UNISEC-GLOBAL Climate Change Constellation (UGC^3-Mission)

Group B

8th UNISEC-GLOBAL Meeting

Istanbul, Turkiye, October 20-21, 2022

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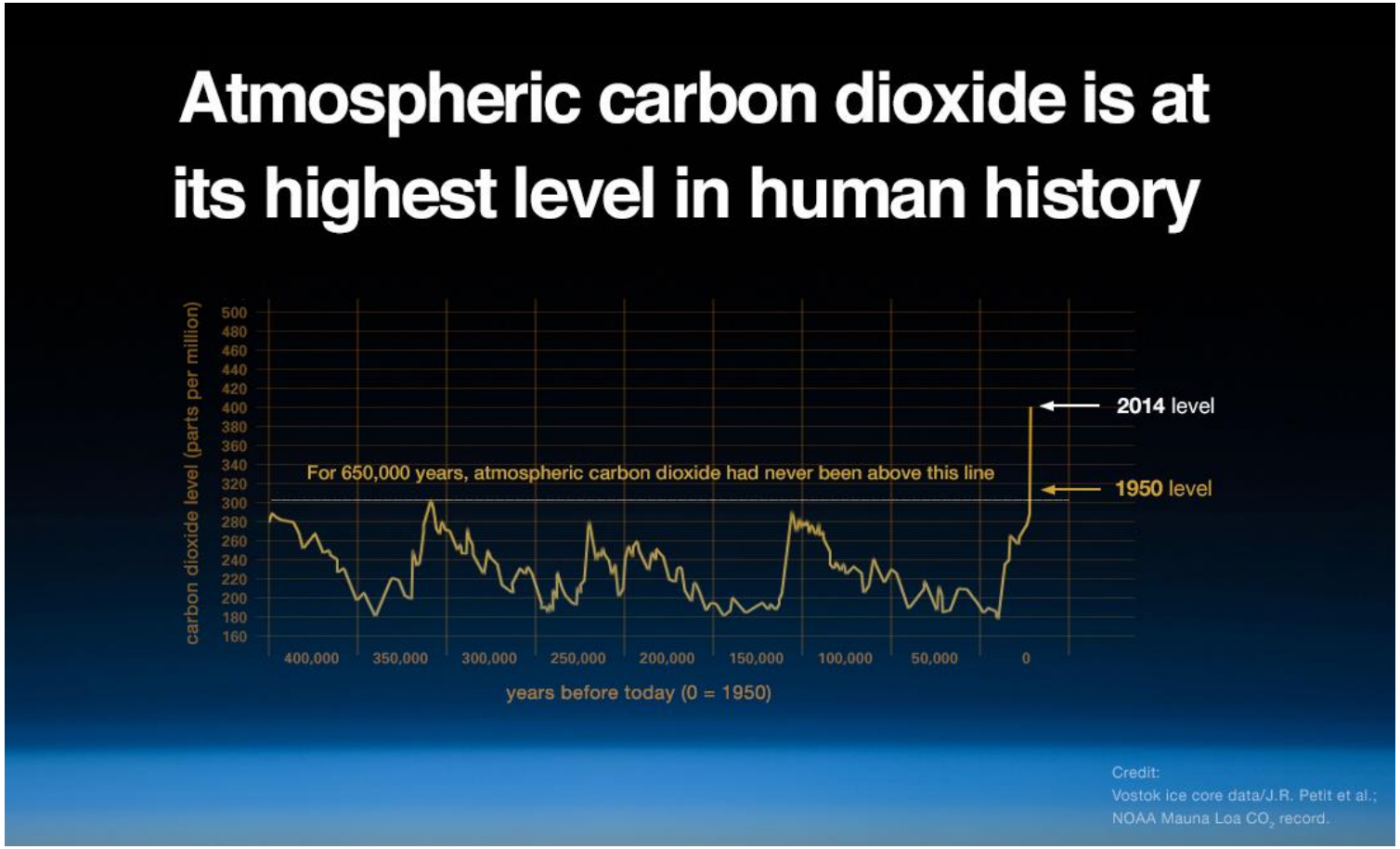
Group B Members

- Professor: Herman Steyn, South Africa
- Mohammed Khalil Ibrahim, Egypt
- Nursultan Doszhan, Kazakhstan
- Andres Guarnizo, Colombia
- Eyoas Ergetus Areda, Ethiopia
- Batuhan Kiremitcigil, Turkiye
- Bilge Memis, Turkiye
- Osman Berkan Akdere, Turkiye

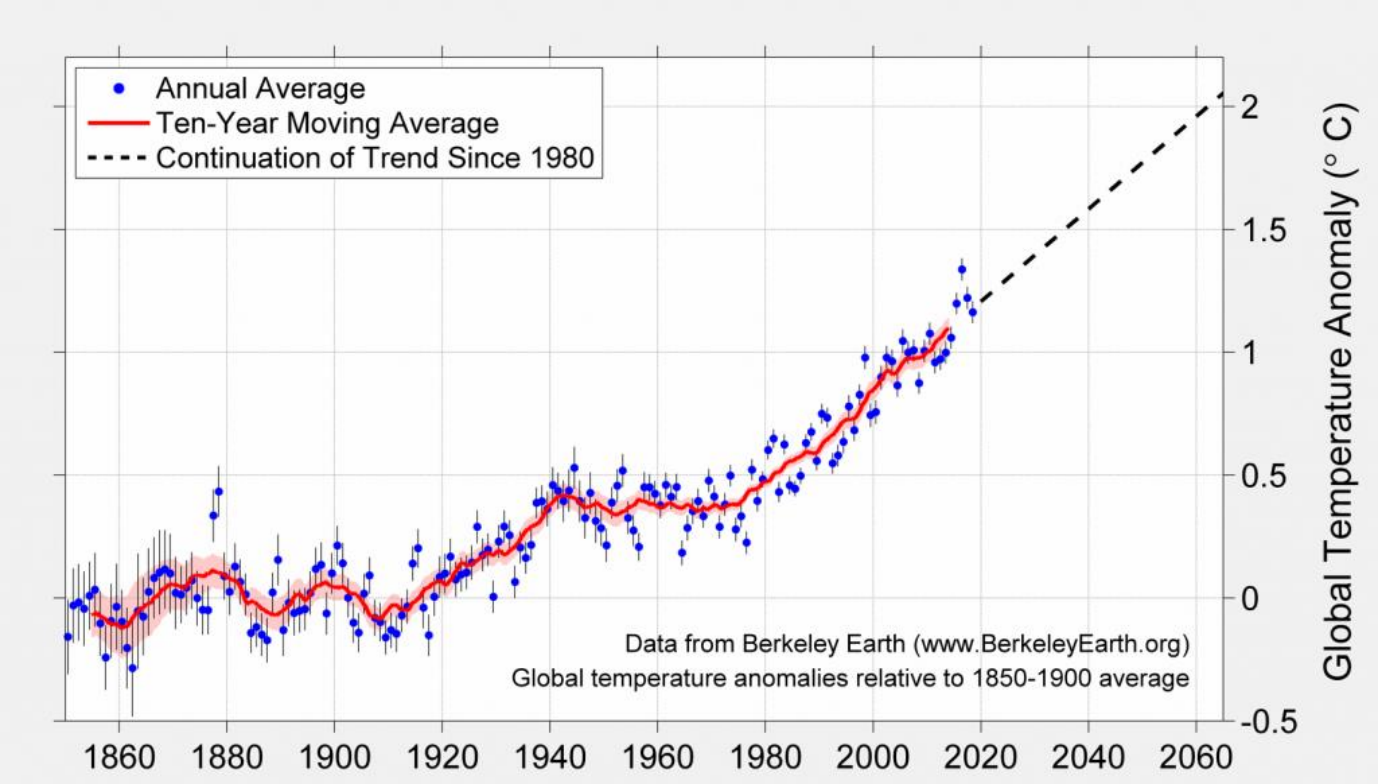
Background

- Human Activities
  - Industry
  - Energy Production
  - Deforestation
  - Transportation
  - Coal Mining
  - Others



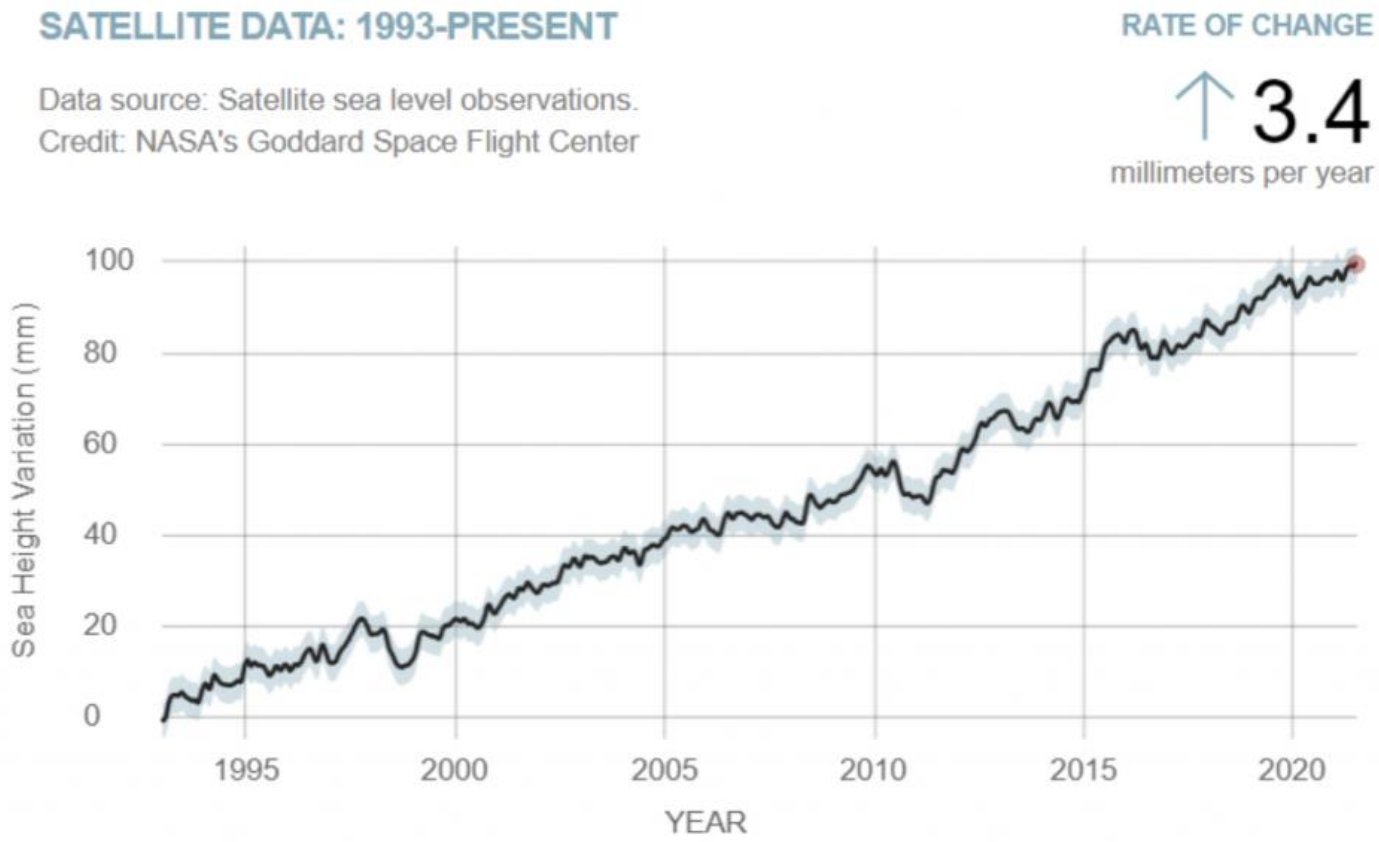
Background

- Global Temperature Increase



Background

Sea level raise due to global working



Background – Glacier Melting in Alaska

Background – Drought in Europe

Mission Statement

Continuous monitoring of Carbon Dioxide that Impacted the Earth Climate and Cause Global Warming as well as Monitoring the Consequences of Climate Change such as Rise in Sea Level, Drought, Vegetation, Earth surface Temperature, and Air Pollution.

Local Chapters Participation

No Local-Chapter Will Left Behind

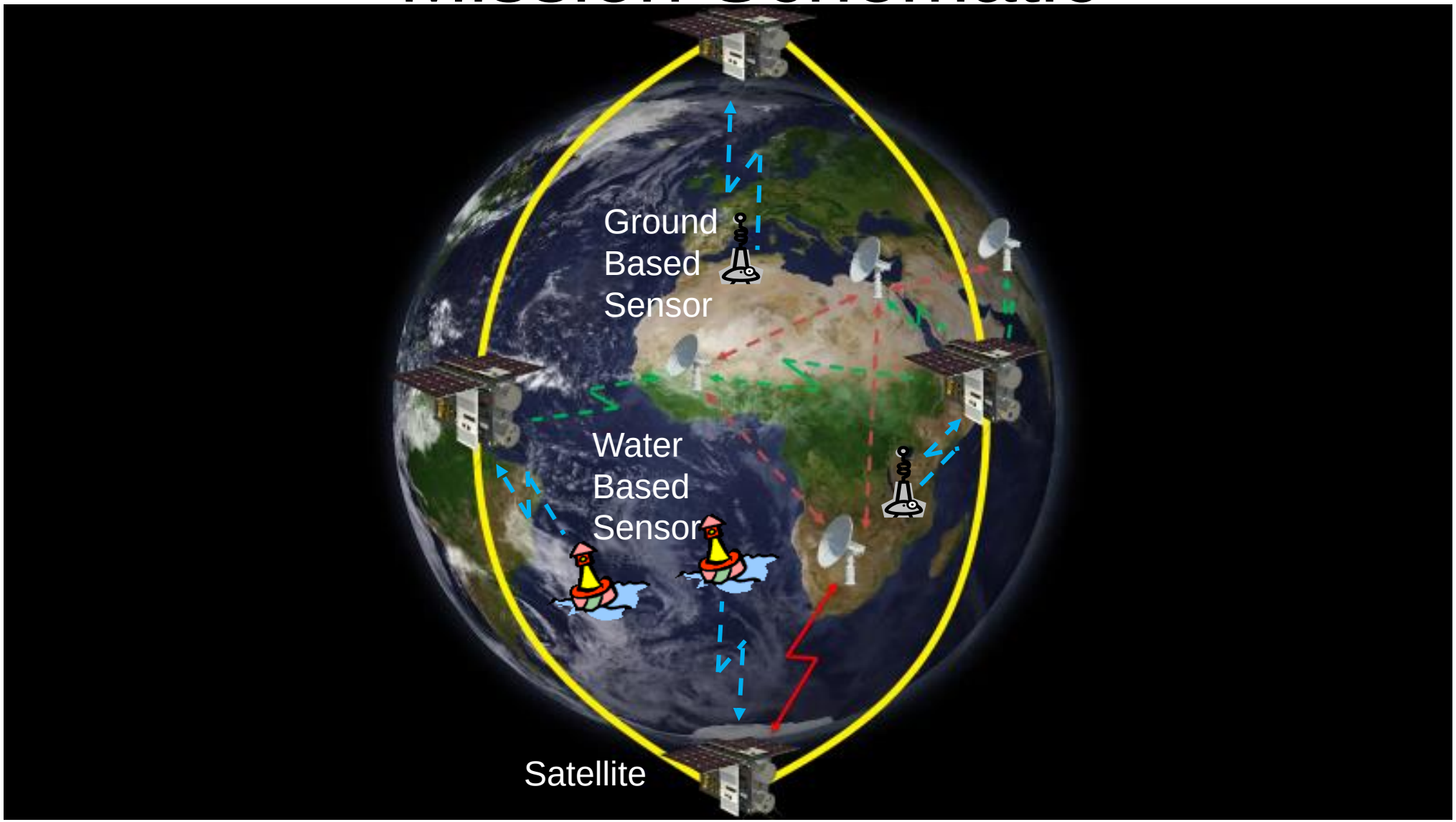
Local Chapter can participate in the project through:

1. Develop, build, test, launch and operate **6U Nano-satellite**
2. Develop, build, test, and operate, **Ground Control Station or Ground Data Reception Station or both.**
3. Develop, build, test, and operate, **Water-Based IOT sensor to be installed in oceans and lakes**.
4. Develop, build, test, and operate, **Ground-Based IOT sensor to be installed in land**.
5. Manage and analyze of the satellite data and share the analysis results to scientific community, universities, and governmental institutions.
6. Define applications for the scientific data

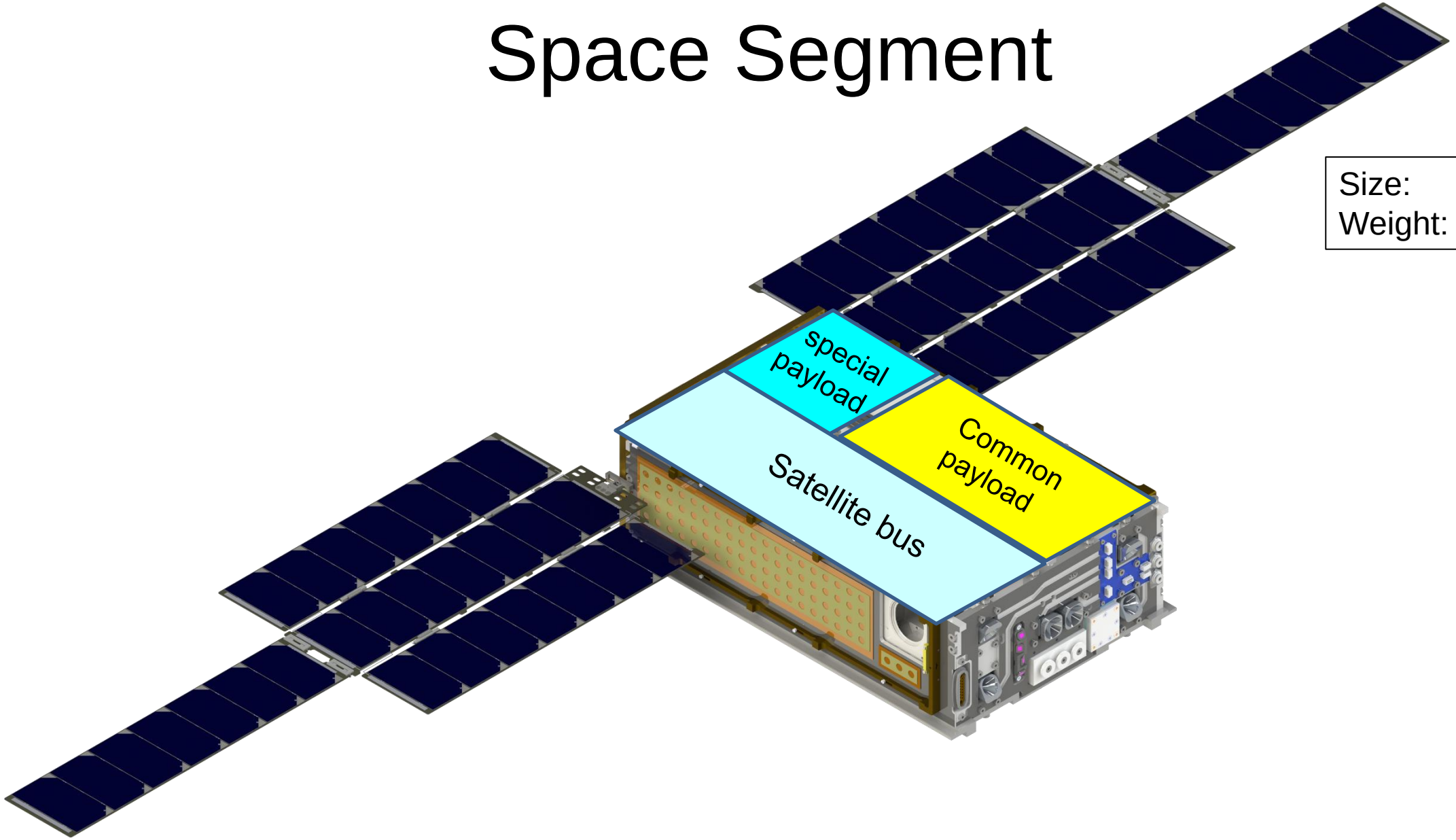
Constellation Characteristic

- Two SSO orbits with 90º RAAN separation
- **8** nano-satellites of size 6U
- **4** Nano-Satellites with IR Camera as common payload.
- **4** Nano-satellites with Multispectral Camera as common payload.
- Each orbital plan will have **two** nano-satellites with **IR-Camera** and **two** nano-satellites with **Multispectral Camera** with separation of 90 degrees true anomaly.

Mission Schematic



Space Segment



Size: 6U
Weight: 11kg

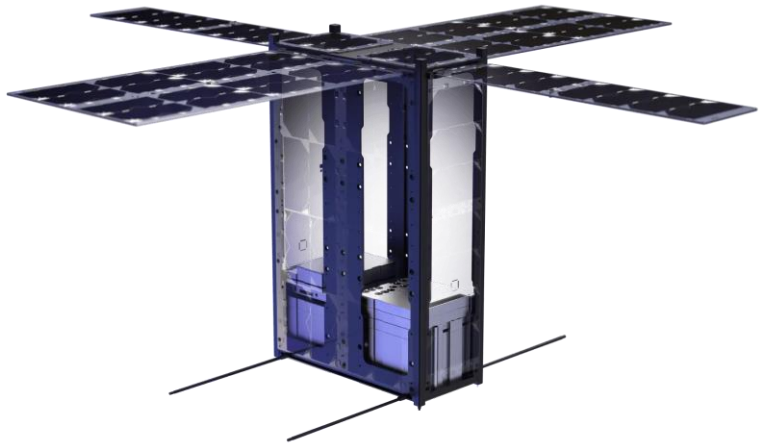
Satellite Bus

- The Satellite Bus consists of the following subsystems:

1. EPS
2. Communication (TTC & Payload)
3. ADCS
4. Propulsion
5. Structure
6. CDH
7. Thermal Control

EPS

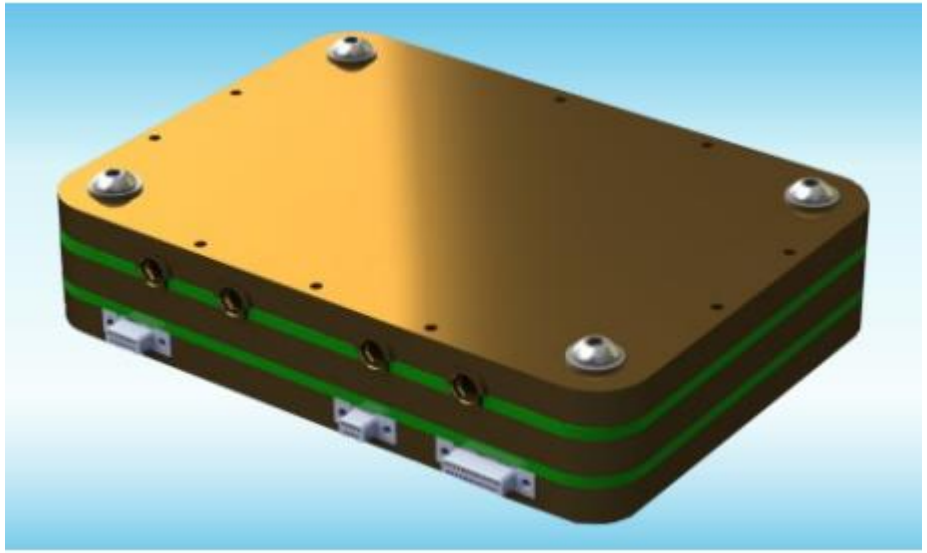
Bus Mass	4.2-4.8 kg (configuration dependent)
Available Payload Mass	7.2-7.8 kg (configuration dependent)
Available Payload Volume	97 x 197 x 223 mm^3
Average Payload Power Available	10-30 W (configuration dependent)
Available Power Buses	3.3 V, 5 V, customizable 6-12 V and Battery raw
Telemetry Data Rate	19.2 kbps
Payload Data Rate	up to 125 Mbps



Communication

XLink X Band Transceiver SDR

- SDR high speed data links
- Micro, nano or pico satellite usage
- Bidirectional communication links
- Downlink / TM & Payload 25 Mbps+
- Uplink / Tele-command 64 kbps+



Communication

ISIS TXS High Data Rate S-Band Transmitter

- Adjustable RF output power from 27 to 33dBm (0.5dB steps)
- High Data-rate S-band downlinks of up to 4.3 Mbps

ADCS

Reaction Wheel - **CW0162**

- Nominal Voltage 12
- Max Speed [RPM] 10000
- Momentum @ 6000 RPM [mNms] 16.2
- Saturation Torque [mNm] 12
- Dynamic Imbalance [g.cm2] <0.014
- Mass [g] 144
- Dimensions [mm] 46x46x24
- Supply Voltage Range [V] 3V3 & 6.4-16.8
- Average Power [2000 rpm] [mW] 336
- Peak Power [Max Torque] [mW] 16.5 W
- There will be 4 reaction wheels in pyramid configuration

CUBEWHEEL
GEN 2

ADCS

Star Tracker

- Accuracy [3-sigma] 0.02°
- Mass [g] 47
- Dimensions [mm] 35x24x49
- Detection Field of View [°] 42 (Horizontal/vertical)
- Supply Voltage [V] 3.3
- Peak Power [mW] 271
- Average Power [mW] 165
- 2 star trackers will be used for redundancy.
- There will be 90° between the star trackers

CUBESTAR
GEN 2

Propulsion

Busek – BIT-1

Total Thruster Power*	10 W
Ion Beam Current	1.5 mA
Propellant Mass Flow	4.9 µg/sec Xe
Thrust	105 µN
Specific Impulse	2250 sec
Propellant Utilization	43%
Energy Efficiency**	28%
Grid Input Voltage	2 kV
Thruster Mass***	53 g

** Does not include PPU efficiency or neutralizer consumption*
*** Defined as $P_{grid}/(P_{grid} + P_{ig})$*
**** A complete BIT-1 propulsion system will need to include neutralizer, PPU, feedsystem, and propellant tank*

Common Payload

- The common payload consists of the following:

1. IR-Camera or Multi-Spectral
2. Transreceiver for IOT sensors
3. Altitude Sensor for Water Level
4. GPS

Common Payload

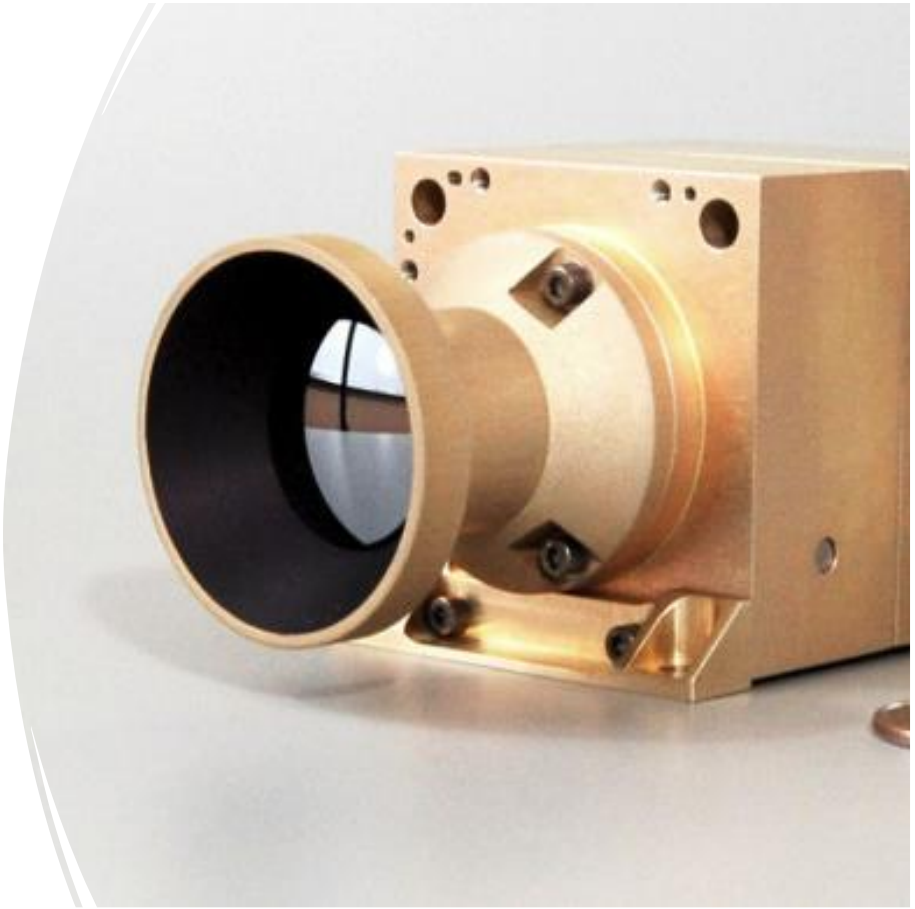
Multispectral camera (Dragonfly – Caiman Imager)

- Spatial resolution: 3-6 m
- Swath: 12 km
- Product size: 2.5U
- Mass: 1.8kg
- Power usage: 5-10.0 W
- Data storage: ~ 128 G

Common Payload

IR camera (ECAM-IR)

- Resolution: 31 m @500km
- Swath: 12 km
- Pixel size: 25μm
- Product size: 78 x 58 x 63 (cm)
- Mass: 330 g
- Power usage: 5 W



Common Payload

GPS receiver (Celeste)

- Weighs: 25g
- Power consumption: ±100mW
- Area: 67 x 42 mm

Water-Based Sensor

Water-Based Sensor will measure the following:

1. Water Level,
2. Temperature,
3. PH Value,

Temperature sensor:

- High accuracy digital sensor ±0.5°C and ±5%

Digital PH sensor

Water level sensor

Ground-Based Sensor

- Ground-Based Sensor will measure the following:

1. CO_2,
2. Temperature,
3. Ground moisture,
4. PH Value,
5. Air Pollution

Temperature sensor:

- High accuracy digital sensor ±0.5°C and ±5%

Soil Moisture Sensor (WET-2)

CO_2 Sensor – M800

Air Quality sensor

- Particulate Matter (PM1, $PM_{2.5}$, PM10)
- Nitrogen Dioxide (NO_2)

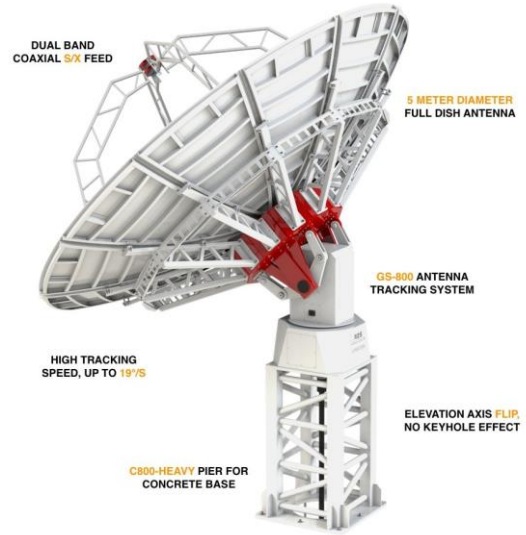
Digital PH sensor

UNISEC GLOBAL
University Space Engineering Consortium

Ground Data Receiving/Control Station

INTREPID 500XS 5.0m S/X-band ground station antenna

- Antenna diameter (m): 5.0
- Feed: Dual S/X band, coaxial, LHCP and RHCP
- Frequency: 2100–2400 MHz in S-band and 8300–8600 MHz in X-band
- Azimuth max Travel: 360±90°
- Minimum Tracking Elevation : 5°
- Encoders read resolution: 0,00002°
- Operating Altitude: 3000m max, above 1000m derating of 1%/100m
- Operating Temperature: -20°C to +55°c (optional extended -40°C +55°C)
- Continuous wind speed for operational tracking: 70 km/h
- Maximum ice load: 4mm (optional De-Icing System available)
- Weight: 2160 kg
- Supply voltage: 1×100-240VAC, 3×200-380VAC



Cost

- Each Satellite should not cost more than 1M$
- Each Ground/Water IOT sensor should not cost more than 10k$
- Ground Data Receiving Station (X-band and S-band) 50k$ – 200k$
- Ground Control Station (X-band, S-band and UHF) 100k$ - 200k$
- Operational Cost 50k$/year/station

Risk Assessment

- **Funding LC**
  - invite private companies & government
- **Maintenance of ground sensors**
  - company or Unisec member should maintain
- **Human resources (lack of experience)**
  - training the appropriate people
- **Launch failure**
  - lose 1 orbital plane (revisit period - every 2 days)
- **Satellite failure**
  - each orbital plane has 1 redundant satellite
  - use components with FH

Thank you

Questions?