum consumption
- Bad suited for Hybrid / Meshed topology
- Requires hardware and frequential spectrum for new connections

TDMA vs MCPC/SCPC

TDMA is more flexible than MCPC/SCPC, at the expense of RF part.

Both technologies evolve in parallel, TDMA is not newer or better than MCPC/SCPC (both technologies now support Turbo coding), they answer to different needs and topology

→ **Strategic and political choice**

→ **SCPC/MCPC is suited for STAR topology and Autonomous remote sites**



The IP convergence

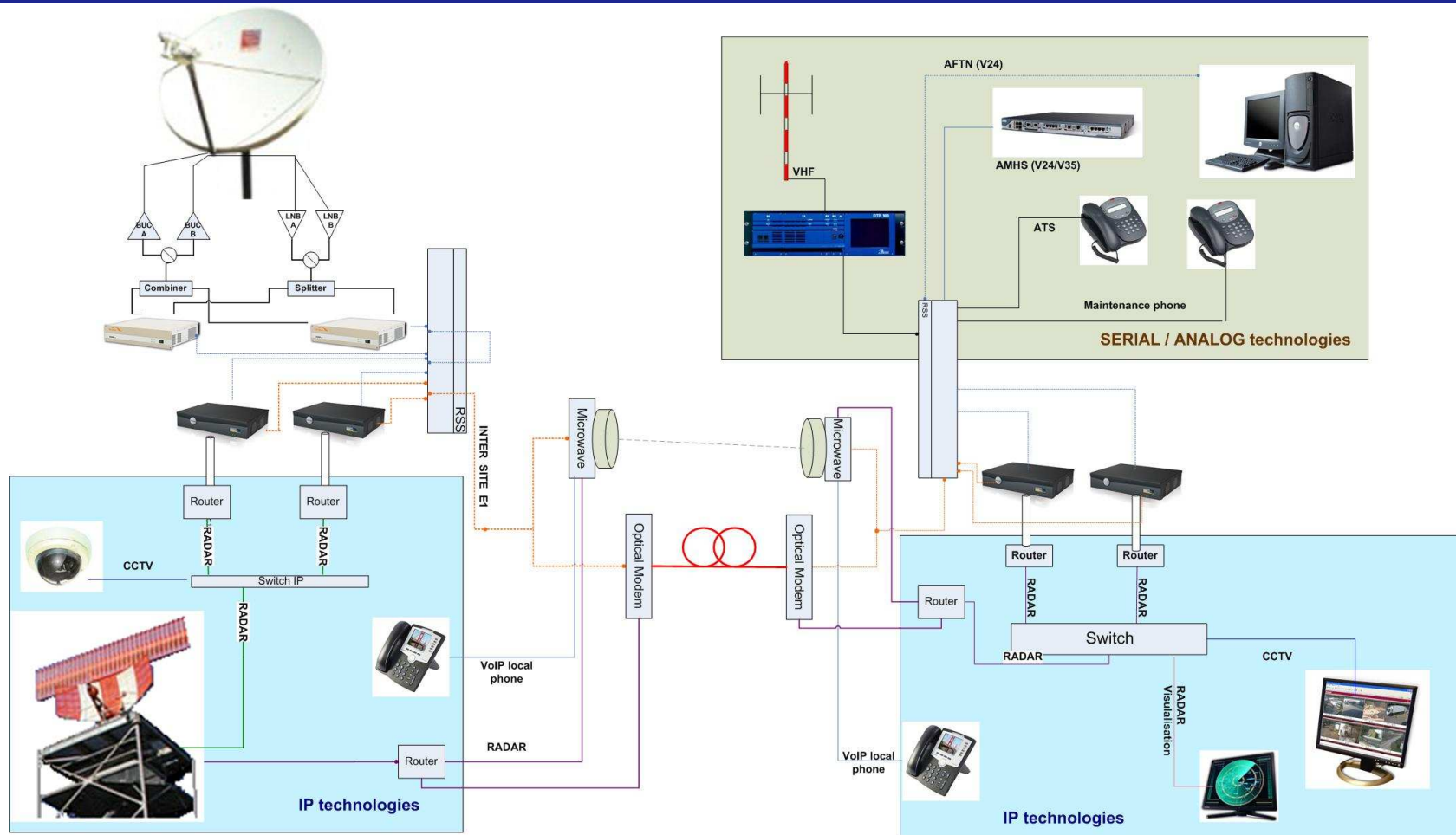
Voice communications

- VCSS will be compatible to be connected directly over IP (and ideally, not through a box converting Voice to IP)
- ATS communication will be fully compatible with VoIP

For the **Mobile Service, Frame Relay remains one of the best options (unless VHF equipment manufacturers come with a solution over IP):**

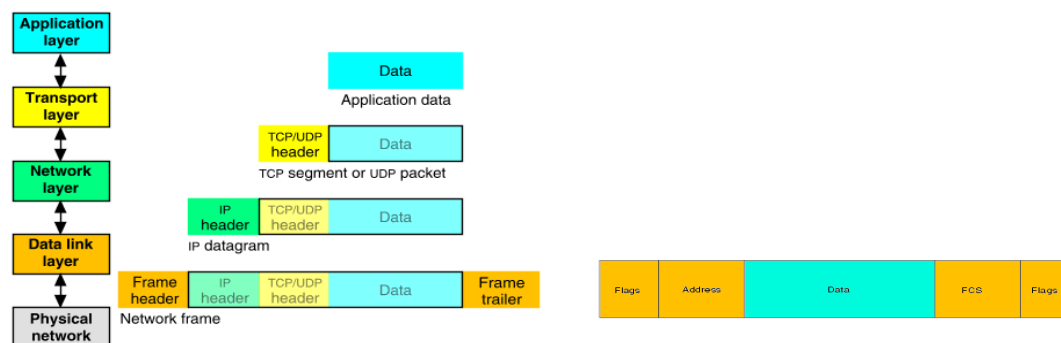
- > PTT information shall arrive before the voice: **not guaranteed with IP**
- > Hybrid architecture required: **IP and Frame Relay**

Hybrid architecture IP and Serial/Analog



IP vs Frame Relay

Frame Relay is a layer 2 protocol, whereas IP is at layer 3



	IP	Frame Relay
ISO level	3	2
Encapsulation	packet	frame
Efficiency	Low -26 % for voice	High – 85% for voice
G729 data rate	31,2 kbps (with MAC addr)	11 kbps
Advantages	<ul style="list-style-type: none"> - Flexibility of configuration - Mesh structure with automatic routing (static or dynamic) - Low price (widespread) 	<ul style="list-style-type: none"> - Optimization of space segment - QOS - Supports various protocols (async, sync, E&M)
Drawbacks	<ul style="list-style-type: none"> - Bandwidth not optimized - QOS 	<ul style="list-style-type: none"> - Hardware cost - Proprietary of access device type

Data transfert tendencies

Most of Data services are turning to IP

- **AMHS** over IP instead of AFTN
- **RADAR** service over IP instead of serial

RADAR service requires fixed delay to compute country-wide data

→ Jitter is critical

→ IP is bad suited to synchronism and jitter-free application

SOLUTION:

Huge bandwidth (Optical Fiber)

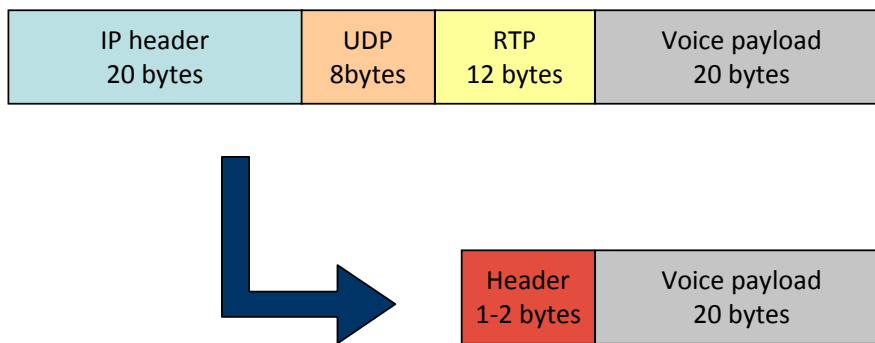
Use of smart concepts: **QOS/TOS IP**

- **Use of Type Of Service (TOS) IP**
 - Identify the type of service associated to an IP flow
 - Associate special treatment according the service
 - Real time circuit (voice, streaming)
 - Non-real time circuit (data transfert)
 - Flow distribution: unicast/multicast

- **Use of Quality Of Service IP**
 - Prioritization
 - Use of header compression
 - TCP-Acceleration for file transfert



Header Compression



Header compression is a decisive step to make VoIP over Satellite competitive

Header compressed up to 1 (RoHC) or 2 bytes (CRTP)

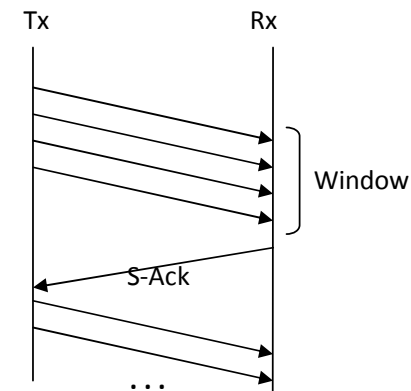
Usual compressed header size: 2 to 4 bytes

- > Data rate 11.6 kbps
- > Full packet needs to be sent periodically

TCP-Acceleration

TCP-A:

- Selective acknowledgement
 - > Receiver informs the transmitter which packets must be re-sent
- Multiple packet emission: large « Window » transmission
 - > Transmission of multiple packets without Ack
 - > Reduced number of Ack
- Improved file transfert through satellite
 - > Lower delay impact on file transferts
 - > Higher data throughput



Confidentiality and Security

IP convergence and world-wide interconnections made possible country-wide cyber-attacks.

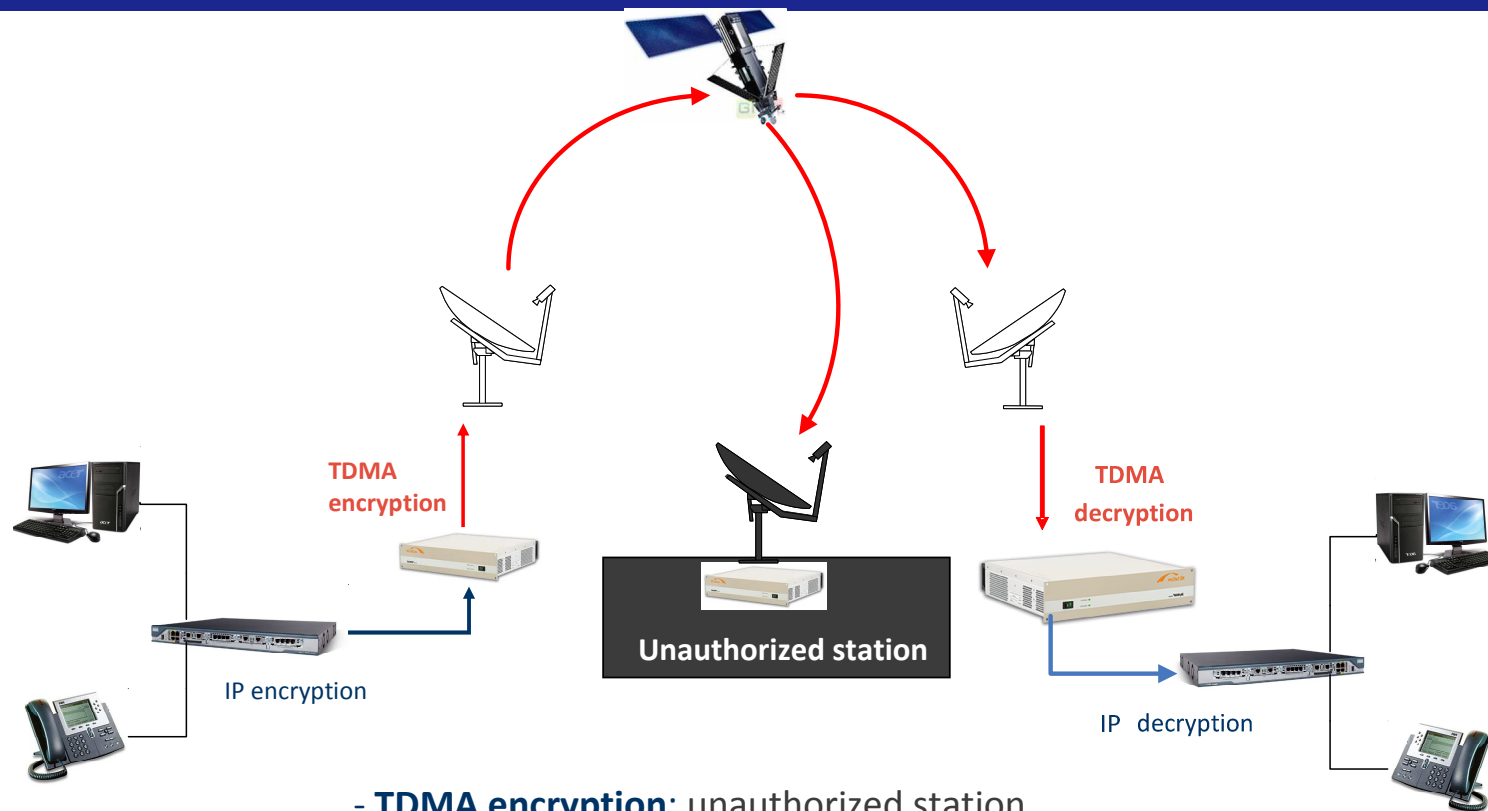
- Flooding or intrusion
- Security in IP networks is a key issue

Solution

- Encryption: IPsec
- Firewalls to prevent intrusions
- TDMA encryption to prevent intrusion or spying



Double encryption



- **TDMA encryption**: unauthorized station cannot enter the network nor decode the data
- **IP encryption**: second encryption
- **Drawback**: slower datarate/bandwidth



INEO E&S

Thank you for your attention

Contacts



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