The 2007 CubeSat Developer's Workshop
LOS ANGELES-CALIFORNIA

CUBESAT – UD TELEMEDICINE AND TELEMETRY

UNIVERSIDAD DISTRITAL FRANCISCO JOSE DE CALDA

BOGOTA-COLOMBIA

GITEM

Ph.D LILIA EDITH APARICIO PICO

Ms.C ERNESTO GOMEZ VARGAS

AGENDA

1. INTRODUCTION
Colombian Aerospace Agenda

Surface:

1.141.178 Km² Territorial

928.660 Km² Maritimes

- **Location:** *South America*.
- **Limits:** 12 FRONTERAS

  5 Terrestrial y 7 Maritimes
- **Population:** 40.000.000
- **Capital:** Bogotá, D.C
- **Language:** Spanish.
- **Money:** Colombian peso.
- **Main Cities:** BOGOTA, CALI, MEDELLIN, BARRANQUILLA, **CARTAGENA.**

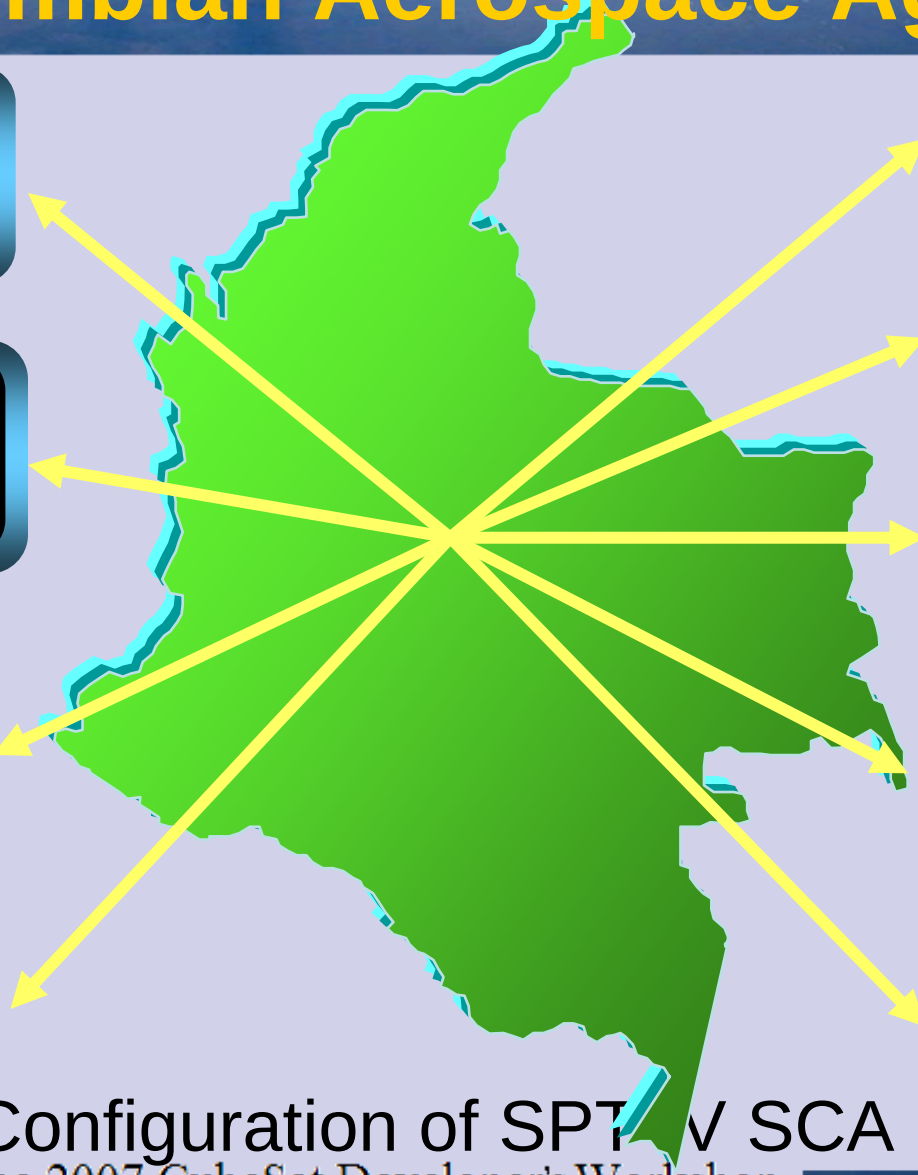
1. INTRODUCTION
Colombian Aerospace Agenda

-Backwards

What has been the Colombia History on Space Affaires?. Some important aspects are:

- Since 1978 Colombia has been part of United Nations- Office of Outer Space Affaires
- Colombia has not signed any of the Space Treatment
- From 2002 to 2006 Colombia was Secretariat Pro-Tempore of the Fourth Space Conference for the Americas **SPT IV SCA** to develop a plan of action on the Space field and in benefit of the American Region
- Since July 2006 **Colombia** has an **Space Agency** represented by the Colombian Space Commission and with the approval of Colombia President.

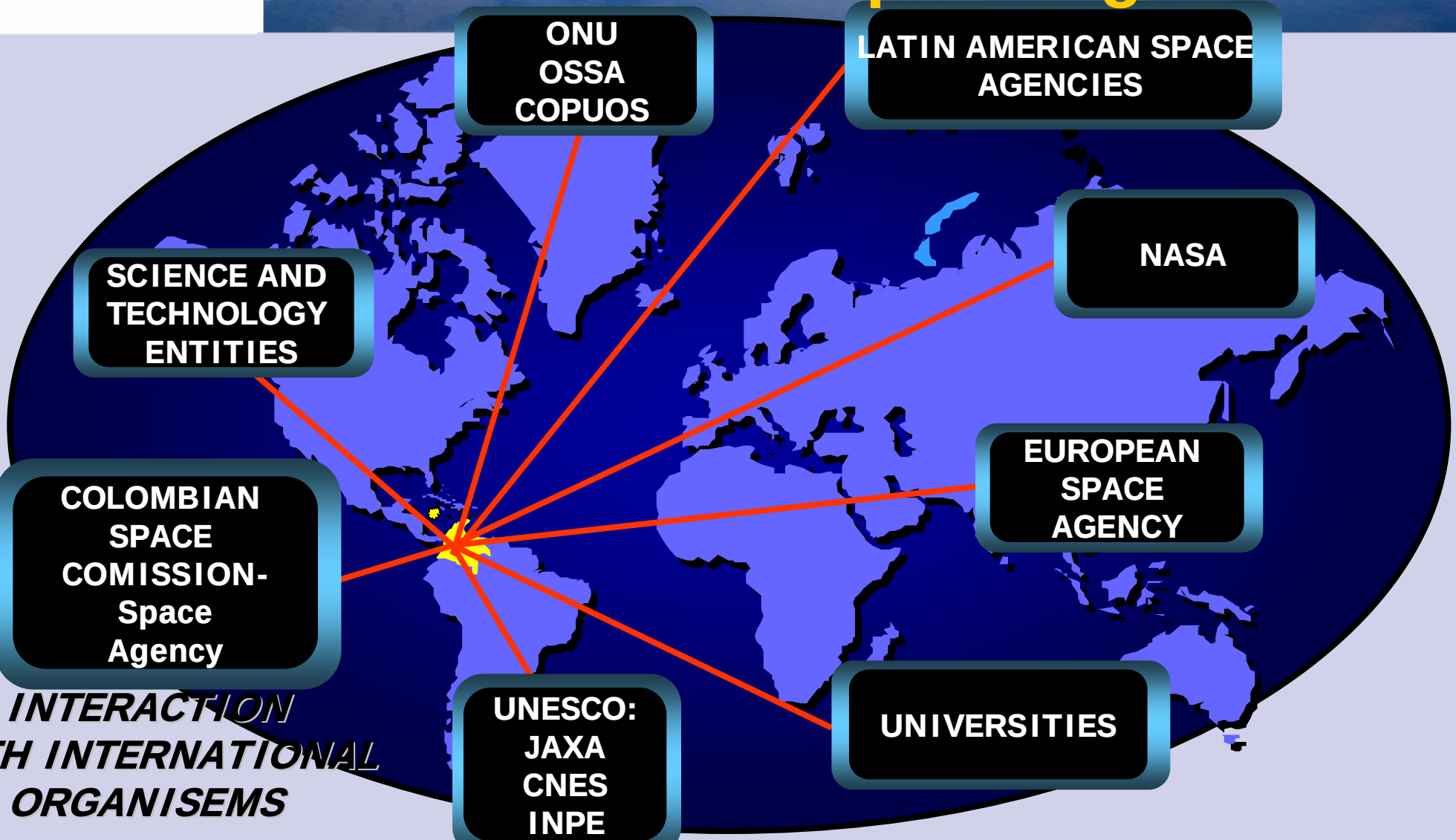
1. INTRODUCTION
Colombian Aerospace Agenda



- MINISTRY OUTER AFFAIRES
- GEOGRAFICAL INSTITUTE AGUSTIN CODAZZI
- TRANSPORTATION MINISTRY
- DISASTER PREVENTION DIRECTION
- CIVIL AVIATION OF COLOMBIA
- COLOMBIA AIR FORCES
- EDUCATION MINISTRY
- PRIVATE PUBLIC UNIVERSITIES
- OTHER INSTITUTIONS

Configuration of SPT V SCA

1. INTRODUCTION
Colombian Aerospace Agenda



INTERACTION WITH INTERNATIONAL ORGANISEMS

1. INTRODUCTION
Colombian Aerospace Agenda

COLOMBIA AS SPT IV SC

A. Focal point: Civil Aviation of Colombia: Engineer Msc Satellite Based CNS Juan Carlos Narvaez.

B. PLAN OF ACTION OF SPT IV SCA

   A. Sustainable Development

   B. Disaster Prevention and Telemedicine

   C. Education

   D. Political

   E. Broadcasting

1. INTRODUCTION
Colombian Aerospace Agenda

ACADEMIC PICOSATELITE PROGRAM IN COLOMBIA

A. Pico satellite Project carried out in Colombia by:

- Sergio Arboleda University
  - Mission: Down Load Telemetry
  - Current Status: Launched
- Distrital University
  - Mission: Telemedicine as a demonstration of Space Technology
  - Current status: starting CDR
- San Buenaventura University (SBU)
  - CANSAT Project. Feasibility

1. INTRODUCTION
Colombian Aerospace Agenda

PROGRAM ORGANIZATION

Libertad y Orden

AERONAUTICA CIVIL

Carrier provider

CAL POLY

Subsystem Provider

CUBE SAT KIT

Expected to search for Sponsors

Dnepr Launch Vehicle Services

2. PDR GENERAL SCENARIO

- **2.1 MISSION STATEMENT**
- **To develop, an academic pico satellite, endowed with the specific technical requirements that allow the training of the human resource in Science and Space Technology and the infrastructure establishment that allows to develop Telemedicine applications in order to improving the quality life of the communities.**

2. PDR GENERAL SCENARIO

- **2.2 OBJECTIVES**
- **To implement a Laboratory of picosatellites research for training and development of a space program that it is reverted in the academic environment.**
- **To implement a telemedicine pilot project with space technology, for transmission and reception of ECG signals.**

2. PDR GENERAL SCENARIO

2.2 OBJECTIVES

- To obtain telemetry data that can be used to prove project success and guarantee future research process.

2. PDR GENERAL SCENARIO

2.3 . MISSION

PRIMARY MISSION

- The primary mission is telecardiology –test-bed between Bogotá to Neiva for telemedicine research.

SECUNDARY MISSION

- Uplink -Downlink Telemetry and control through the establishment of Ground Segment

2. PDR GENERAL SCENARIO

- **2.3 MISSION**
- **PRIMARY MISSION**
- **Background:** We have designed an experiment to research the performance of the telecardiology system using internet the principal interest is to bring medical services to isolated communities through satellite networks.

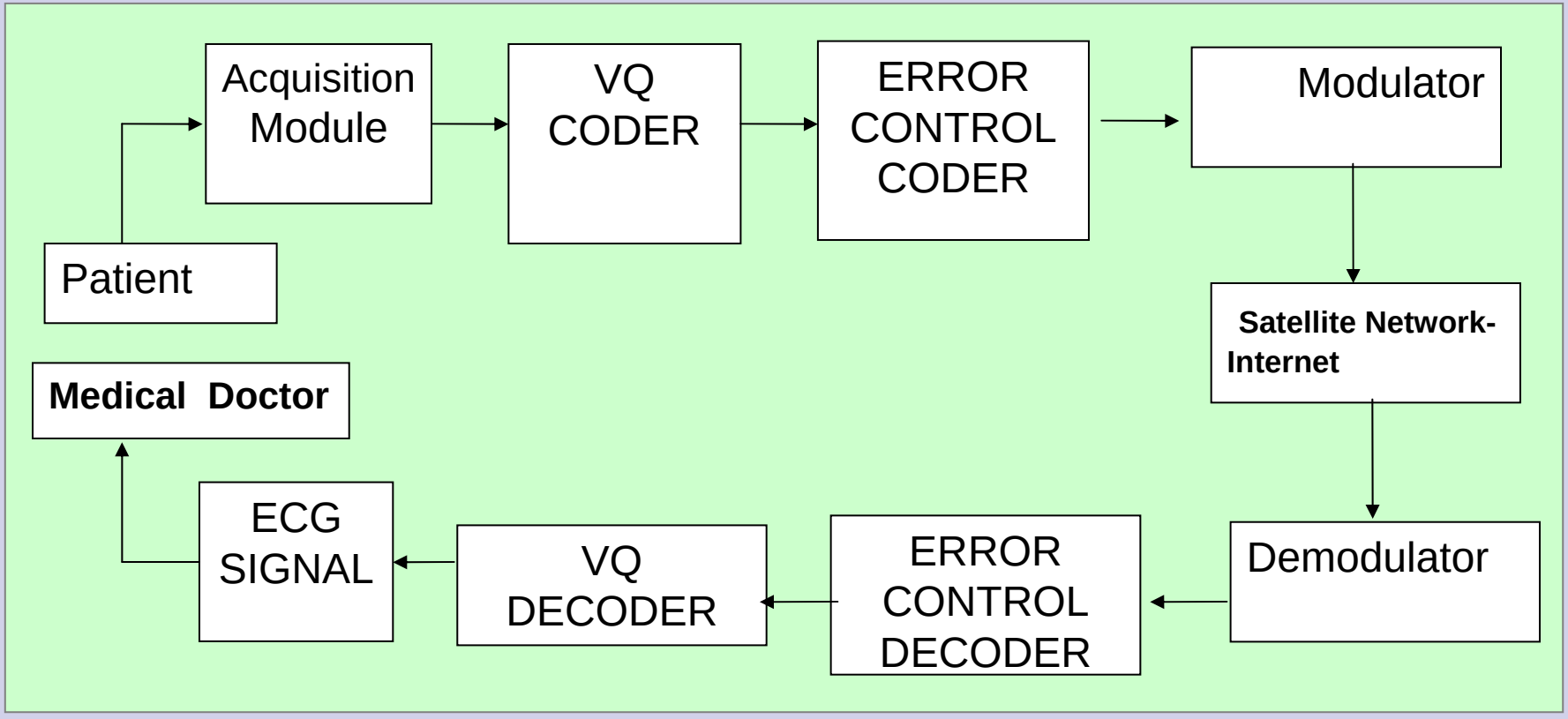
2. PDR GENERAL SCENARIO

- **2.3 MISSION**
- **PRIMARY MISSION**
- **Objective**: The objective of this research is to evaluate the performance of a telecardiology system on internet and picosatellite networks using cubesat-ud

2. PDR GENERAL SCENARIO

2.3 MISSION

PRIMARY MISSION



Telecardiology System

2. PDR GENERAL SCENARIO

2.4. MININUM SUCCESS CRITERIA

Cubesat Project

To deliver CubeSat-ud at the El Dorado Airport for launching.

Mission

To transmit a virtual patient cardiology information set between Bogotá-Neiva.

2. PDR GENERAL SCENARIO

- 2.5. OPERATION CONCEPT

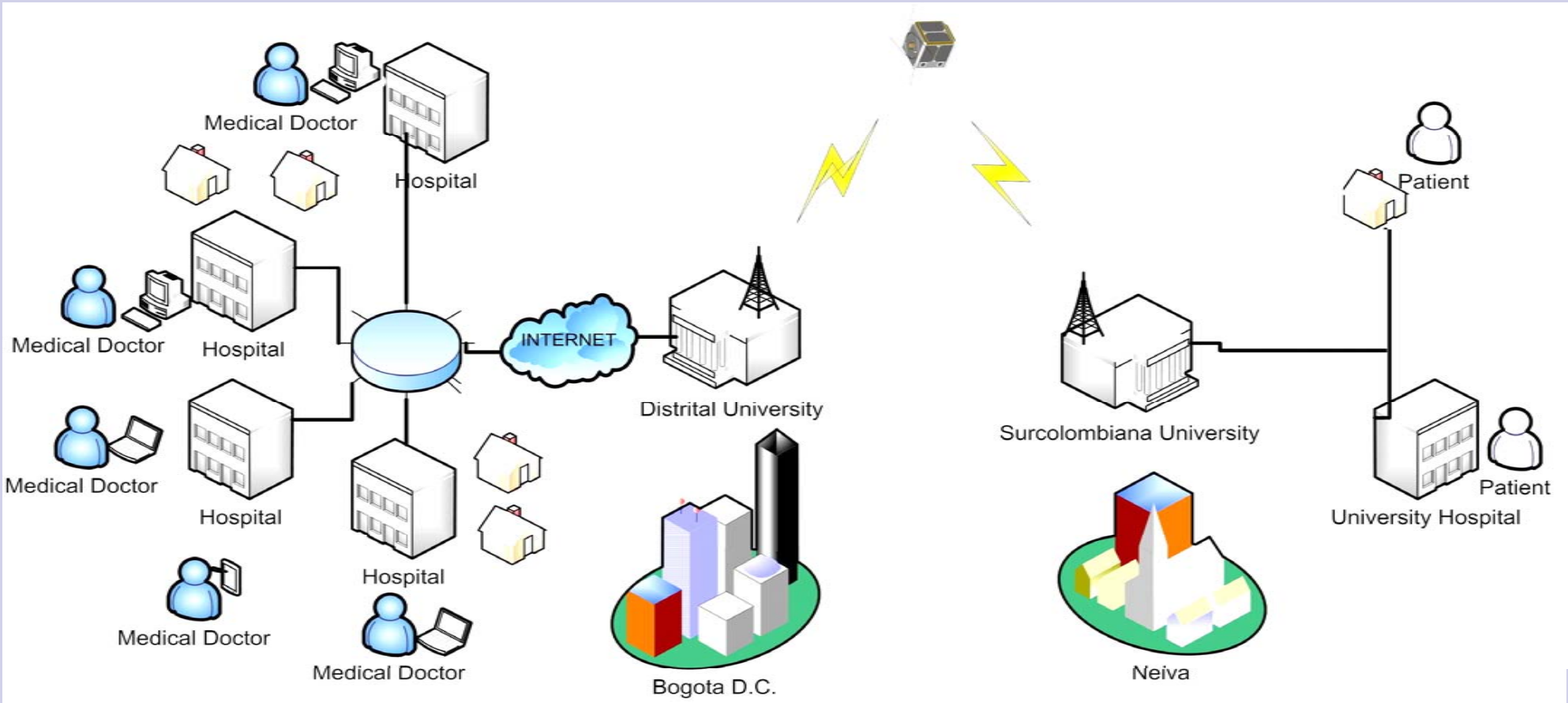
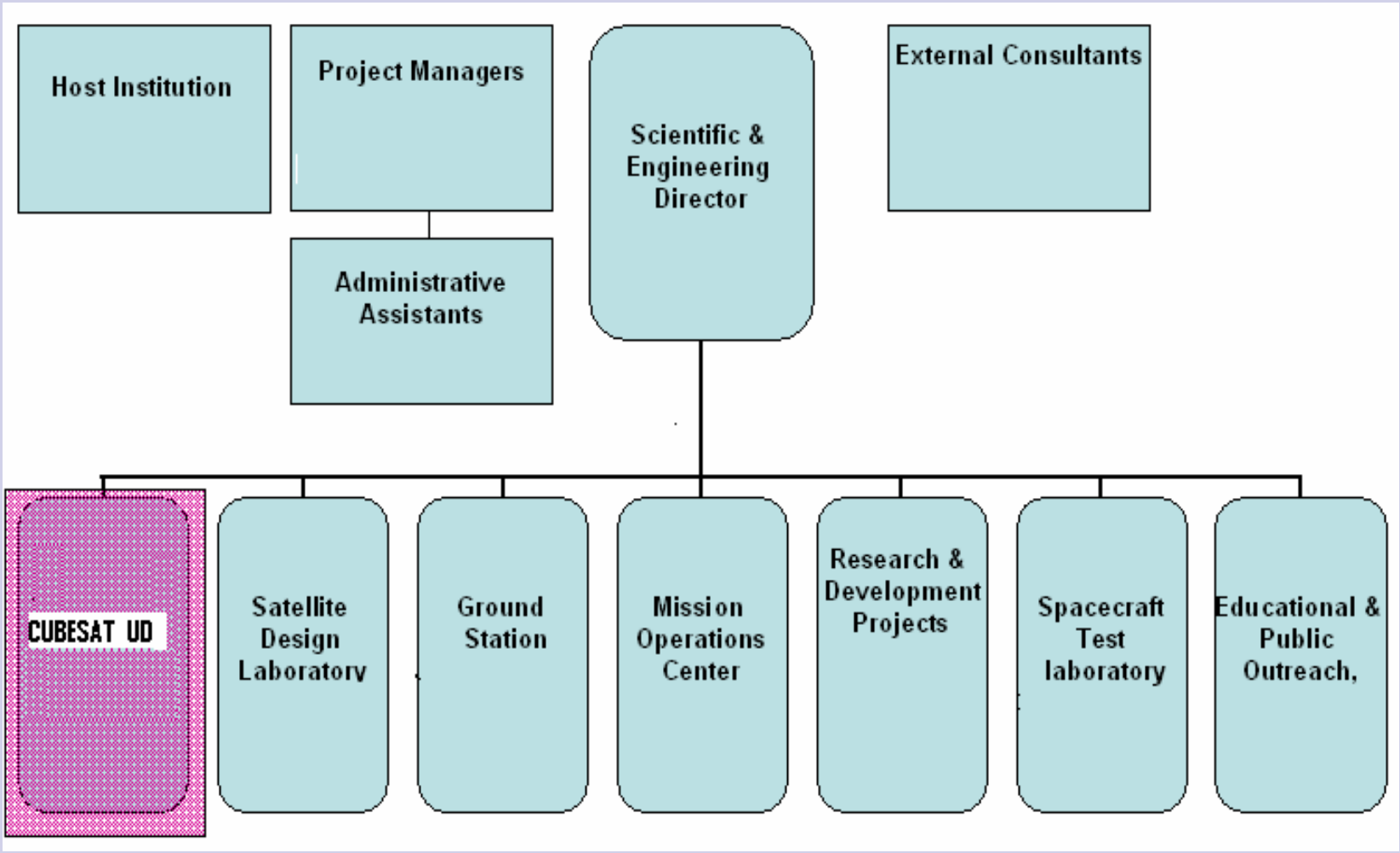


Figure 2: Telecommunications Network for Telecardiology system

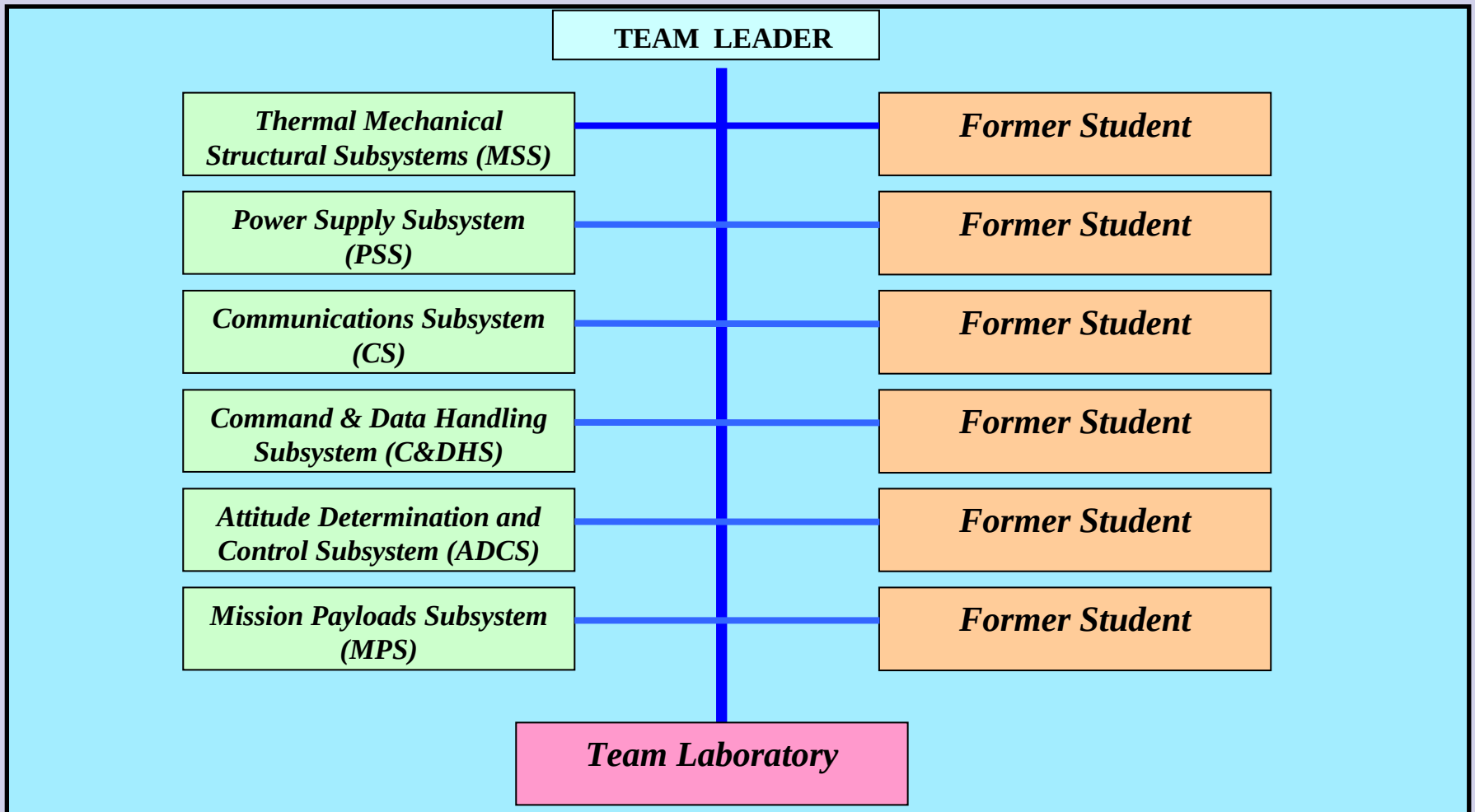
2. PDR GENERAL SCENARIO

- ## 2.6. ORGANIZATION MANAGEMENT



2. PDR GENERAL SCENARIO

- ## 2.6. ORGANIZATION MANAGEMENT



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**

Subsystem

-Power Supply Subsystem (PSS),
-Communications Subsystem (CS),
-Thermal-Mechanical Structural S. (TMSS),
-Attitude Determination and Control Susbsytem (ADCS),
-Command & Data Handling Subsystem (C&DHS)

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Power Supply Subsystem (PSS)***

-Scientific Director:Lilia Edith Aparicio Ph.D

-Leader: Ernesto Gomez Vargas Ms.C.

Team Members:

- Ms. C. Roberto Ferro
- Augusto Chavez

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Power Supply Subsystem (PSS)***
- **The system design requires a maximum efficiency as for the energy management**
- **The objective of the system is to provide power for all the modules of the satellite.**
- **CubeSat UD, uses a PSS basic that includes: solar Cells, Batteries, power distribution Unit, Charge Circuit and switch source circuit.**

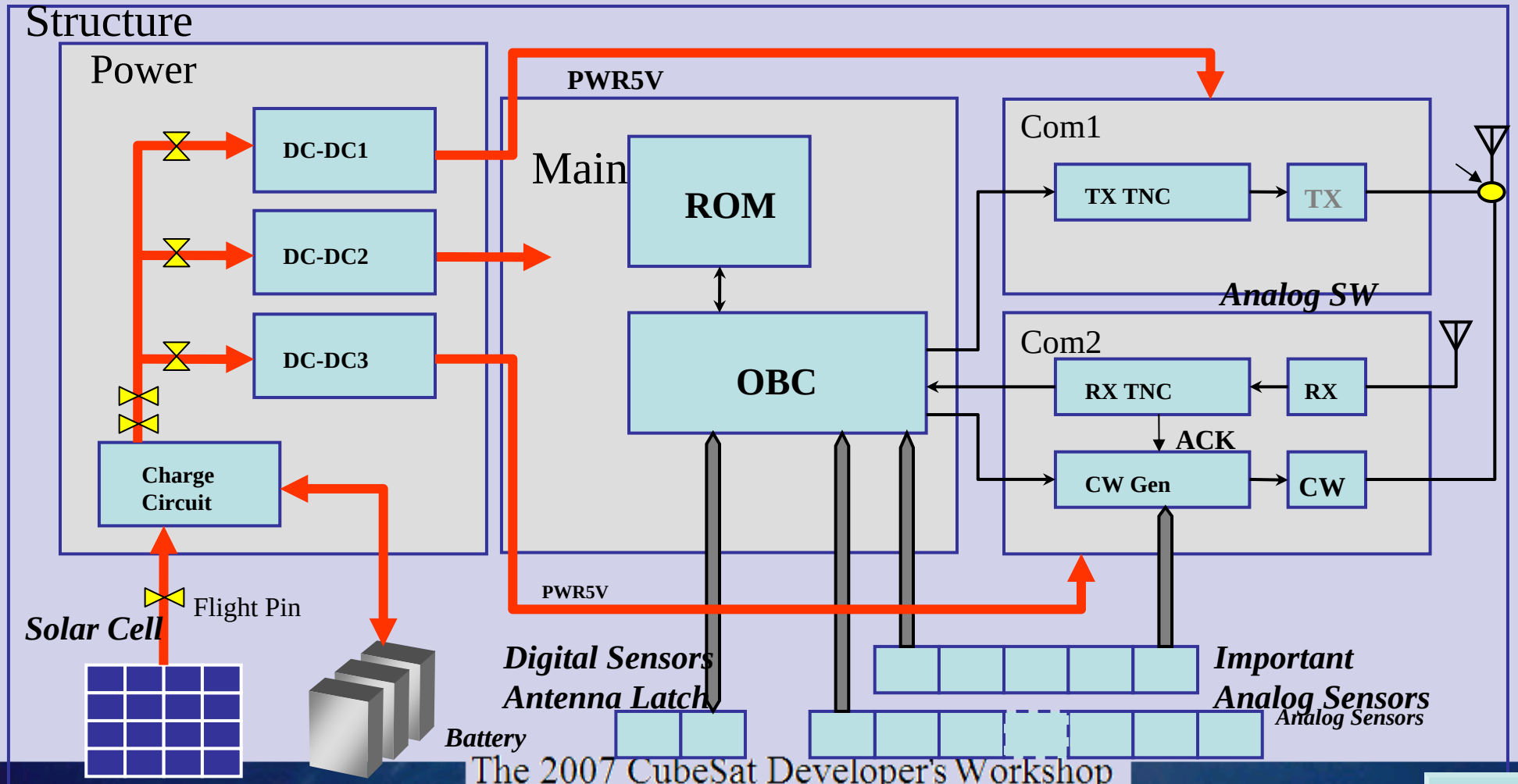
2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Power Supply Subsystem (PSS)***
- **The main purpose of the PSS is to take power from the solar cells on the sides of the satellite and store it in the batteries as well as deliver it to the other subsystems of the satellite on a 5V power-bus and protect these users from latch-ups caused by radiation.**

2. PDR GENERAL SCENARIO

2.7 SATELLITE SUBSYSTEMS

Power Supply Subsystem (PSS)



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Thermal-Mechanical Structural Subsystems (TMSS)***

Scientific Director:Lilia Edith Aparicio Ph.D

Leader: Jairo Chaur Bernal Ph.D

Team Members:

- Jorge Luis Rodriguez
- Alejandro Rubio Petrelly
- José Laureano Cruz
- Victor Ruiz Rosas

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Thermal-Mechanical Structural Subsystems (TMSS)***
- Objectives
- Analysis Thermal stress
- Temperatures Tests.
- Vibration tests
- To development a computer Software in order to simulate heat transfer in the CubeSat.
- Heat transfer by conduction and external radiation
- Analysis of the transient effects, Internal radiation, Temperature gradients and a resistance criterion.
- The numerical analysis is used to optimize the thermal design, which is based on the restrictions of the electronic components.

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Communications Subsystem (CS)***

Leader: Ernesto Gomez Vargas Ms.C.

Team Members:

» Ing. Orlando Rodriguez Cuenca

» Ing. Jhon Jairo Narvaez

» Ing. Eduardo Gaona

» Ing. Cesar Perdomo

» Ing. Ignacio Castañeda

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- **Communications Subsystem (CS)**
- The main purpose of CS is to receive signs of telemetry of the satellite like internal, external temperature, temperature of batteries, load of batteries, space in memory and data of electrocardiographical signal for passing.
- Ground Station: the main part is the antenna system (array of intelligent antennas).

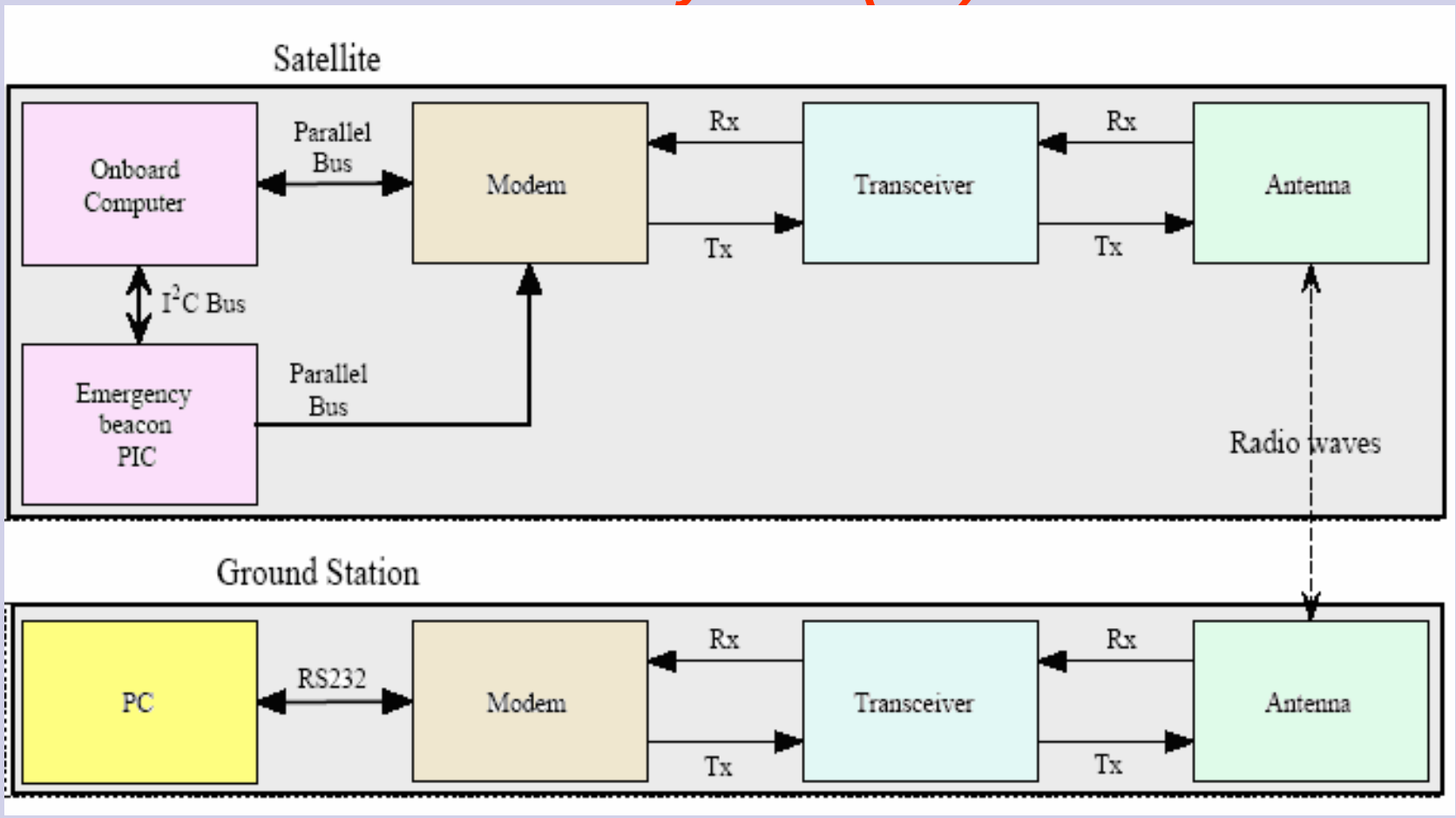
2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Communications Subsystem (CS)***

Modulation:	FSK
Protocols:	AX.25
Transmission:	1.200 bps, 9.600 bps
Downlink:	435 MHz
Uplink:	145 MHz.
Beacon:	436 MHz.

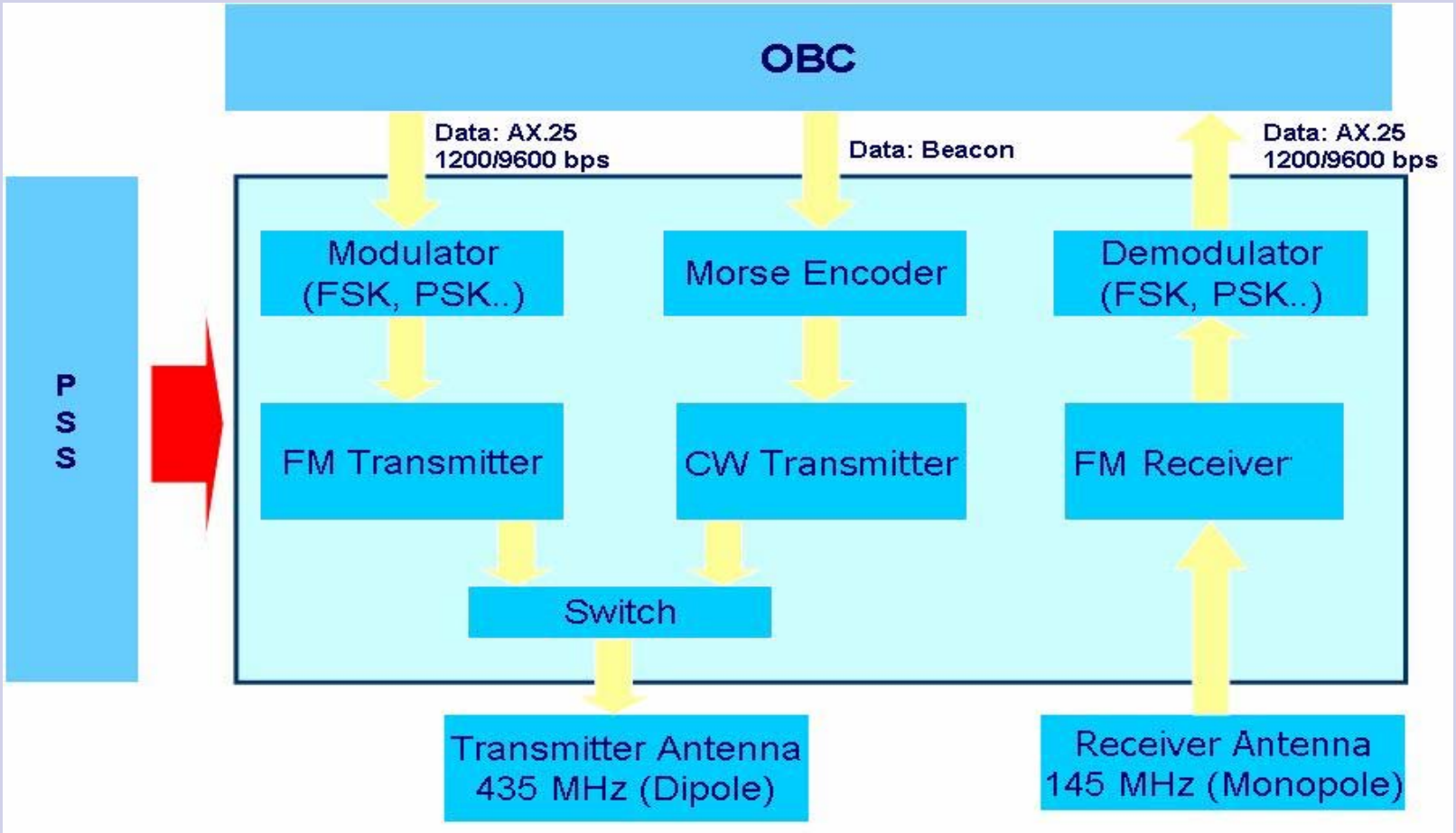
2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Communications Subsystem (CS)***



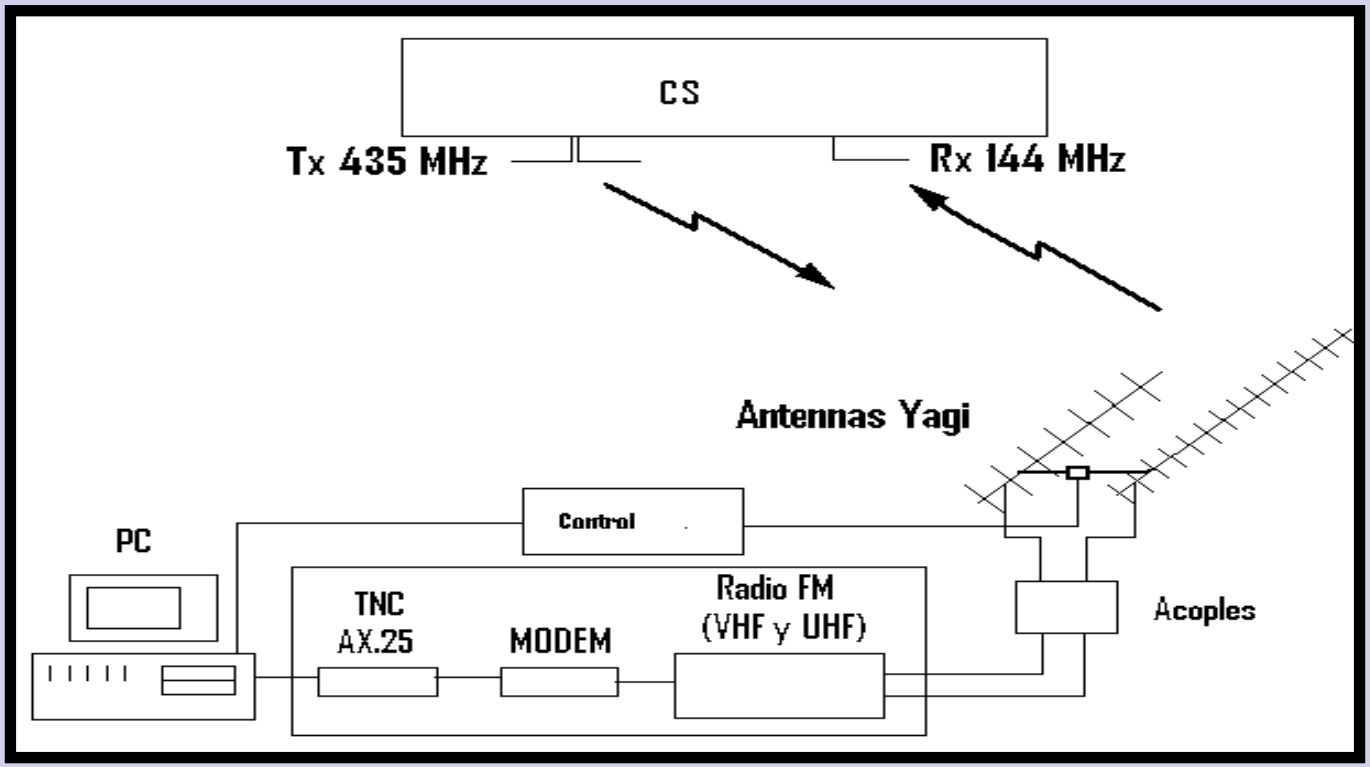
2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Communications Subsystem (CS)***



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- **Communications Subsystem (CS)**



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Attitude Determination and Control Subsystem (ADCS)***

Scientific Director:Lilia Edith Aparicio Ph.D

Leader: Miguel Avila Ms.C.

Team Members:

» Ing. Fernando Hernandez

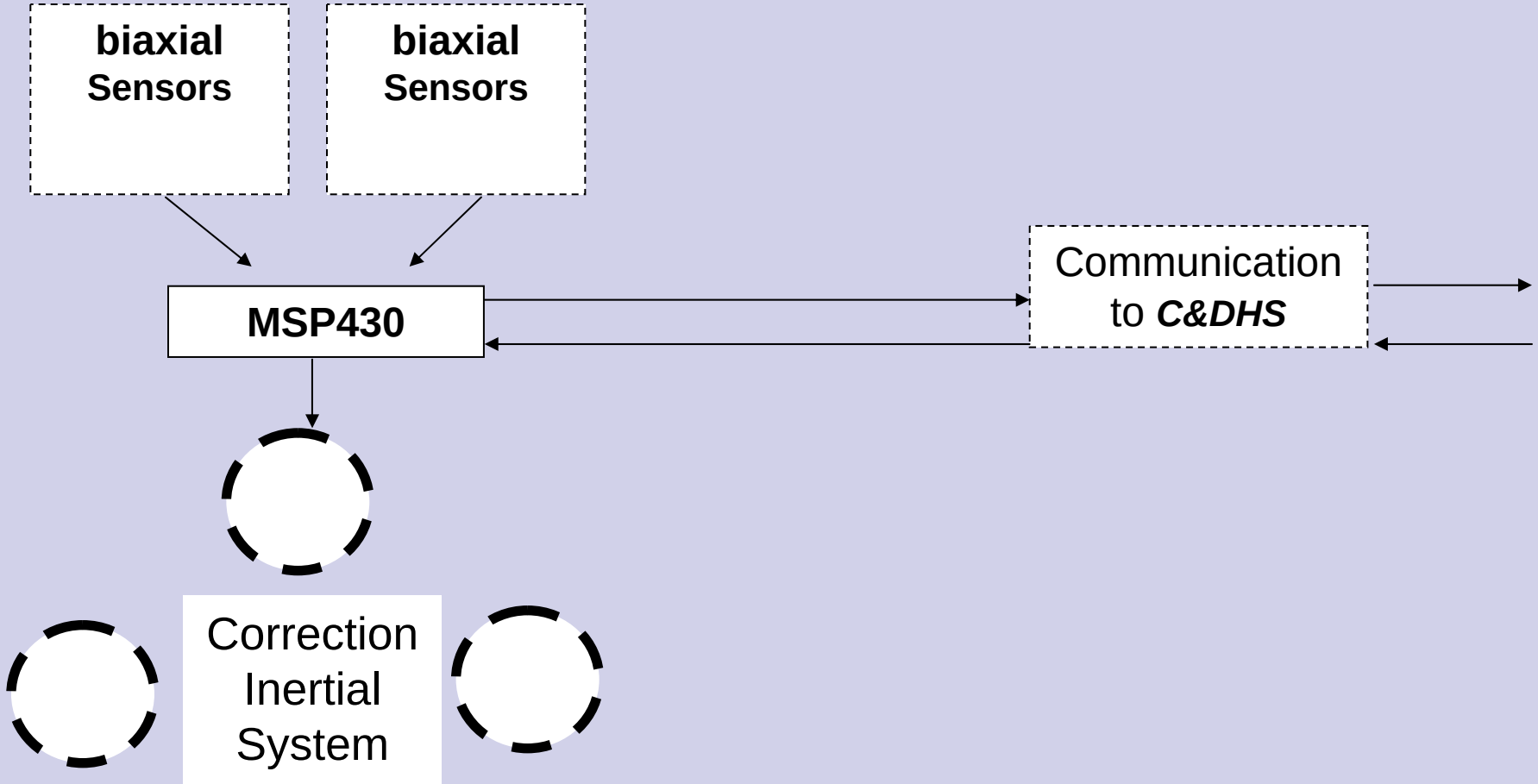
2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Attitude Determination and Control Subsystem (ADCS)***
- Stability
- Localization of the satellite in orbit
- Orbital mechanics
- Control System
- Attitude determination
- Software development
- Interferences

2. PDR GENERAL SCENARIO

•2.7 SATELLITE SUBSYSTEMS

Attitude Determination and Control Subsystem (ADCS)



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Command & Data Handling Subsystem (C&DHS)***

Scientific Director:Lilia Edith Aparicio Ph.D

Leader: Ernesto Gomez Vargas Ms.C.

Team Members:

» Ing. Leonardo Plazas

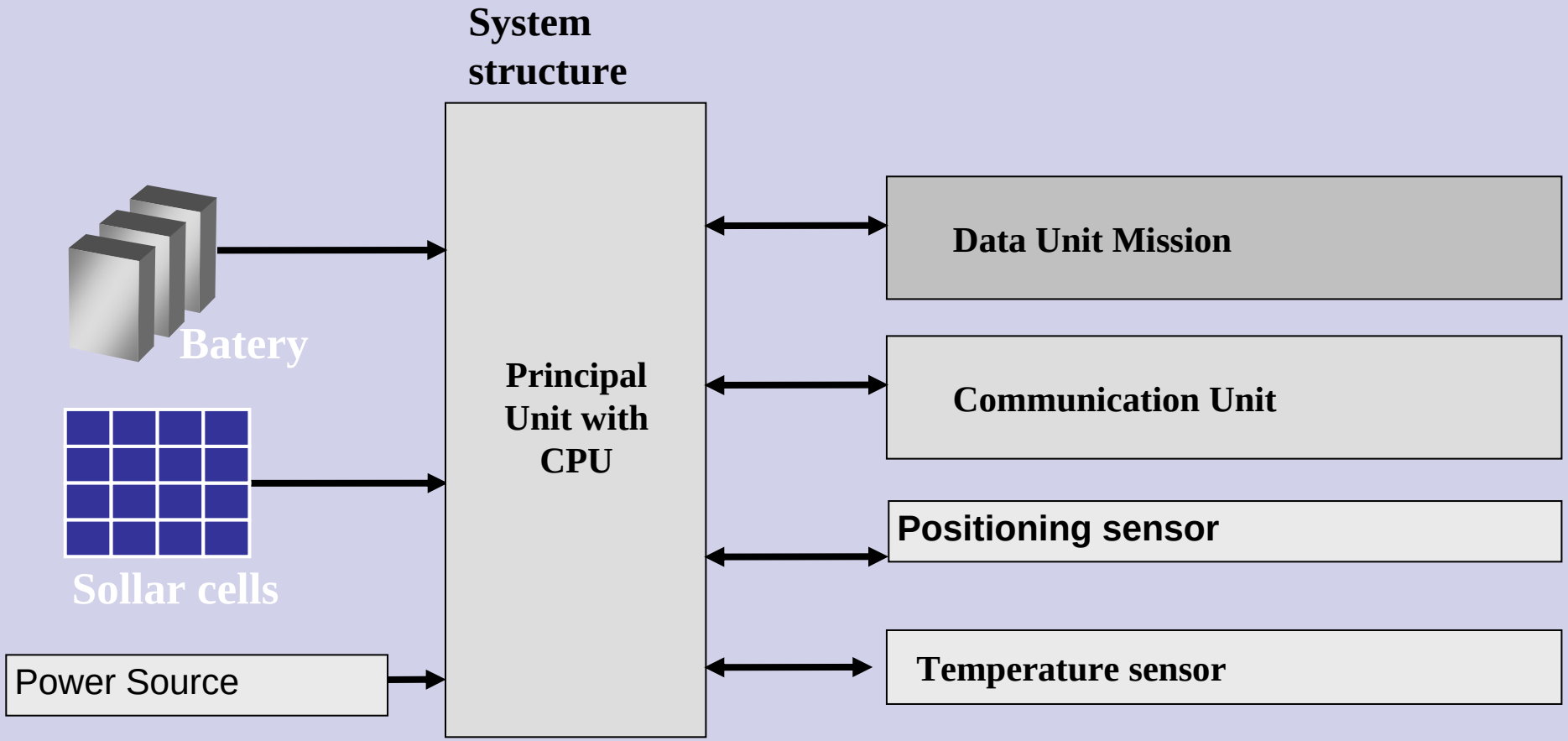
» Ing. German Moncada

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Command & Data Handling Subsystem (C&DHS)***
- This is the Interfaz between the communication subsystem and the microcontroller, data mission, power control, temperature sensor, position control, diagnosis control of solar panels.
- Principal processor, microcontroler MSP430,
  - CPU 16-bits RISC technology,
  - 3.3Mhz clock,
  - 16KB in memory
  - RAM 512,
  - Communications input/outut ports, 3.3 – 5.0V operation voltage.
- Development software is Salvo Pro RTOS and development tools are CrossWorks for MSP430 de Rowley Software.

2. PDR GENERAL SCENARIO

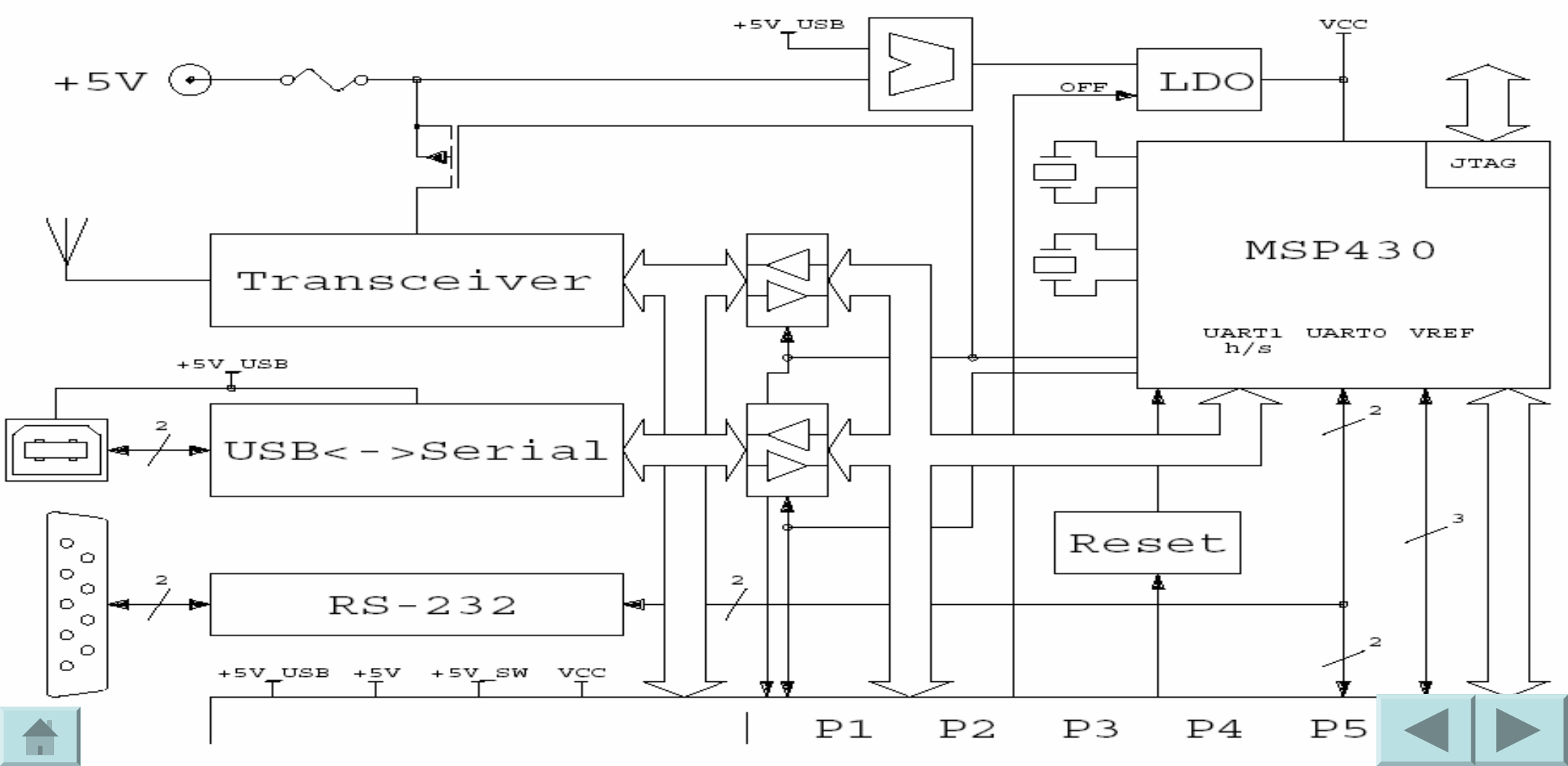
- **2.7 SATELLITE SUBSYSTEMS**
- ***Command & Data Handling Subsystem (C&DHS)***



2. PDR GENERAL SCENARIO

2.7 SATELLITE SUBSYSTEMS

Command & Data Handling Subsystem (C&DHS)



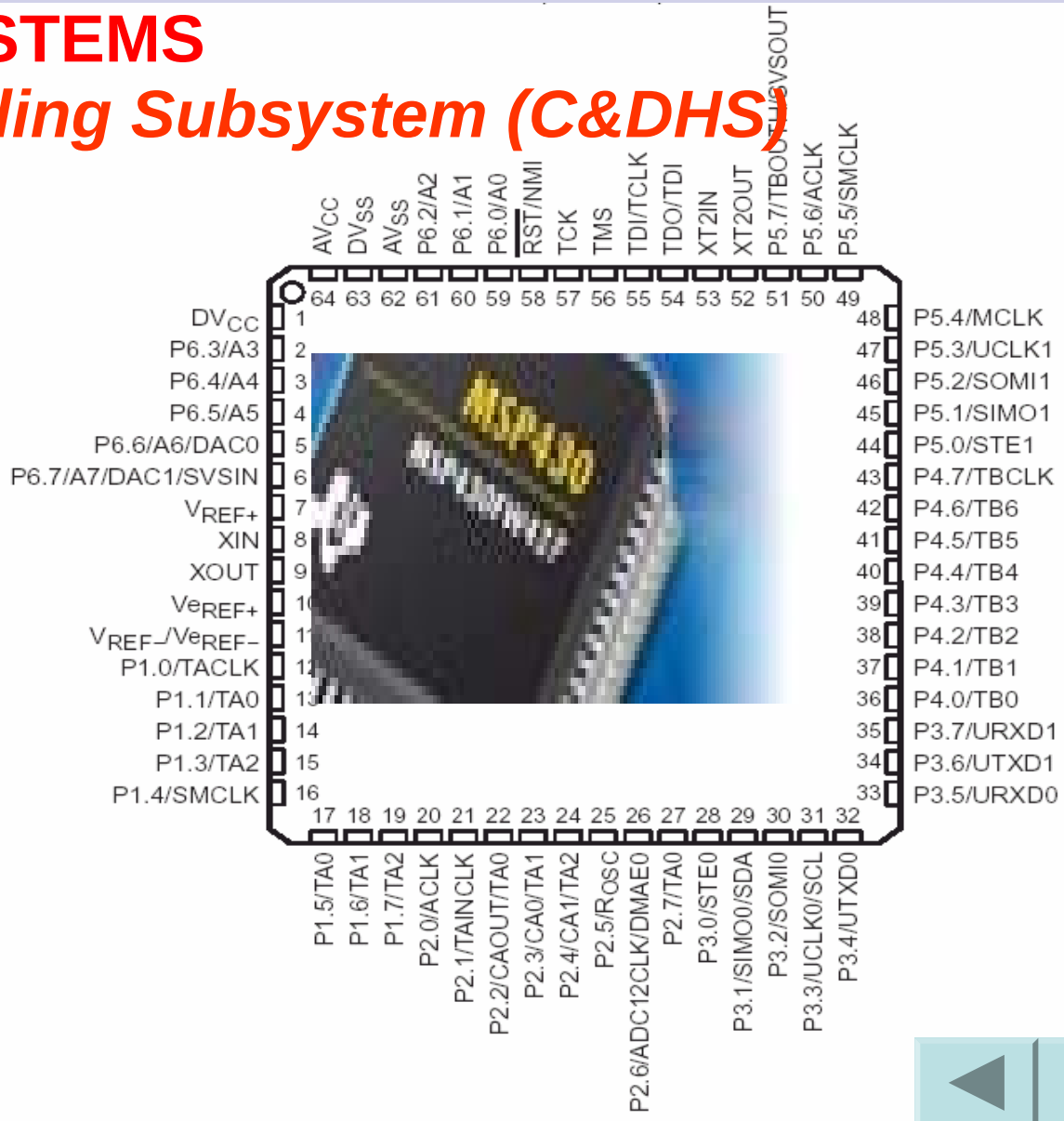
2. PDR GENERAL SCENARIO

2.7 SATELLITE SUBSYSTEMS

Command & Data Handling Subsystem (C&DHS)

TI MSP4301612

Pin	Use
P[0..6]	Free
P1.7	Dedicated to control USB interface
P2[0..7]	Free
P3[0..3]	Free, (3.1, 3.3) I2C
P3.4	Free on flight module (Dev Rx)
P3.5	Free on flight module (Dev Tx)
P3.6	Used when MCU Tx data to USB or Transceiver
P3.7	Used when MCU Rx data to USB or Transceiver
P4[0..5]	Free
P4.6	Controls +5V_SW power
P4.7	Free
P5[0..7]	Free
P6[0..5]	Used when USB or Transceiver active
P6.6	Controls Tranceiver interface
P6.7	Free



2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Mission Payloads Subsystem (MPS)***

Scientific Director:Lilia Edith Aparicio Ph.D

Leader: Lilia Edith Aparicio Ph.D

Team Members:

» Ing. Orlando Rodriguez Cuenca

» Ing. Diego Urbano

» Ing. Nestor Suarez

» Ing Francisco Javier Lopez

» Jairo Tamayo

2. PDR GENERAL SCENARIO

- **2.7 SATELLITE SUBSYSTEMS**
- ***Team Laboratory***
  - Scientific Director:Lilia Edith Aparicio Ph.D
  - Leader: Lilia Edith Aparicio Ph.D

    Team Members:
    - » Ing. Leonel Giraldo
    - » Ing. Jaime Vitola

3. RESULS

- **3.1 EDUCATIONAL PROGRAM**
- **The Distrital University has been started a new educational program in the Master of Science in Communications and Information System with the former students in Satellite Networks where the CubeSat program is the first experiment to be developed: Its study plan includes five specific modules on satellite networks and the laboratory is the support to develop research in this area. The program includes the interdisciplinary works with students of Electrical, Electronic, Industrial, System and Mechanical Engineering.**

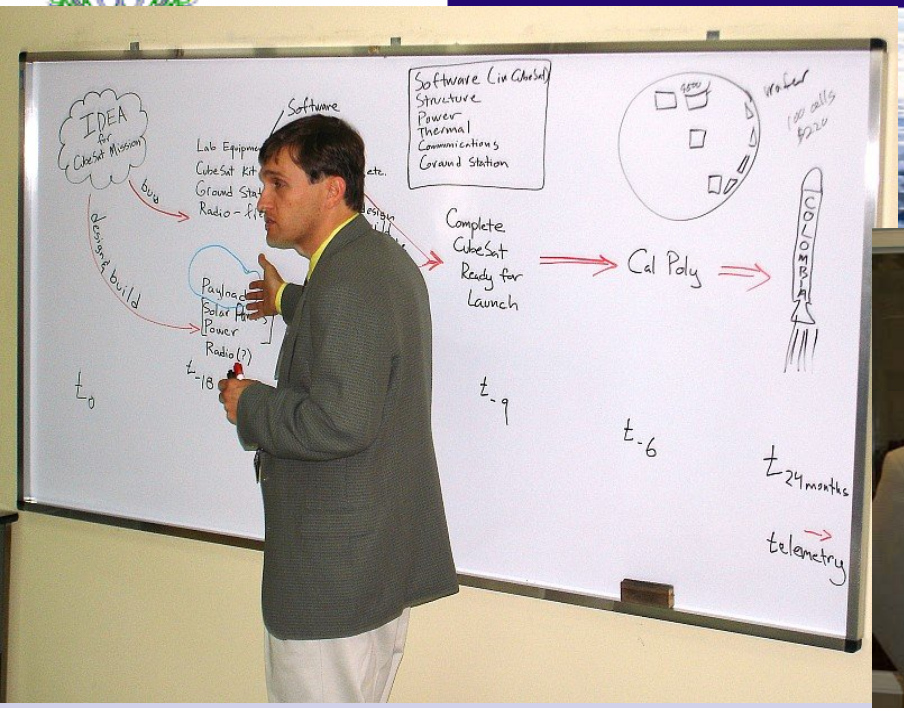
3. RESULS

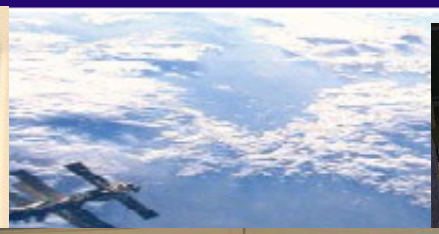
- **3.2. IMPACTS**
- Science, Technology And Society Impacts
- Science, Technology And Productive Sector
- Science, Technology And Environment
- Science, Technology And Education

4. CONCLUSIONS

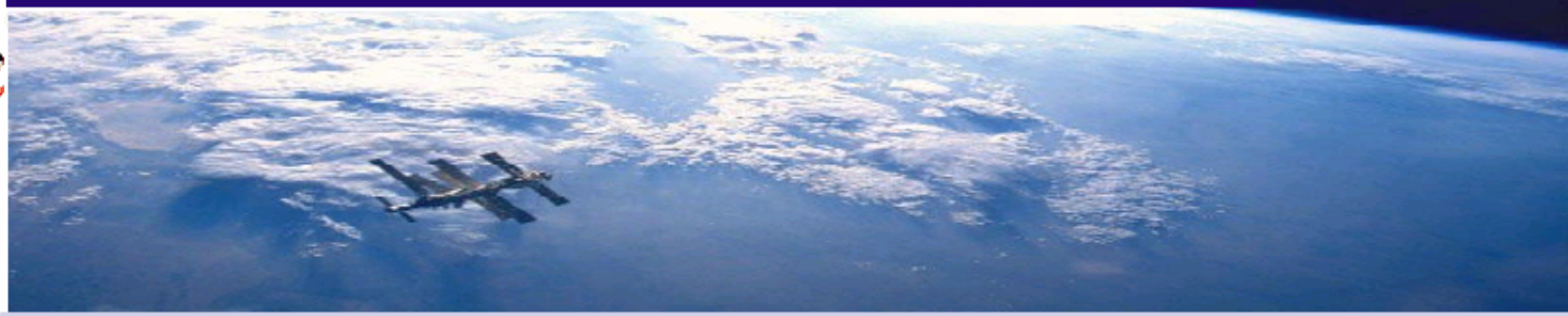
In conclusion the CubeSat project has achieved three major results:

1. **A large group of students and teachers will leave the university with a great deal of ”Hands-on experience” within satellite design and experience with working with a large project that requires cooperation between everybody that are involved.**
2. **The development of small satellites it can begin a space career for countries that have not incurred in these scientific fields.**
3. **It is important the satellite system provides facilities for solving social impact problems as they are those of the health field.**


IDEA for CubeSat Mission
Software
Software (in CubeSat)
Structure
Power
Thermal
Communications
Ground Station
Complete CubeSat Ready for Launch
Cal Poly
COLOMBIA
design & build
Payload
Solar Power
Radio (?)
t_0
t_{-18}
t_{-9}
t_{-6}
$t_{24\ months}$
telemetry




CUBE SAT KIT



THANK YOU VERY MUCH

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egomez@udistrital.edu.co

3. RESULS

- **3.2 IMPACTS**
- **Science, Technology And Society Impacts**
- Brings Colombia to the club of space faring nations
- Establishes an infrastructure to support future satellite projects in Colombia
- Trains Colombian students and professionals for the development and operation of a spacecraft system
- Provides an incentive for the further development of a Colombian Space Agency
- Provides the capability to commercialize the development of satellites for scientific, military, or commercial applications for both Colombia and the international community

3. RESULS

3.2 IMPACTS

Science, Technology And Society Impacts

- Public Outreach via Civil Aviation's communications mechanisms, or Colombian media, will motivate the public, professionals, and students of all levels to support and/or pursue technologies that will aid Colombia's development over the next century.
- Project is small in both cost and personnel
- Project is focused with a strict schedule for milestones and deliverables
- Project includes qualified and capable individuals
- Commitment from the Distrital University and Consultants from French entities such as CNES, SUPAERO could be established in support from their host institutions.

3. RESULS

- **3.2 IMPACTS**
- **Science, Technology And Productive Sector**
- To enhance the production capacity and integration among entities of all the sectors (private, government, etc)
- Improving of the health services coverage and quality for isolated areas in Colombia
- To provide incentive for the aerospace political consolidation "AGENCY."
- Implementation of satellite systems development infrastructure
- Generation of the Aerospace Colombian Industry.

3. RESULS

- **3.2 IMPACTS**
- **Science, Technology And Environment**
- There is not a significant impact on the natural environment due to the character of the satellite communication system involved which supports medical services such as in the case of telemedicine.

3. RESULS

- **3.2 IMPACTS**
- **Science, Technology And Education.**
- To integrate society, productivity and environment into pedagogy and didactics of national education at all levels in order to guarantee continuous renovation and interaction. Significant contribution to space education in Colombia into the following scenarios
    - Space education program
    - Academic Research Opportunities.
    - Space System development
    - Pico, nano and micro-satellite technology development
    - Provision of a Satellite Design and Development Laboratory to serve as the facility where this project will be carried out and a place to train highly qualified students in the space field.
    - Contribution to develop aerospace industry.