Technical Note V.1.1

PoLo Sensor Description

Lakitha Wijeratne
Research Associate
Office of Information Technology

Gokul Balagopal
Research Assistant
ECE Department

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University of Texas at Dallas
Department of Physics

Multi-Scale Integrated Sensing and Simulation
https://mints.utdallas.edu/
https://github.com/mi3nts

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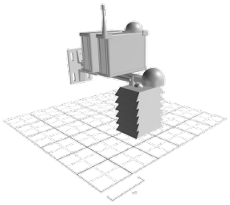
1. Introduction

The Central Node is a stationery sensor system consisting an array of iot sensors which is an extensible platform in which many newer sensors can be adopted into. The source code for the Central Node as well as most mints projects are open source and is available at https://github.com/mi3nts. The central Node consists of an array of sensor listed below:

1. Main Module
2. Light Module
3. Air Module
4. LoRa Module
5. Power Module
6. GPS Module
7. Rain Module

2. PoLo Node

Sensor Nodes	PoLo Node
Sketches	
SBC	Odroid C4
Attached sensors	• IPS7100 • BME280 • SCD30 • RG15 • SCD30 • AS7265x • Microphone

3. PoLo Node Data

Data from each PoLo Node is initially saved as *csv* files.There are two Single board computers(OdroidC4) that record the data from the sensors.Each of the SBC have unique node id's and a group of sensors connected to each of them. A *csv* file is provided for each sensor within a central node per day and is collected under the respective nodeid. In order to maintain a record of the most recent data read, a unique json file is updated for each individual sensor.Upon connection to the internet both the *csv* and *json* files are transferred via *rsync* [**?**]. Upon transmission the data to the graphical dashboards are updated using an *mqtt* [**?**] pipeline.For each day, each sensor will have a single csv file saved inside the respective node, with the following folder structure @ *\home\teamlary\mintsData*.

```
mintsData
    raw
        001e0636e547
            2023
                01
                    04
                        MINTS_001e0636e547_APDS9002_2023_01_04.csv
                        MINTS_001e0636e547_AS7262_2023_01_04.csv
                        MINTS_001e0636e547_BME280_2023_01_04.csv
                        MINTS_001e0636e547_BME680_2023_01_04.csv
                        MINTS_001e0636e547_APDS9002_2023_01_04.csv
                            .
                            .
                            .
                            .

                        MINTS_001e0636e547_SI114X_2023_01_04.csv
                        MINTS_001e0636e547_TB108L_2023_01_04.csv
                        MINTS_001e0636e547_TMG3993_2023_01_04.csv
                        MINTS_001e0636e547_TSL2591_2023_01_04.csv
                        MINTS_001e0636e547_VEML6075_2023_01_04.csv

mintsData
    raw
        001e06430225
            2023
                01
                    04
                        MINTS_001e06430225_AS3935_2023_01_04.csv
                        MINTS_001e06430225_SEN0232_2023_01_04.csv
                        MINTS_001e06430225_SKYCAM003_2023_01_04.csv
```

```
MINTS_001e06430225_WIMDA_2023_01_04.csv
MINTS_001e06430225_YXXDR_2023_01_04.csv
snaps
    MINTS_001e06430225_SKYCAM003_
     2023_01_04_16_00_43.png
    .
    .
    .
    MINTS_001e06430225_SKYCAM003_
    2023_01_04_18_35_03.png
    MINTS_001e06430225_SKYCAM_binary003_
    2023_01_04_16_37_44.png
    .
    .
    MINTS_001e06430225_SKYCAM_binary003_
    2023_01_04_18_35_03.png
```

In this example, the sensor ID happens to be *001e0636e547*, *001e06430225* which is the unique ID corresponding to the XU4 and N2+ respectively .

3.1 Data Format for Each Sensing Module

3.1.1 Particulate Matter Sensors

IPS7100

dateTime	pc0_1	pc0_3	pc0_5	.....	pm10_0
2023-01-04 00:00:00.059604	64474	18205	11661	.....	5.74317020
2023-01-04 00:00:01.061184	62047	17368	11109	.....	5.57649617
2023-01-04 00:00:02.062446	59468	16571	10640	.....	5.40531891
2023-01-04 00:00:03.063477	56790	15791	10198	.....	5.23171629
2023-01-04 00:00:04.064636	54282	15017	9777	.....	5.06503846
2023-01-04 00:00:05.065186	51981	14281	9377	.....	4.90459504
2023-01-04 00:00:06.066297	49793	13580	9015	.....	4.76209408

The data format of the **IPS7100** *csv* is described on table 1.

Table 1. Data Format used on the **IPS7100** data *csv*

Parameter	Column Name	Format	Unit	Errors	Example	Comments
UTC Time	dateTime	yyyy-MM-dd hh:mm:ss			2023-02-09 00:00:07.143333	
Particles Counts	pc0_1 to pc10_0	Integer	$\#/Liter$	Particle Counts per *liter* for particle diameters 0.1, 0.3, 0.5, 1.0, 2.5, 5, 10 μm	3272	
Particulate mass fractions	pm0_1 to pm10_0	Float	$\mu g/m^3$	Particle mass fractions for particle diameters 0.1, 0.3, 0.5, 1.0, 2.5, 5, 10 μm	2.56	

3.1.2 Climate Sensors

BME280

dateTime	temperature	pressure	humidity	altitude
2023-01-04 00:00:06.268466	16.81	99540.00	29.00	149.66
2023-01-04 00:00:16.296297	16.81	99542.00	29.00	149.49
2023-01-04 00:00:26.309238	16.80	99537.00	29.00	149.91
2023-01-04 00:00:36.337023	16.80	99538.00	29.00	149.83
2023-01-04 00:00:46.350128	16.80	99539.00	29.00	149.75
2023-01-04 00:00:56.362813	16.79	99539.00	29.00	149.75
2023-01-04 00:01:06.390603	16.79	99539.00	29.00	149.75
2023-01-04 00:01:16.403502	16.77	99538.00	29.00	149.83
2023-01-04 00:01:26.416226	16.77	99540.00	29.00	149.66
2023-01-04 00:01:36.429101	16.78	99542.00	29.00	149.49
2023-01-04 00:01:46.456660	16.78	99539.00	29.00	149.75

The data format of the **BME280** *csv* is described on table 2.

Table 2. Data format used on **BME280** data *csv*

Parameter	Column Name	Format	Unit	Errors	Example	Comments
UTC Time	dateTime	yyyy-MM-dd hh:mm:ss			2023-01-04 00:00:06.268466	
Temperature	temperature	Float	$^{\circ}C$		16.81	
Pressure	pressure	Float	$millibars * 100$		99540.00	
Humidity	humidity	Float	%		29.00	
Altitude	altitude	Float	meters		149.66	

3.1.3 CO_2 Sensor

SCD30

dateTime	c02	temperature	humidity
2023-01-04 00:00:08.763232	405	19.44	27.58
2023-01-04 00:00:18.775858	406	19.44	27.53
2023-01-04 00:00:28.803976	405	19.42	27.62
2023-01-04 00:00:38.816727	405	19.44	27.64
2023-01-04 00:00:48.829733	405	19.44	27.59
2023-01-04 00:00:58.857351	406	19.44	27.62
2023-01-04 00:01:08.870275	406	19.41	27.59
2023-01-04 00:01:18.883096	406	19.41	27.67
2023-01-04 00:01:28.911038	407	19.42	27.62
2023-01-04 00:01:38.923842	406	19.42	27.70

The data format of the **SCD30** *csv* is described on table 3.

Table 3. Data format used on **SCD30** data *csv*

Parameter	Column Name	Format	Unit	Errors	Example	Comments
UTC Time	dateTime	yyyy-MM-dd hh:mm:ss			2023-01-04 00:00:04.568350	
CO_2	co2	Integer	ppm		405	
Temperature	temperature	Float	$^{\circ}C$		19.44	
Humidity	humidity	Float	%		27.58	

3.1.4 Light Sensors

AS7265x

dateTime	luminance	voltage	raw
2023-01-04 00:00:08.974372	1.01	0.00	0
2023-01-04 00:00:20.521757	1.01	0.00	0
2023-01-04 00:00:32.069220	1.01	0.00	0
2023-01-04 00:00:43.616382	1.01	0.00	0
2023-01-04 00:00:55.163985	1.01	0.00	0
2023-01-04 00:01:06.711284	1.01	0.00	0
2023-01-04 00:01:18.273649	1.01	0.00	0
2023-01-04 00:01:29.821167	1.01	0.00	0
2023-01-04 00:01:41.368623	1.01	0.00	0

The data format of the **APDS9002** *csv* is described on table 4.

Table 4. Data format used on **APDS9002** data *csv*

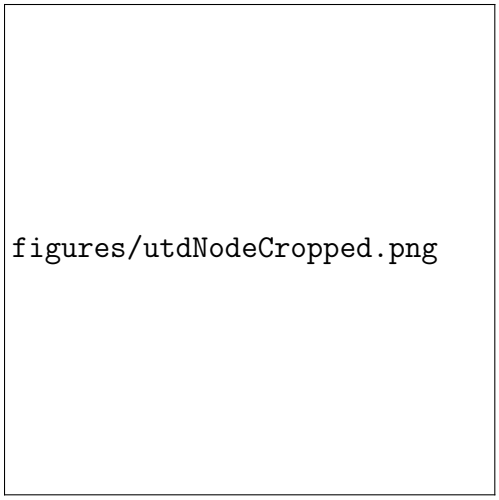
Parameter	Column Name	Format	Unit	Errors	Example	Comments
UTC Time	dateTime	yyyy-MM-dd hh:mm:ss			2023-01-04 00:00:08.974372	
Luminance	luminance	Float			1.01	
Voltage	voltage	Float	V		0.00	
Raw	raw	Integer	%		0	

References

Appendix C: Stationary Sensing Systems

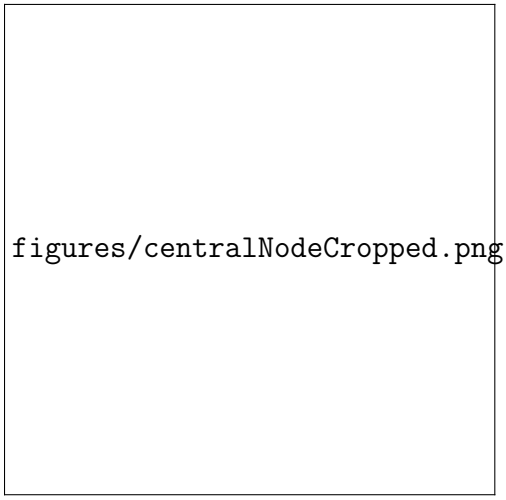
MINTS has been developing multiple sensor systems for a wide range of applications. One subset of such systems is 24/7 Streaming Distributed Sentinels, where the data is provided on a frequent and continuous basis.

1st Generation: UTD Nodes



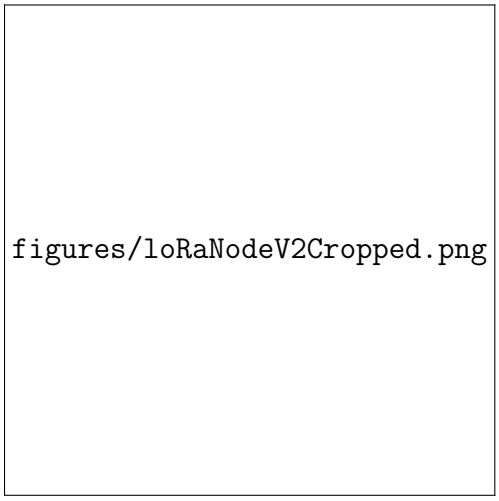
The UTD Node is a stationery sensor system consisting an array of iot sensors which is an extensible platform in which many newer sensors can be adopted into. The UTD Node houses a particulate matter sensor, CO_2 sensor, climate sensor, a set of light sensors as well as an skyward facing camera.

2nd Generation: Central Nodes



Central Nodes are the second generation of UTD Nodes. In addition to providing all the sensors provided by the UTD Node, the Central Node has an expanded light sensing module as well as a radiation sensor, a sound sensor that detects bird calls as well as gunshots, a research grade ozone sensor, a lightning sensor, and remote power management capabilities. Additionally, the Central Node serves as a central gateway for a mesh network of LoRaWAN Nodes described in section 3.1.4.

LoRaWAN Nodes



LoRa is an infant communication technology based on ISM (Industrial, Scientific and Medical) bands which are capable of low power and Long Range applications. LoRaWAN is a Wide Area Network protocol that is designed to embed LoRa technology into a network infrastructure . The LoRa Nodes are designed to make use of LoRaWAN technology with each node a part of a mesh network communicating with one Central Node.

The LoRa Nodes are designed to work without the need of direct power nor internet connectivity. This makes it extremely versatile. The main source of power for the LoRa Nodes is sunlight and thus it consists of two solar panels to harness solar energy.

A LoRa Node consists of a particulate matter sensor and a climate sensor.

Appendix D: MINTS GitHub repositories

- Version 1, 3 firmware:
  https://github.com/mi3nts/minWeNodes
- Version 4 firmware:
  https://github.com/mi3nts/minWeZeroNodes
- UTD Node firmware:
  https://github.com/mi3nts/UTDNodes
- Central Nodes firmware:
  https://github.com/mi3nts/centralHub
- LoRaWAN Nodes firmware:
  https://github.com/mi3nts/LoRaWANNodes