

OpenIoTwx

Improving the Accessibility of Open
Source Weather Sensing & Data



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**COLORADO
COLLEGE**

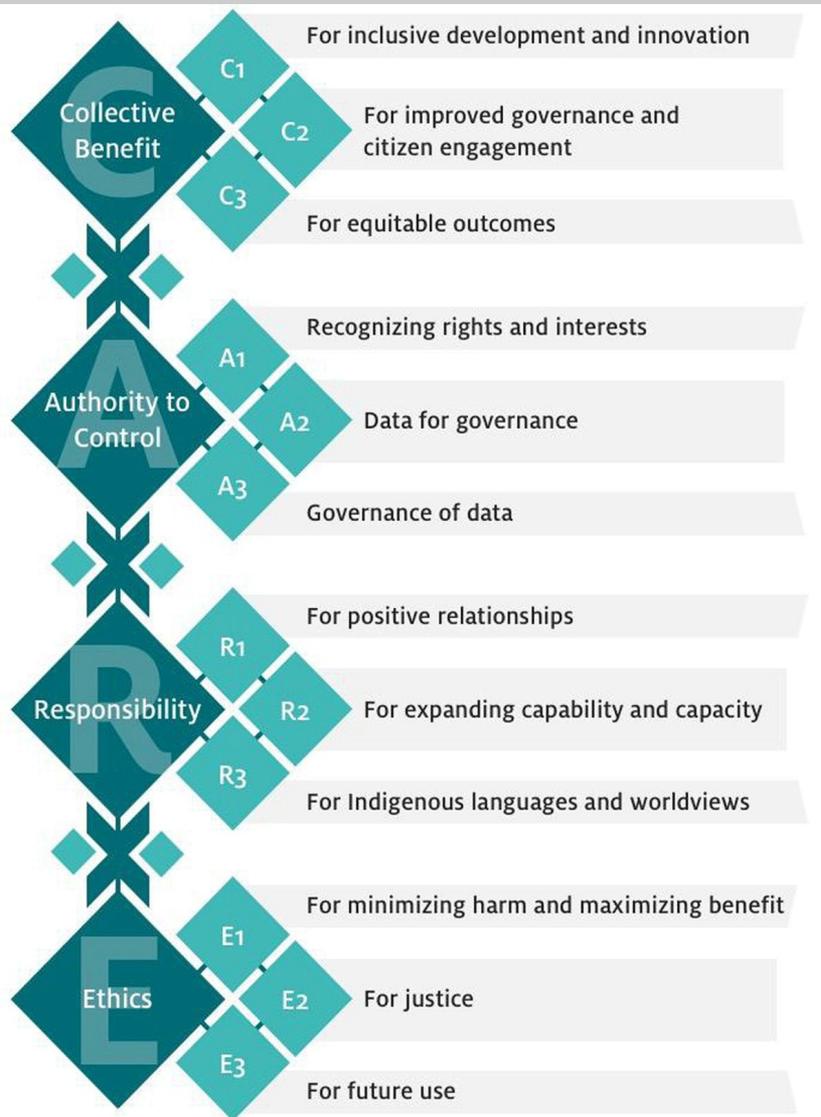


What is OpenIoTwx

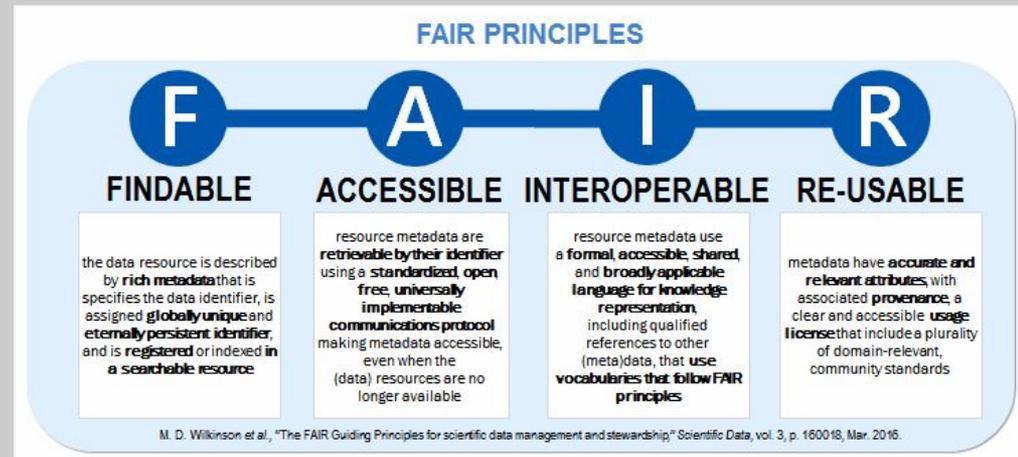
- Personal Weather Station grade, modular, sensor set
- End-to-end Open Source
- 3d printable body
- Easy to assemble electronics
- Created for educational trainings and data equity work.



Our Philosophy

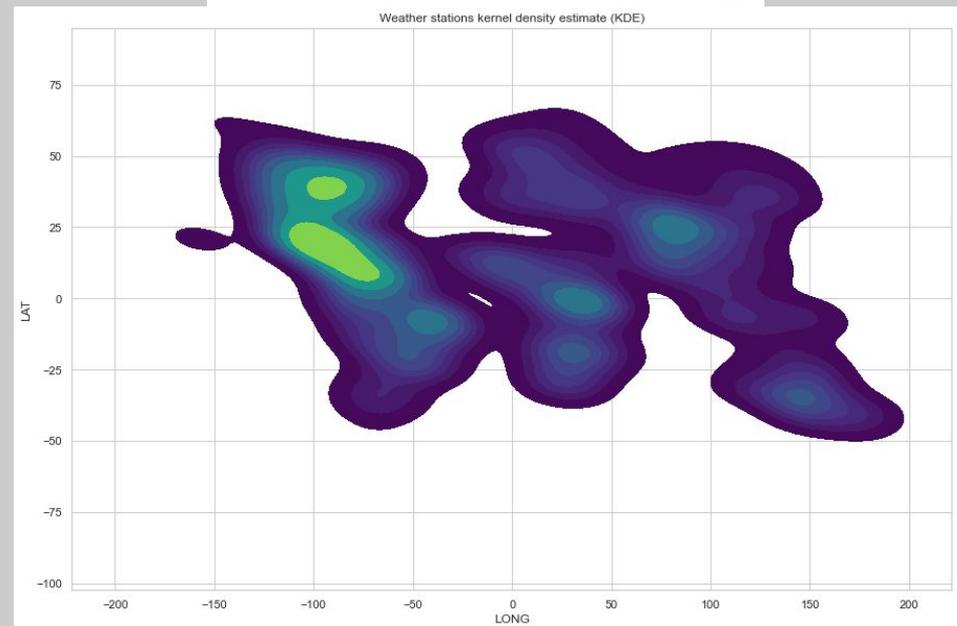
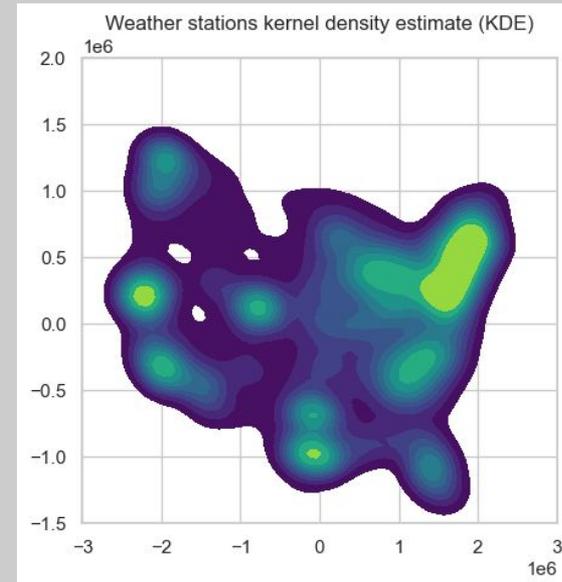


We follow FAIR and CARE principles for data maintenance and governance



Data Equity

- Inequity both globally and nationally
- Missing personal data on the global scale, skewing measurements
- Data deserts, especially in rural, impoverished, and indigenous communities



Why OpenloTwx

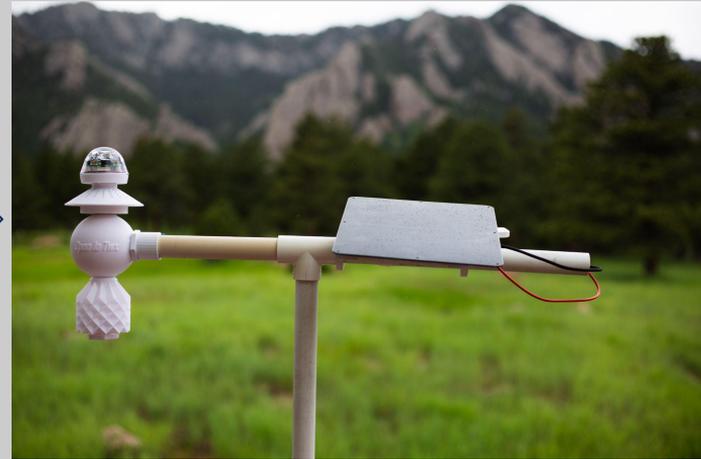
The NCAR/UCAR 3D-printable progression



3DPaws (UCAR COMET)

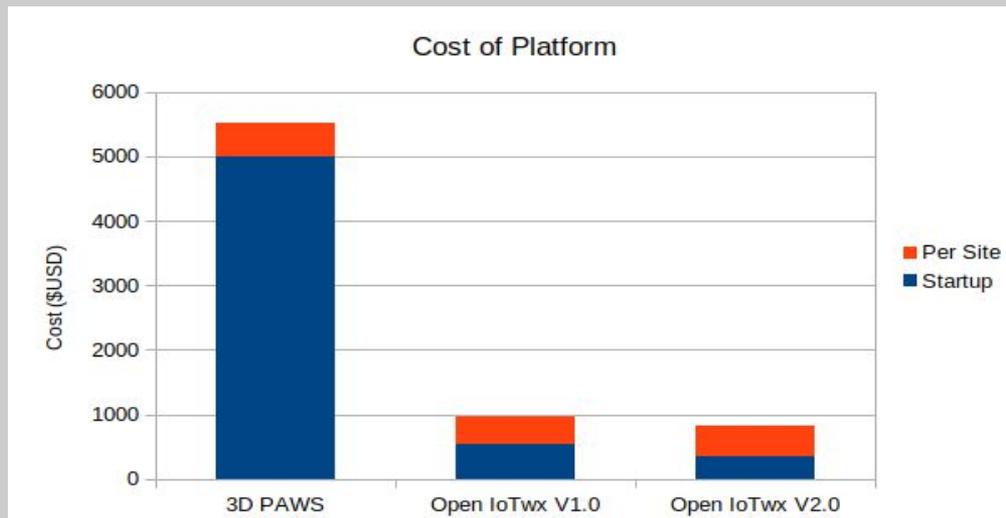
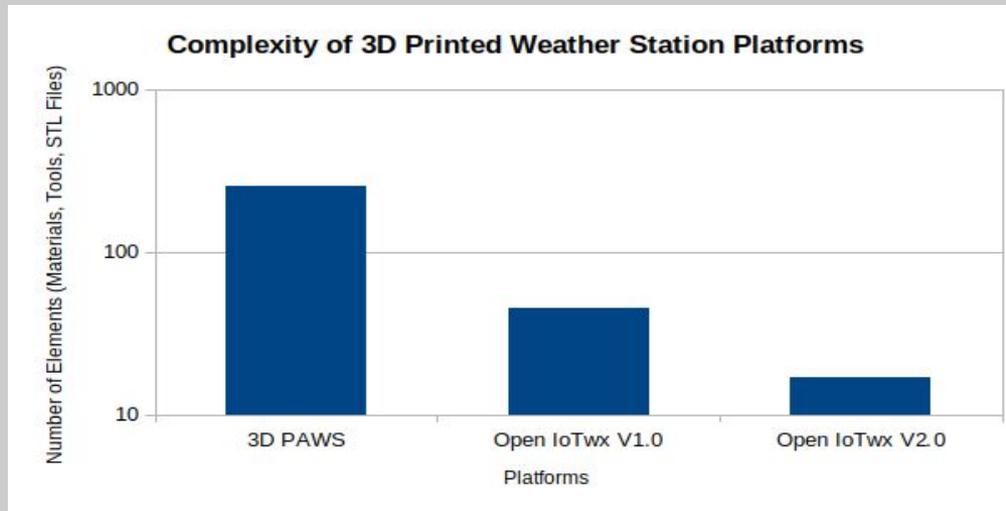


OpenloTwx V1



OpenloTwx V2

Why OpenIoTwx



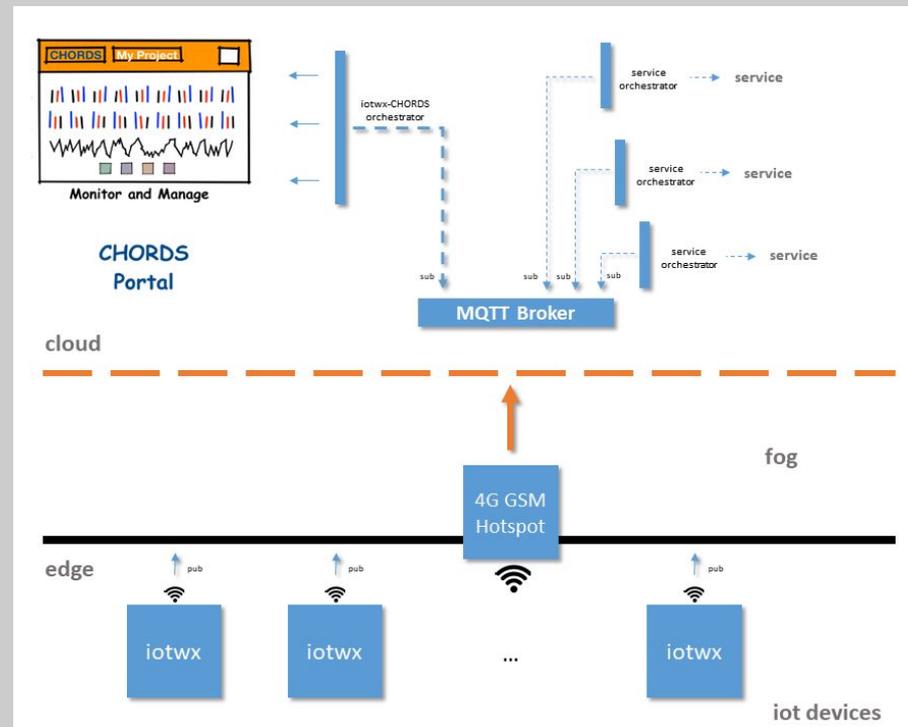
Internet Of Things and Edge Computing

Edge Computing:

- Decentralized computing paradigm
- Processing closer to data source
- Enables real-time analysis, faster response, and lowers bandwidth requirements.

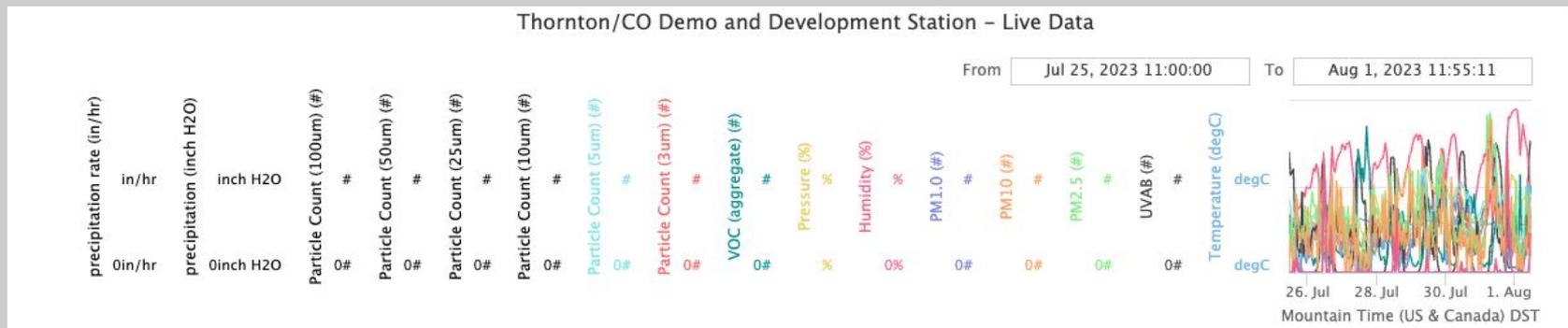
Internet of Things (IoT):

- Network of connected physical objects
- Embedded with sensors and software
- Collects and exchanges data over the internet.



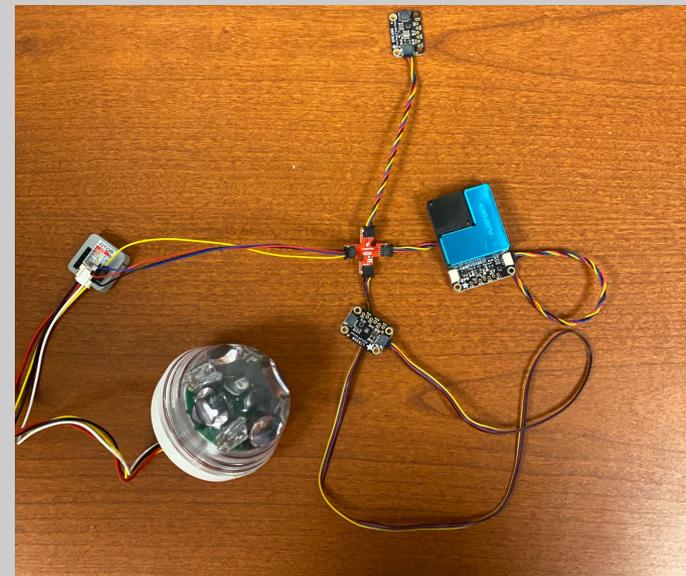
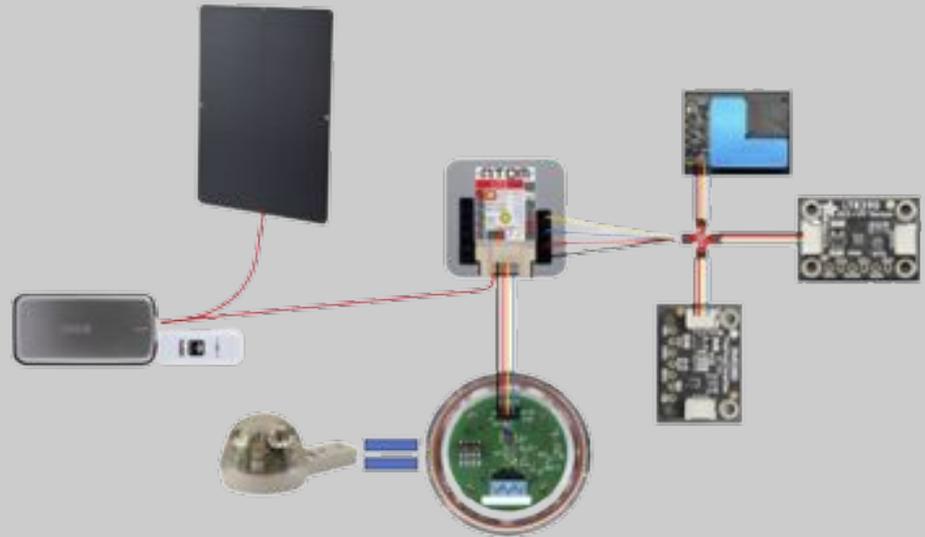
Sensors

- BME680 - Temperature, Humidity, Pressure, VOC
- RG15 - Precipitation quantity and rate
- LTR390 - UV
- PMSA003I - Air Quality and Particulate
- SCD40 - CO2



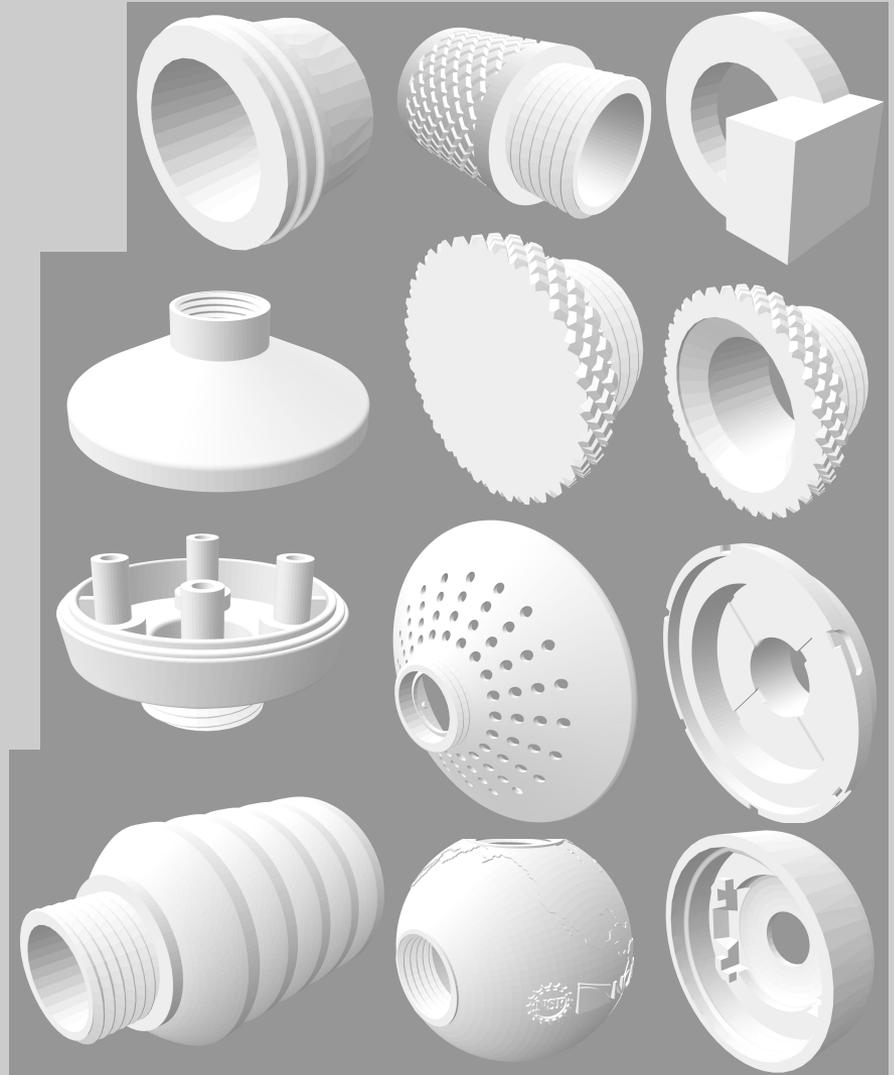
Electronics

- Except for a few pins, everything runs on Qwiic hubbed connections
- This is a base station, modular on top of this system.
- Divisible into multiple 'nodes' running as the same publishing client

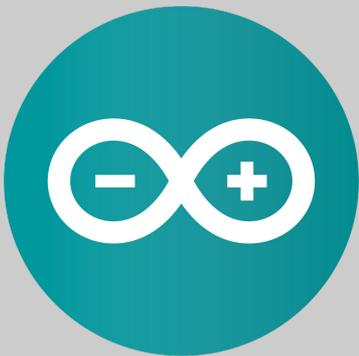


Housing and Prints

- 12 required prints
- Users are guided through the printing process
- Printable on easy-to-use, consumer grade printers
- Printed using Ultimaker Cura

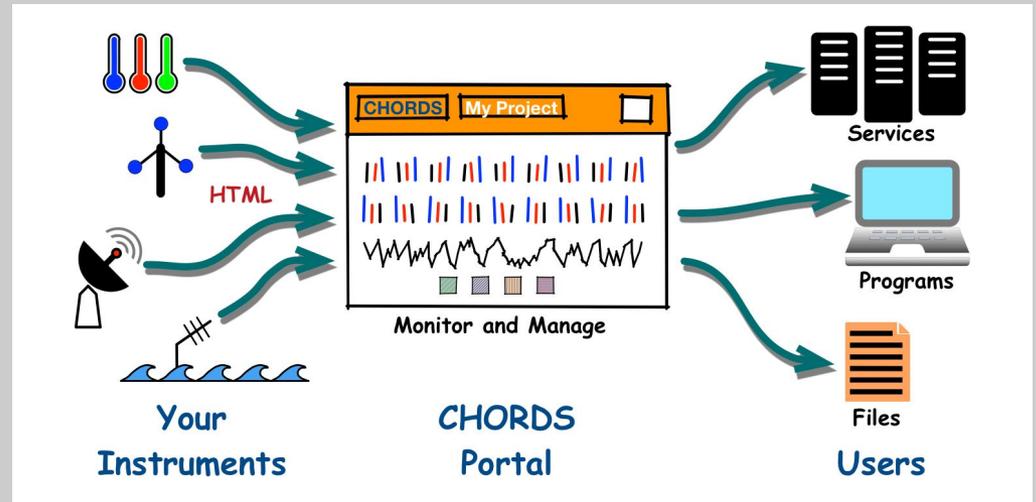


- Built on Arduino
- Uses a lightweight file system to allow for user configuration without entering the codebase
- Allows publishing at custom intervals
- Allows for bidirectional communication between stations and clients

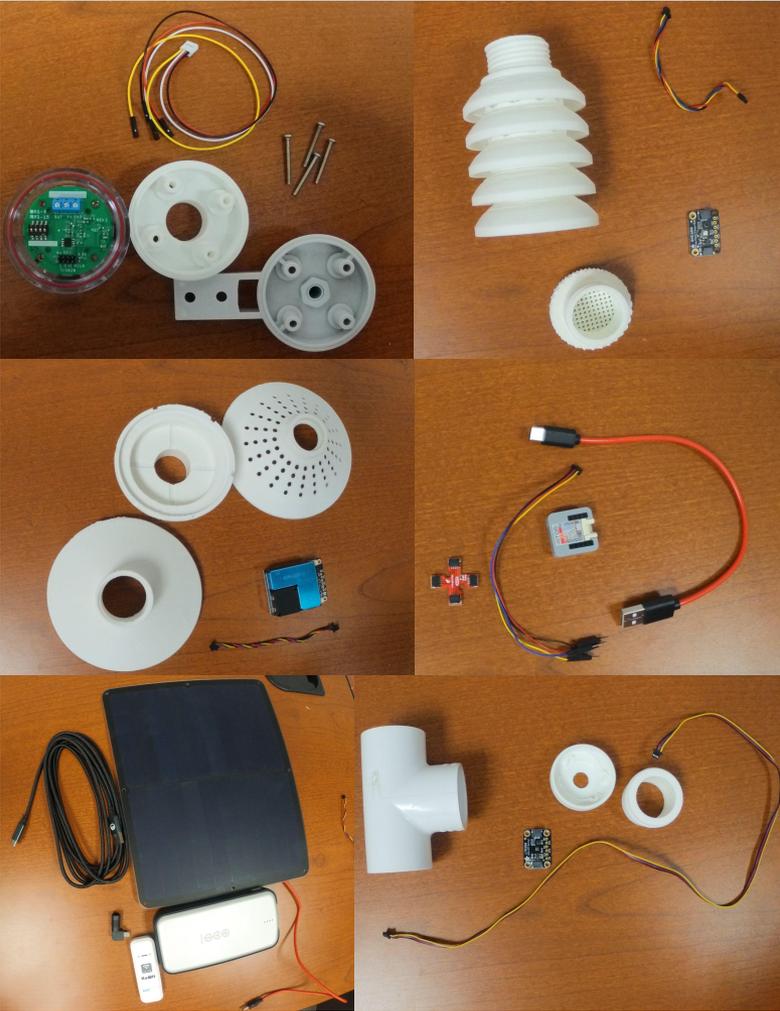


Data Protocols

- Data are collected and computed at the ESP32 microcontroller
- Using the onboard cellular modem the data are transmitted via MQTT
- A backend orchestrator functions as the broker, sending measurements to CHORDS (visualization API)
- Data are customized and visualized in CHORDS

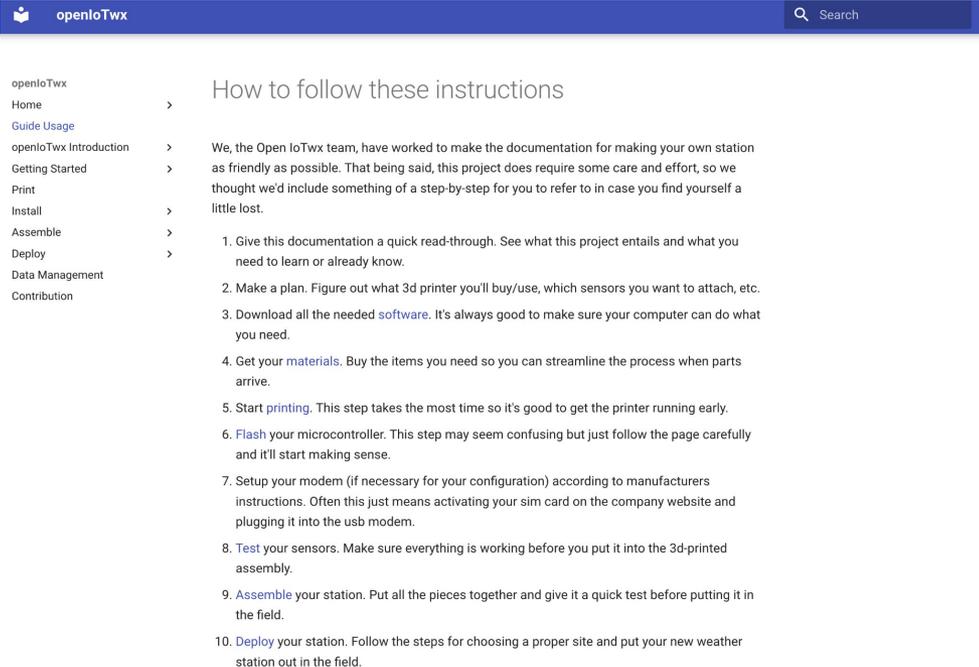


Assembly



Accessibility

- Formatted to minimize jargon
- Static, allowing user download for use in no-bandwidth zones
- Integrating pre-compiled flash and on-the-fly configuration for easier upload



The screenshot shows the openIoTwx website. The header includes the logo and a search bar. A navigation menu on the left lists: Home, Guide Usage, openIoTwx Introduction, Getting Started, Print, Install, Assemble, Deploy, Data Management, and Contribution. The main content area is titled 'How to follow these instructions' and contains a list of 10 numbered steps for setting up the station.

1. Give this documentation a quick read-through. See what this project entails and what you need to learn or already know.
2. Make a plan. Figure out what 3d printer you'll buy/use, which sensors you want to attach, etc.
3. Download all the needed [software](#). It's always good to make sure your computer can do what you need.
4. Get your [materials](#). Buy the items you need so you can streamline the process when parts arrive.
5. Start [printing](#). This step takes the most time so it's good to get the printer running early.
6. [Flash](#) your microcontroller. This step may seem confusing but just follow the page carefully and it'll start making sense.
7. Setup your modem (if necessary for your configuration) according to manufacturers instructions. Often this just means activating your sim card on the company website and plugging it into the usb modem.
8. [Test](#) your sensors. Make sure everything is working before you put it into the 3d-printed assembly.
9. [Assemble](#) your station. Put all the pieces together and give it a quick test before putting it in the field.
10. [Deploy](#) your station. Follow the steps for choosing a proper site and put your new weather station out in the field.

IoTwx CONFIGURATION Wizard [step 1/3]

Wifi SSID

Wifi Password

Download Server URL (direct .bin)

<https://app.iotwx.net/ota/>

Download Server SSL Certificate

```
-----BEGIN CERTIFICATE-----
MIIFazCCA10gAwIBAgIRAI1Qz70D500
N2RGPgu20C1wAwDQYJKoZIhvcNAQEL
BQAw
TzELMAkGA1UEBhMCVmxKTAnBgNVBA
oTIElud6VybW0IFNlY3VyaXR5IFJl
c2Vh
cmNoIEdyb3VwMRUwEwYDV0QDEwXzU1
JHIFJvb3QwDEwHhcMMTUwNjABMTEw
NDM4
```

Force data reset

Submit

Future Work

- Over the Air updates
- Micropython for easier data testing
- Open source anemometry and method for robust siting thereof
- Large scale station deployment
- Radiation shield calibration
- Adding a hydrologic measurement node and a soil node.
- Publish the papers we're working on

Article title

OpenIoTwx: A Decentralized Automated IoT Weather Station Architecture

Authors

"K. E. Maull*, R. Alter, A. Ameko, and others" others: "A. Honors, J. Powell, A. Banihirwe and E. Foust "

Affiliations

Please include the full address of each author institution

Corresponding author's email address and Twitter handle

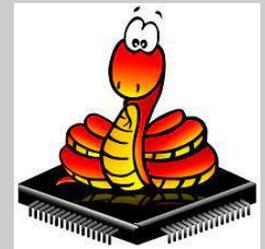
Institutional email address preferred. If you have a Twitter handle, please add it here 'twitter: ...'

Abstract

We present an architecture for the development of an IoT-based weather station, using low-cost System On a Chip (SOC), microcontroller and mobile phone hardware atop the lightweight messaging technology, MQTT. We demonstrate the flexibility of decentralizing weather station operations and meteorological measurements through basic commodity sensor technologies, and show how this approach may encourage development of novel and significantly less expensive sensing techniques that extend what is currently only possible with commercial-grade technologies. Our IoT approach is implemented and discussed through the lens of a reference deployment of a low-cost 3d-printed weather station design.

Keywords

weather station, remote sensing, iot sensing, MQTT



Acknowledgements and Questions

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