

# NetCubeSat and SDR Based Communication System for Climate Change Understanding

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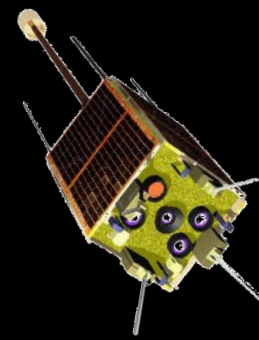
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# Idea



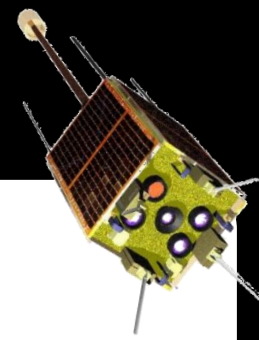
Over **90%** of  
**Scientists** Agree  
**Global Warming**  
is a **Reality**

GlobalWarming Facts#1  
[Interesting-facts.com](http://Interesting-facts.com)

**M**onitor and **C**ontrol **C**limate **C**hanges

... Fight against air pollution and global warming

# Introduction



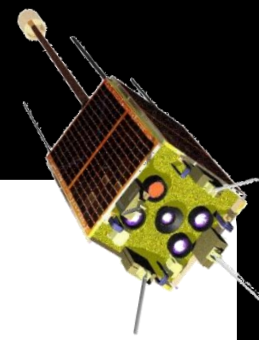
**ipcc**  
INTERGOVERNMENTAL PANEL ON  
climate change



Temperature  0.3 to 4.8 °C



# Introduction



## Factors causes Global Warming

### Natural causes

- Natural calamities
- Greenhouse effect
- Sunspots ...

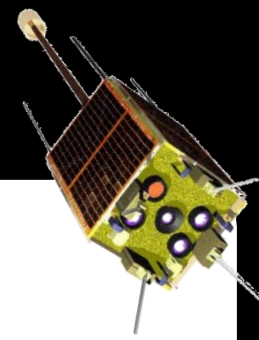
### Anthropogenic causes

- Deforestation
- Rapid industrialization
- Increased automobile use ...  
(CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and PM ...)

**“....global warming is very likely man-made  
(or anthropogenic).”**



# Mission Objectives



Integrating the nano satellite technology in air monitoring routine for climate protection purpose

- ❑ Fight against air pollution in order to limit the temperature rising
- ❑ Provide a system for a real time air quality monitoring
- ❑ Lower the barriers to transmit data in the region without infrastructure in real time

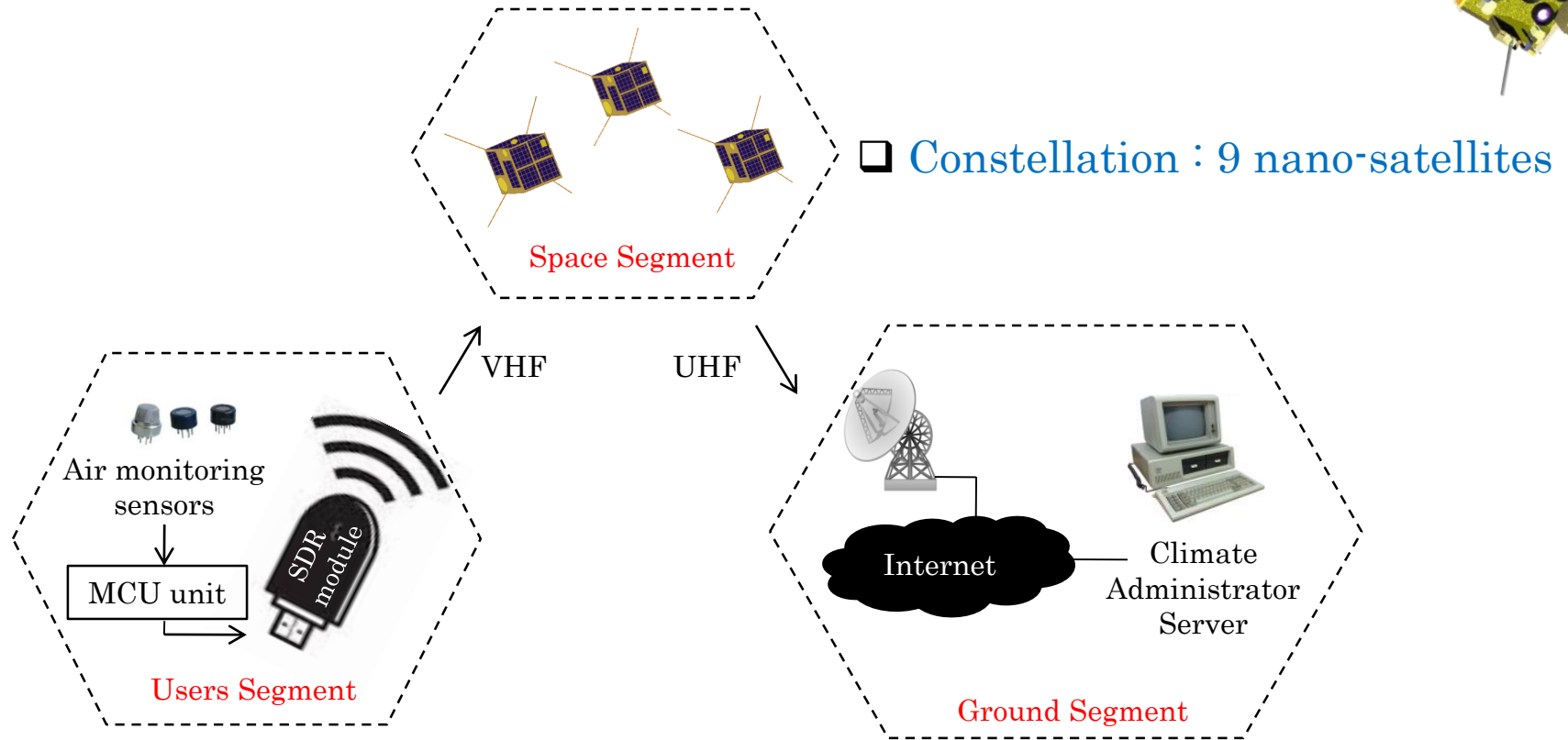
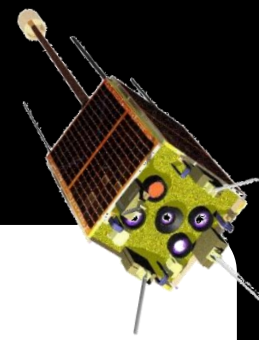
## STEP 1:

Provide a permanent coverage for a real time monitoring, especially for the areas in the countries under development (eg. North Africa)

Why ?

# Concept of Operations

## ■ System Architecture

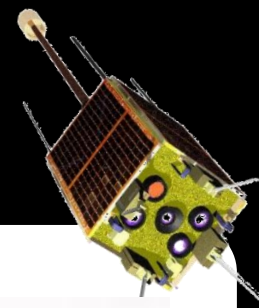


□ Constellation : 9 nano-satellites

- Sensors
- Microcontroller unit
- Software Defined Radio (SDR) module

- Ground station
- Climate Administrator

# Concept of Operations



## ■ Space Segment

### • Satellite structure Overview

- 1U structure :  $10 \times 10 \times 10 \text{ cm}^3$
- Mass  $\sim 1 \text{ Kg}$
- COM : - SDR module ( VHF  $\nearrow$  UHF  $\searrow$  )  
- S-band : ISL
- Attitude Determination and Control System  
(Sun sensor, gyro and magnetometer sensors, magnetorquers)

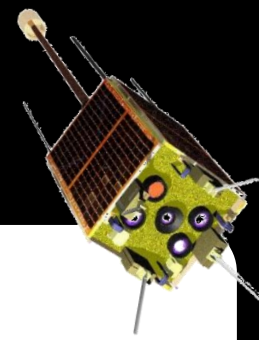


### • Launcher

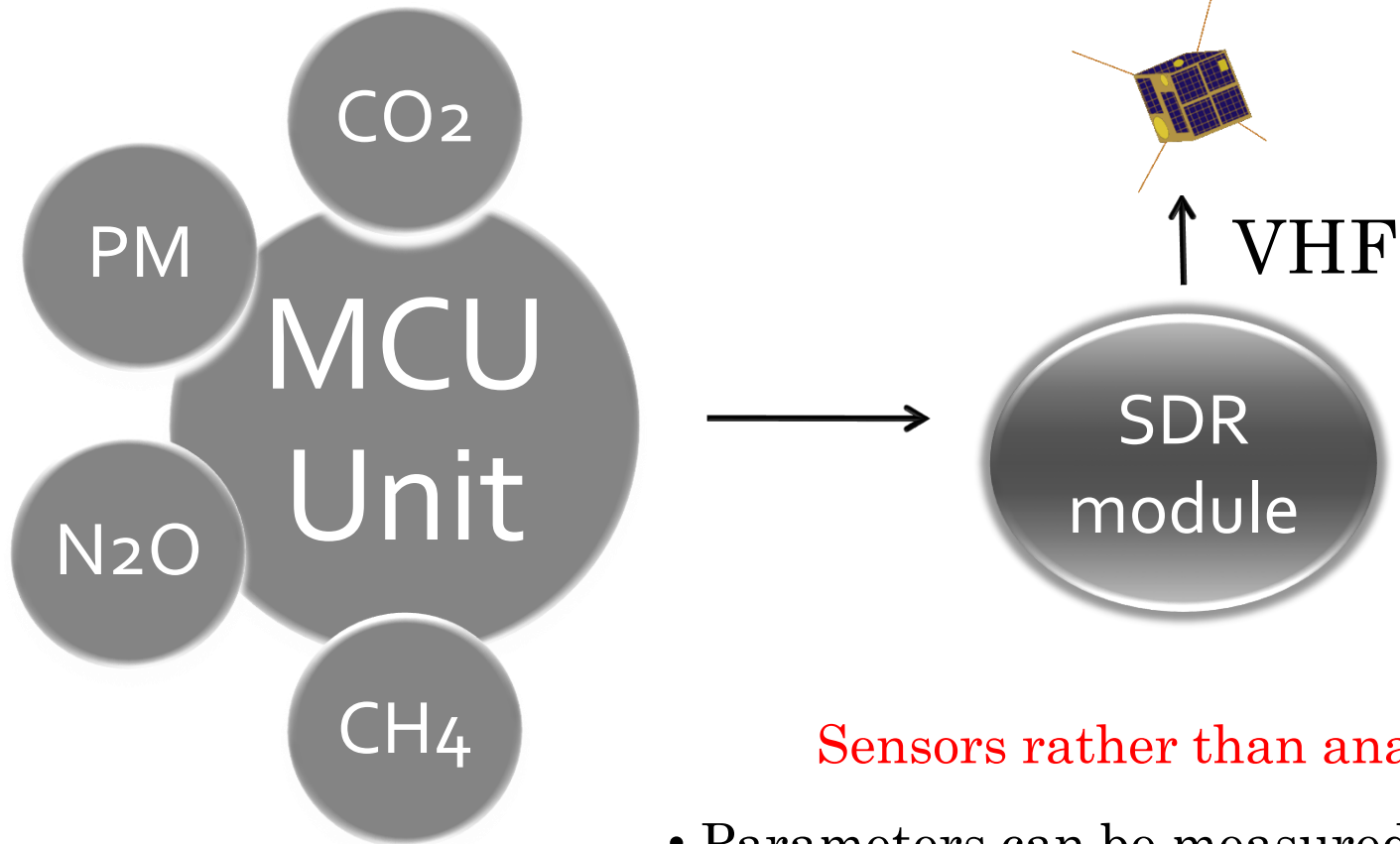
- Poly-PicoSatellite Orbital Deployer (P-POD)



# Concept of Operations



## Users Segment



### Sensors rather than analyzers

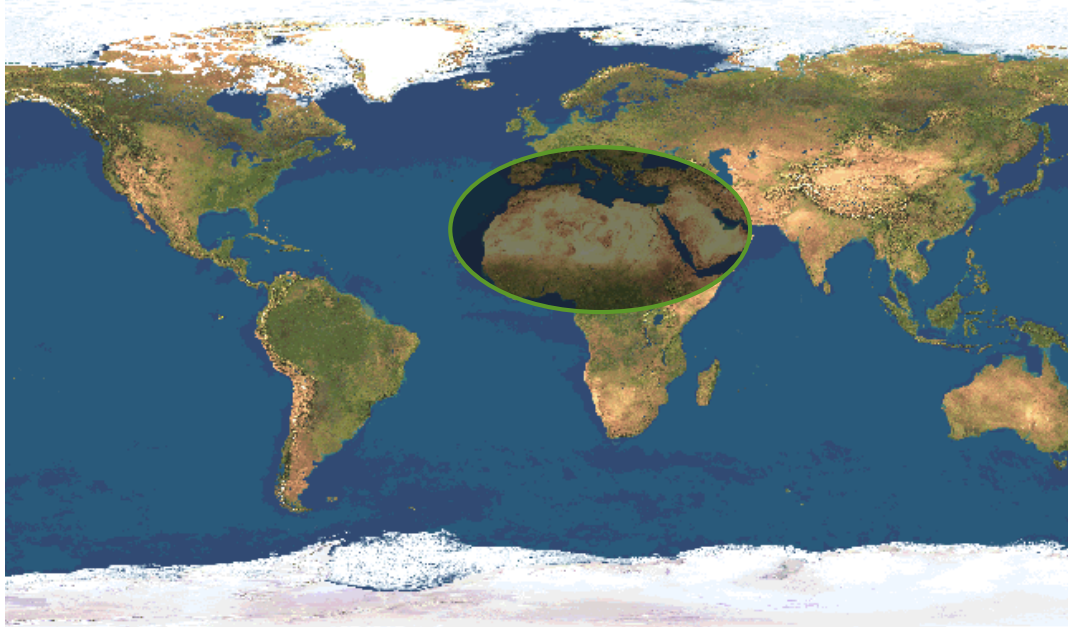
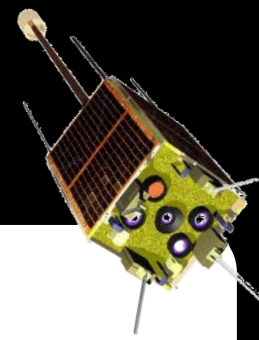
- PM : Particle Matter
- CO<sub>2</sub> : Carbon Dioxide
- N<sub>2</sub>O : Nitrous Oxide
- CH<sub>4</sub> : Methane

- Parameters can be measured and logged every minute.
- Sensors are cheaper than analyzers.



# Concept of Operations

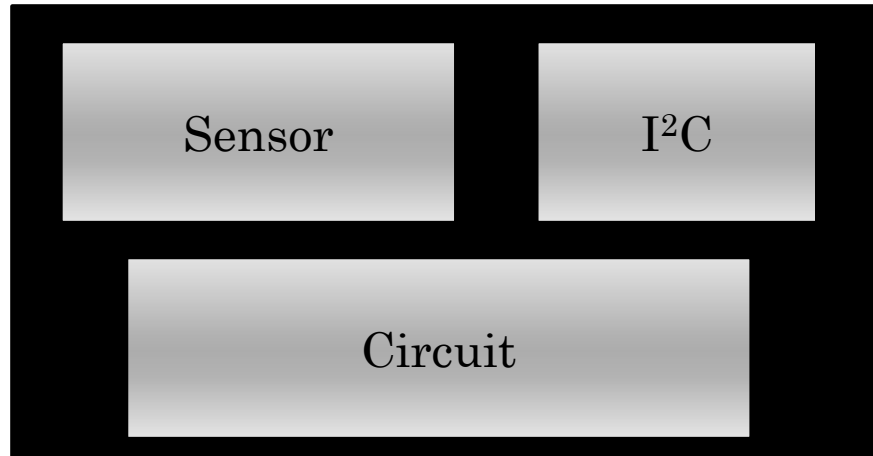
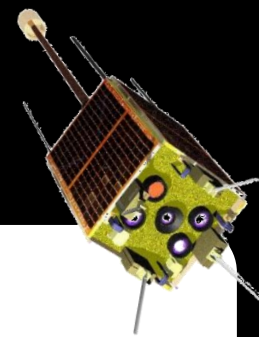
## ■ Ground Segment



- The ground station connected with the climate administrator server through Internet
- Downlink mission data : UHF / 437 MHz – 9600 bps
- Uplink commands : VHF / 145 MHz – 1200 bps
- Visibility ~ 10 min
- Receive the monitoring data each orbital period

# Key performance parameters

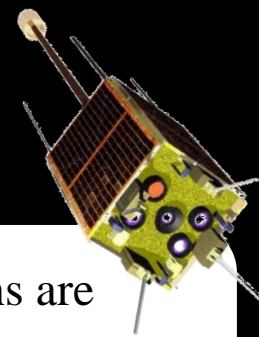
## Sensors



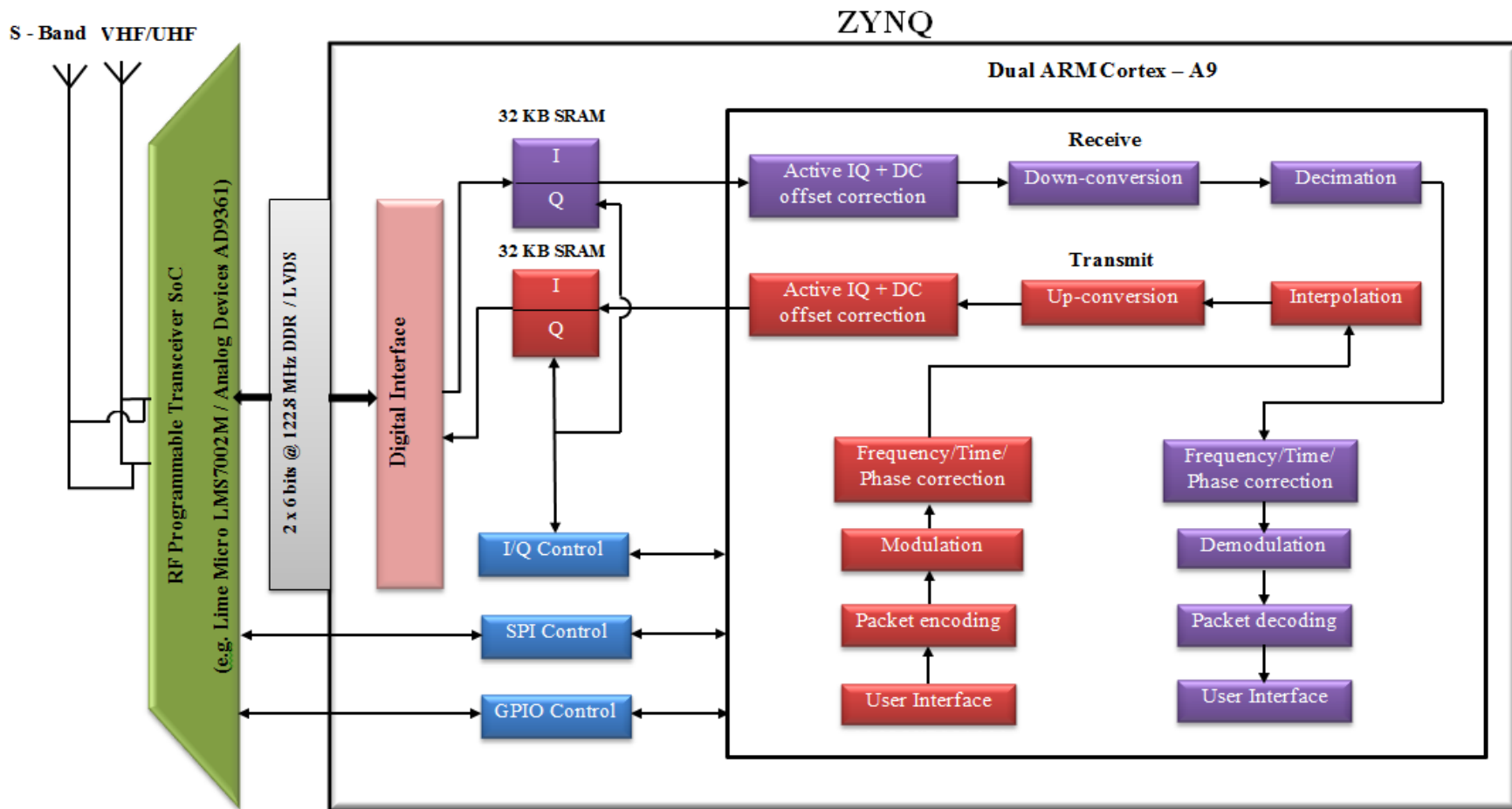
- **Low cost sensor** networks are an exciting idea with **great potential**
- These instruments can be configured to log **real time data** on gas, particulate, noise and weather parameters
- Data can be transmitted **wirelessly**
- **Ease** of integration

# Key performance parameters

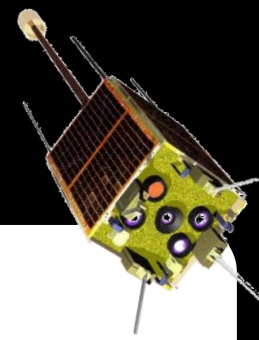
## SDR



- A wireless communication device where the transmitter and receiver operations are changed or modified by software alone without making any changes to the hardware



# Key performance parameters SDR



## OBJECTIVES

- **Reduce** the development costs:

A **single** Hardware Platform for **several standards** and systems

- Reduce the equipment costs:

Use as much as possible '**Off the Shelf**' Components

- Additional benefits:

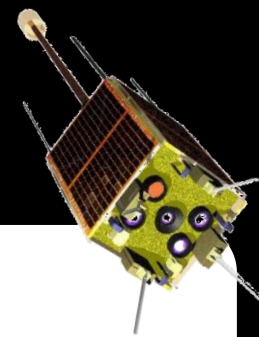
**Reduction** of size and weight of equipment

Radio waveform can be changed in operation through **software control**

Provide **high data rate** which allows the download of mission data directly upon request

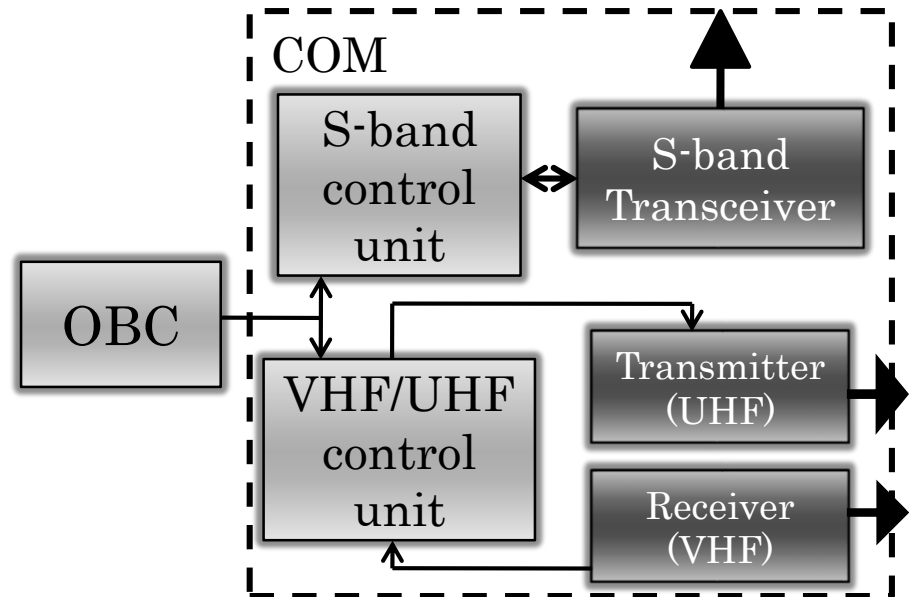
# Key performance parameters

## COM

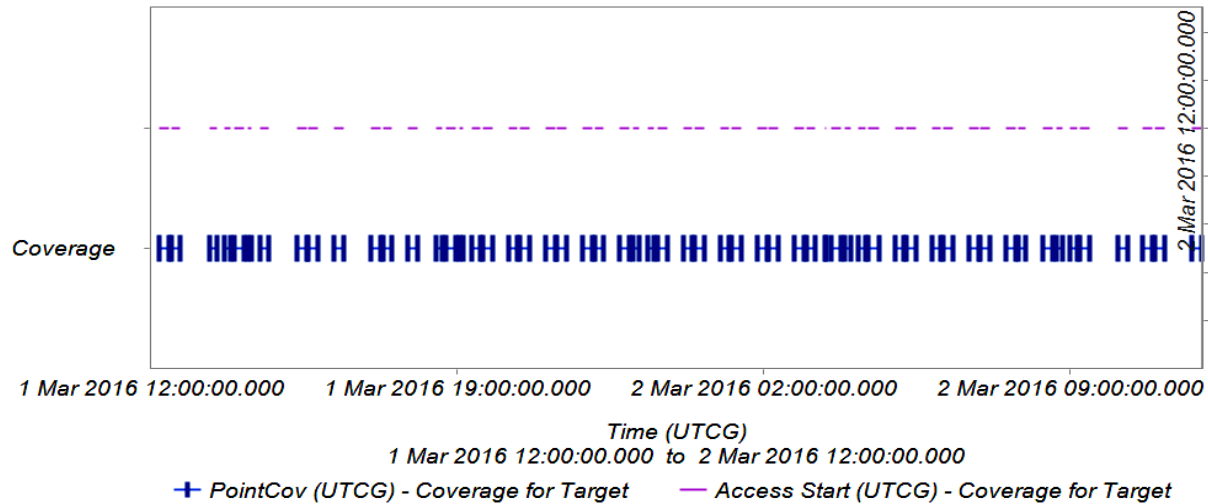
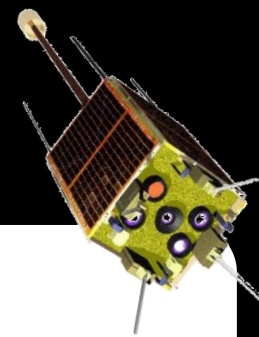


- COM Link budget

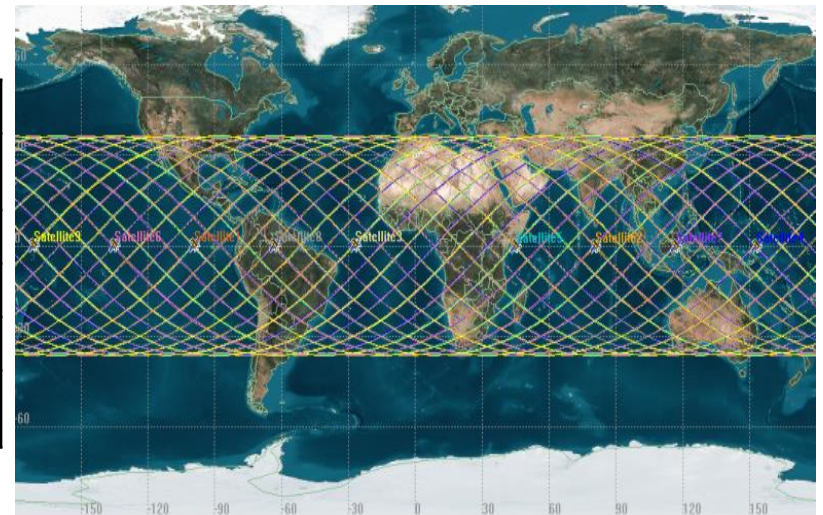
| Freq (MHz)               | VHF /<br>145 | UHF /<br>437 | S-band<br>2200 |
|--------------------------|--------------|--------------|----------------|
| data rate<br>(Kbps)      | 9.6          | 9.6          | 1000           |
| antenna gain<br>(dBi)    | 2.2          | 2.2          | 4.5            |
| Modulation               | AFSK         | BPSK         | BPSK           |
| Transmitter<br>power (W) | 1            | 1            | 1              |
| FSL (dB)                 | 131.229      | 140.812      | 154.85         |



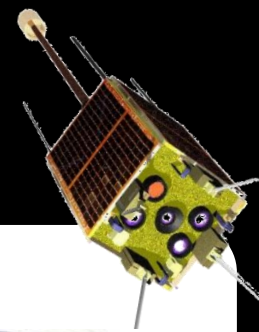
# Orbit & Constellation



|              | Sat-1 | Sat-2 | Sat-3 | Sat-4 | Sat-5 | Sat-6 | Sat-7 | Sat-8 | Sat-9 |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| a (Km)       | 600   | 600   | 600   | 600   | 600   | 600   | 600   | 600   | 600   |
| e            | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |
| I (°)        | 36    | 36    | 36    | 36    | 36    | 36    | 36    | 36    | 36    |
| $\Omega$ (°) | 0     | 0     | 72    | 72    | 144   | 144   | 216   | 216   | 288   |
| TA (°)       | 0     | 180   | 0     | 180   | 0     | 180   | 0     | 180   | 0     |



# Implementation plan



## $\mu$ Ei-Lab : Monastir University

- Air monitoring system
- ADCS system
- Orbit and Constellation management
- Ground station



Microélectronique et instrumentation  
MESRST : 03/UR/13-04

|                      |                   |
|----------------------|-------------------|
| Conceptual design    | Feb 2016-Dec 2016 |
| Engineering model    | Jan 2017          |
| Flight model         | 2018              |
| Constellation        | 2019              |
| Constellation launch | 2020              |

## Expected partners:

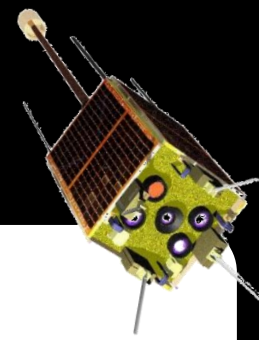
### REGIM-Lab : Sfax University

- Satellite's data processing algorithms
- Satellite bus design

### VSEE-Lab : Sousse University

- Communication network Management

# Conclusion



- ❑ If global warming continues to worsen, and anthropogenic activity continues to exacerbate our fragile environments we will most certainly see a threat in our life security
- ❑ The mission provides a solution to monitor and control climate changes in order to mitigate the global warming

**We probably can not stop climate change, but we can slow it down!**



LET'S SAVE THE



Thank you