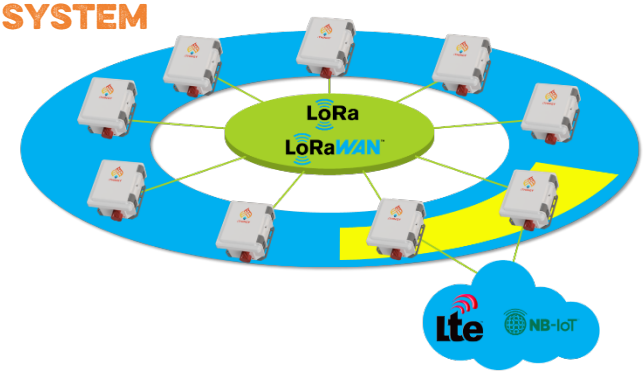
THINGY:AQ

Wildland Fire Real-Time Monitoring System Data Sheet

THINGY:AQ is a real-time Air Quality monitoring and telemetry system. The initial implementation was developed to provide information to first responders and firefighters combatting Wildland Fires / Bush fires. The system has been designed to be a lightweight and easily deployable air pollution monitoring solution that can be installed permanently or quickly during a fire event. The sensor system supports multiple geographically dispersed sensor nodes and a central receiver. The central receiver can be either a physical central receiver unit (CRU) or it can be a virtual receiver deployed in the public or private could. The central receiver collects information from the sensor nodes. Multiple sensor nodes will collect air quality information, which is then transmitted back to the central receiver for retrieval and optional real-time analytics via an external system.

THINGY: AQ SYSTEM



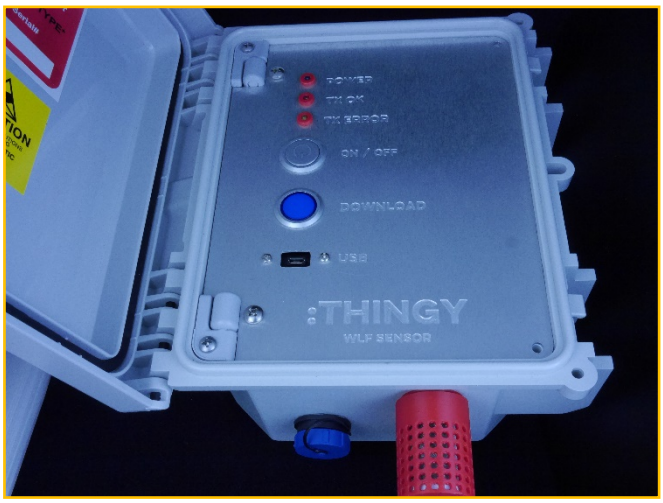
SENSOR NODES OVERVIEW

Battery powered sensor nodes measure air pollutants including fine particulate matter $PM_{2.5}$, PM_{10}, carbon monoxide, carbon dioxide and ozone. The sensor nodes also measure air temperature, humidity and geo-location data. Location data, latitude and longitude and system error status are stored on the sensor node and are transmitted in real time over long distance utilizing a Lora encoded radio link. Lora (LoRa) is a long range, low power wireless technology. The Sensor Nodes also support optional alternative radio telemetry options including GSM/LTE and NB-IoT.

The system has been designed to be lightweight and easily deployable by a single, non-specialist operator and to be suitable for harsh environments. The sensor nodes include two 50um particulate filters, one on the air inlet and one on the exhaust from the sensor node. These filters limit both the ingress of larger pollutant material and biological entities. The system does not pose any hazards, if exposed directly to wildfire.

CENTRAL RECEIVER UNIT

The optional central receiver unit (CRU) is a physical device that receives and centrally records data from multiple remote sensor nodes. It provides a USB interface for presenting the data from the sensor nodes as well as optional WiFi, Bluetooth, LTE (Cat-M1) and NB-IoT (LTE-Cat-NB1) interfaces for communicating with third party systems including cloud hosted services on public or private clouds.



The CRU is powered by an external 9 to 18V DC power source and includes a battery backup system in the event of temporary interruption to the external power source. The system will transmit error status messages in the event the external power source is interrupted.

SENSOR NODES DETAIL

The sensor nodes are designed to record and telemeter data with minimal or no operator intervention. Once the system has been turned on, it will start measuring sensors, logging the data and telemetering the data. The scan cycle time defines when the sensor node will start a scan cycle, which involves powering up the particulate matter and CO2 sensors, waiting 15 seconds for the system to stabilize and then commencing a series of sensor measurements, reading each sensor every 2 seconds multiple times before filtering, averaging, and storing the data. At the end of the scan sequence, the sensor node powers down the sensors, powers up the radio transmitter, telemeters the data and powers down the radio. The sensor node enters a sleep state until the next scan cycle or input from the operator.

The only operator configurable variable is the sensor node **Scan Interval** (SI) cycle. The value is stored in non-volatile memory and can be configured for a 1, 2, 5, 15, 20, 30 or 60 minute scan interval. When the sensor node is powered on, it reads the scan interval configuration from its non-volatile memory and automatically commences operation based on this parameter. The operator can change this scan interval via the USB serial port on the sensor node. If the operator changes the scan interval, the new value is stored in non-volatile memory and becomes the new power-on default value. The operator can interrogate system status, upload system logs and upload recorded data via the sensor nodes USB interface. The data on the sensor node is logged on the microSD card. The data can be read from this card without removing the card. When the microSD card is swapped or replaced the system will automatically commence logging to the media.

BUILT AROUND WILDLAND FIRE SENSOR CHALLENGE REQUIREMENTS

Thingy:AQ was originally designed in response the EPA and their US Federal partners ***"Wildland Fire Sensor Challenge".*** The system continuously monitors air pollution during a fire event and includes the following characteristics:

MEASUREMENTS

The sensor system supports multiple sensor nodes and a central receiver. The central receiver is either virtual, hosted on a public or private cloud platform, or a physical unit. The physical hardware central receiver unit collects, records, and outputs information from the sensor nodes. Multiple sensor nodes will collect air quality information, which is then transmitted back to the central receiver unit. The solution includes the following measurements for each sensor node as per the challenge requirements:

- fine particulate matter (PM2.5 particulate matter with a mean aerodynamic diameter of 2.5µm or smaller)
- carbon monoxide (CO)
- ozone (O3)
- Carbon Dioxide (CO_2)
- geo-location (latitude, longitude)

Additionally, the sensor nodes include the following measurements:

- fine particulate matter (PM_{10}).
- Temperature deg C (T)
- Relative Humidity (RH)

Parameter	Technology	Range	Resolution	Accuracy
PM 2.5	Fan Aspirated, laser scattering, optical processing for particulate sizing and yield	0.0 to 999.9µg/m3	0.3µg/m3	Maximum of 15% or reading and ± 10µg/m3 (25DegC, 50%RH)
PM 10	Fan Aspirated, laser scattering, optical processing for particulate sizing and yield	0.0 to 999.9µg/m3	0.3µg/m3	Maximum of 15% or reading and ± 10µg/m3 (25DegC, 50%RH)
CO	ElectroChemical	0 to 1000ppm	0.1 ppm	15% of reading
CO2	Non-dispersive Infrared (NDIR)	400 to 5000ppm	1ppm	± 30ppm ± 3% of reading
O3	ElectroChemical	0 to 5 ppm	20ppb	15% of reading
Temp Deg C	Solid State sensor	-99 to +99	0.1	± 1 Deg C
Humidity RH	Solid State sensor	0 to 99%	0.1%	± 3% RH (max), 0–80% RH

Sensors for this system were selected based on the trade-offs between price, accuracy, sensor range, resolution, power consumption, life expectancy and ease of field replacement. Pre-calibrated digital

output sensors were selected because they minimise the problems typically associated with a genetic analogue sensor frontend. This sensor class enables the use of field replaceable sensor modules.

DATA TRANSMISSION AND STORAGE

The system manufacturing default for the Scan Interval is set to 5 minutes. The default value can optionally be changed by the operator and the new value becomes the new power on default. A Sensor Node records locally on its microSD card as well as telemetering the data. The Sensors Nodes are capable of recording continuously for several years without intervention. The data transmission is via a long-range low power radio link utilizing the LoRa platform from the Sensor Nodes to Central Data Receiver. Lora uses the unlicensed radio spectrum in the Industrial, Scientific and Medical (ISM) bands to enable low power, wide area communication between remote sensors and gateways and is capable of line of sight communications well in excess of 15km. In the US and Australia the frequency used by the Sensor Nodes is in the 915MHz band. The Central Data Receiver is capable of storing months of data on its microSD card.

OPERABILITY

The system requires minimal infrastructure and operator effort to set-up, operate, and decommission. The system should be capable of operation for a minimum of 15 days without operator maintenance in harsh environments. The Sensor Nodes can be optionally augmented with an external power source and/or solar panels. In this scenario the system is capable of operating for many months without user intervention.

The system uses two basic data formats, a heavily compressed binary encoded data format for transmission over the long range, low power, very low bandwidth radio link and the **Presentation Format** used to store the data on microSD at the Sensor Nodes and the Central Receiver. The presentation format is also used to present the data over the various interfaces supported by the Central Receiver Unit including the USB serial interface and optional WiFi, Bluetooth, LTE (Cat-M1) and NB-IoT (LTE-Cat-NB1) interfaces for communicating with third party systems including cloud hosted services on public or private clouds. Both the presentation formatted data and the compressed binary encoded data include date and time stamping. The data logged to the Central Receiving Unit's microSD card is virtually identical to the same record stored on Sensor Node that originated the data;

The **Presentation Format** is comma delimited and includes the following information:

- Pollutant name
- Pollutant concentration
- Units of measure (PM2.5 in µg m-3, CO in ppm, O3 in ppb, CO2 in ppm, PM10 in µg m-3, Temp in deg C, RH in %)
- Geo-location of the Sensor Node that originated the data (latitude and longitude specified in decimal degrees)
- Date and Timestamp in ISO 8601 (For example "2077-11-07T14:30")

MAINTENANCE

The system has an estimated five year life before requiring the sensors to be replaced. The consumable items include batteries and enclosure filters. There is no anticipated routine maintenance requirement however systems that are exposed in close proximity to Wildland Fires or other heavy pollutants may require the enclosure filters to be replaced following the event.

ADDITION INFORMATION

The Sensor Node and the optional Central Receiver Unit each include the enclosure for the electronics and a light weight collapsible mast/stand with 915MHz Antenna.

Enclosure Details:

- Weight 4lbs (1.8Kg) without battery
- Weight with battery 5lbs (2.3Kg)
- Enclosure Dimensions: L 10.7 in, W 8.2 in, H 5.5 in (L 270mm, W 210mm, H 140mm)
- NEMA 4, IP67, Flammability UL94 V-0

Mast/Stand Details:

- Weight 6.5lbs (3Kg)
- Collapsed size - L 42in x W 4in (L 1066mm, W 100mm)
- Deployed size - Base W 6ft (1830mm), Mast H 9.5ft (2900mm)

Head to **gothingy.com/WLF** for more information