INVESTIGATING INTERNET OF THINGS (IoT) PLATFORMS FOR 3D PRINTED WEATHER STATIONS

A Prototype for Puerto Rico

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Contributor in IoT Wx set up in Puerto Rico: Steven Rivera, University of Puerto Rico

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Real time monitoring of weather is required to improving weather forecasting and warning decisions.

Figure 1: Cause of major electricity disturbances in the US, 2012-2016
Share of total customer-hours disrupted

- Other Severe Weather: 64.5%
- Hurricane Sandy: 31.7%
- Generation Inadequacy: 0.00056%
- Fuel Supply Emergencies: 0.00007%
- Other: 3.8%

Source: EIA and Whidbey Group analysis

But what can be done with data sparse regions?

It took 11 months to restore power to Puerto Rico after Hurricane Maria. A similar crisis could happen again.

1.5 million customers lost electricity across Puerto Rico, causing the largest blackout in US history.

By Alinea Fernandez Campbell | @AlineaCampbell | alinea@uw.edu | Aug 15, 2016, 12:50pm EDT

 Courtesy: MesoWest, University of Utah

Miyoshi et al 2016
Low cost 3D printed weather stations can be a solution.

- Inexpensive environmental sensors
- Easy and replaceable 3D design
- Flexibility of wireless communications
- Solar powered, and allows for flexible power options over USB
- Configured with lightweight network protocols (MQTT) to transmit data to Internet of Things (IoT) platforms

[Image showing a 3D printed weather station with components labeled: Hall effect sensor (tipping bucket), Temp, humidity, pressure, VOC sensor, UV-C sensor, and microcontroller]
Key attributes of an IoT Platform

- **Cost**
  - Open vs premium

- **Compatibility and integration**
  - Interoperable? (Hardware, Protocols, programming language)

- **Data storage**
  - Internal or external (cost)?

- **Data processing**
  - Scalable? Cost for increasing scalability?

- **Analytics and visualization**
  - Supported? Possibility of adding external engines?
Internet of Things (IoT) platforms: complex and complicated!

Cisco Survey Reveals Close to Three-Fourths of IoT Projects Are Failing

© May 23, 2017
Complexity: Scale and application matters!

IoT Use cases

Big data analytics and predictive modeling

Optimization of Supply chain management

Automation

Predictive maintenance

Monitoring and maintenance of asset

Device management

Data monitoring

Application level

Smart house  Agriculture  Energy sector  Manufacturing  Construction  Health Sector  Transportation  Retail  Education and Research

Application level

High  Med  Low
Compatibility can be enhanced with the flexibility of integration tools.
### Brainstorming suitable IoT platform for weather explorers

<table>
<thead>
<tr>
<th>IoT</th>
<th>Application/Features</th>
<th>Ease of installation</th>
<th>Support material</th>
<th>Skills required</th>
<th>Level of interoperability</th>
<th>Ease of integration</th>
<th>Scalability and features</th>
<th>Data Analytics</th>
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<tbody>
<tr>
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**Levels**
- L: Low
- M: Medium
- H: High

**Scores**

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Notes: Scores will be given out of 3 for each attribute based on 3 desired levels (Low, Medium and High) of specific requirements for weather explorers IoT application as shown in last row.
### Brainstorming suitable IoT platform for weather explorers

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<th>IoT Platform</th>
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<th>Level of Interoperability</th>
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<th>Big data management</th>
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**Notes:** Scores will be given out of 3 for each attribute based on 3 desired levels (Low, Medium and High) of specific requirements for weather explorers IoT application as shown in last row.
## Summary of comparison matrix

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Criteria included</th>
<th>Ease of set up</th>
<th>Ease with Integration</th>
<th>Scalability</th>
<th>Data analytics</th>
<th>Overall score</th>
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</table>
Comparison landscape mapping balancing cost, ease and features

1. Data collection
   - Hardware compatibility issues and integration complicated

2. Data acquisition and visualization
   - Low Interoperability and difficult set up

3. Data Management and scalable
   - Medium Interoperability and support available

4. Custom visualization and scalable
   - Integration possible using adaptors

5. Data analytics
   - Possible
   - Premium
   - Free with limitations
   - Free IoT

6. Predictive modelling and high dynamic scalability
   - Polyglot
   - High Interoperability

Level of horizontal platform

Scalability, level and analytics
Tradeoff between cost, complication and complexity!

1. Data acquisition and visualization
   - Very complicated

2. Data Management and scalable
   - Complicated

3. Custom Visualization and scalable
   - Medium interoperability

4. Data analytics possible
   - Integration possible using adaptors

5. Predictive modelling and high scalability
   - High Interoperability, Polyglot

Ease of set up and integration

Free open source
Premium open source
Implementing Thingsboard as IoT framework for prototype 3D IoTwx
Conclusions and Moving forward

- Thingsboard was used for monitoring and visualizing data streams from mesonet in PR based on highest score in comparison matrix and reasonable tradeoff between cost, complexity and complications of integration.
- **Platform will be tested for scalability** after deploying more stations in PR
- **Implementation of LoRaWAN** will be explored to reduce power usage for network communication.
- Adding data logger nodes within mesonet can help to avoiding losing data incase of connectivity issues.
- Diagnostics tools will be integrated within dashboarding.
Acknowledgements

- Steven Rivera for collaborating in IoTWx deployment in Puerto Rico.
- My SIParCS mentors for expanding my horizon of knowledge about innovative 3D design of IoTWx, deployment and Internet of Things platforms.
- SIParCS staff team (specially AJ, Virginia, Jerry) for organizing all professional development workshops and ensuring that our internship is encouraging, engaging and educating in spite of our remote location.
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- Last but not the least, my college mentors Prof. Mike Baldwin and Prof. Tanamachi for encouraging and recommending me for this internship.
Thank you

Questions, feedback, suggestions?

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