Brian Miles, Ph.D., CGI
September 14, 2018
Air Sensors International Conference
Oakland, California

ASIC

Lafayette

UNIVERSITY OF LOUISIANA Lafayette

LAFAYETTE PARISH SCHOOL SYSTEM

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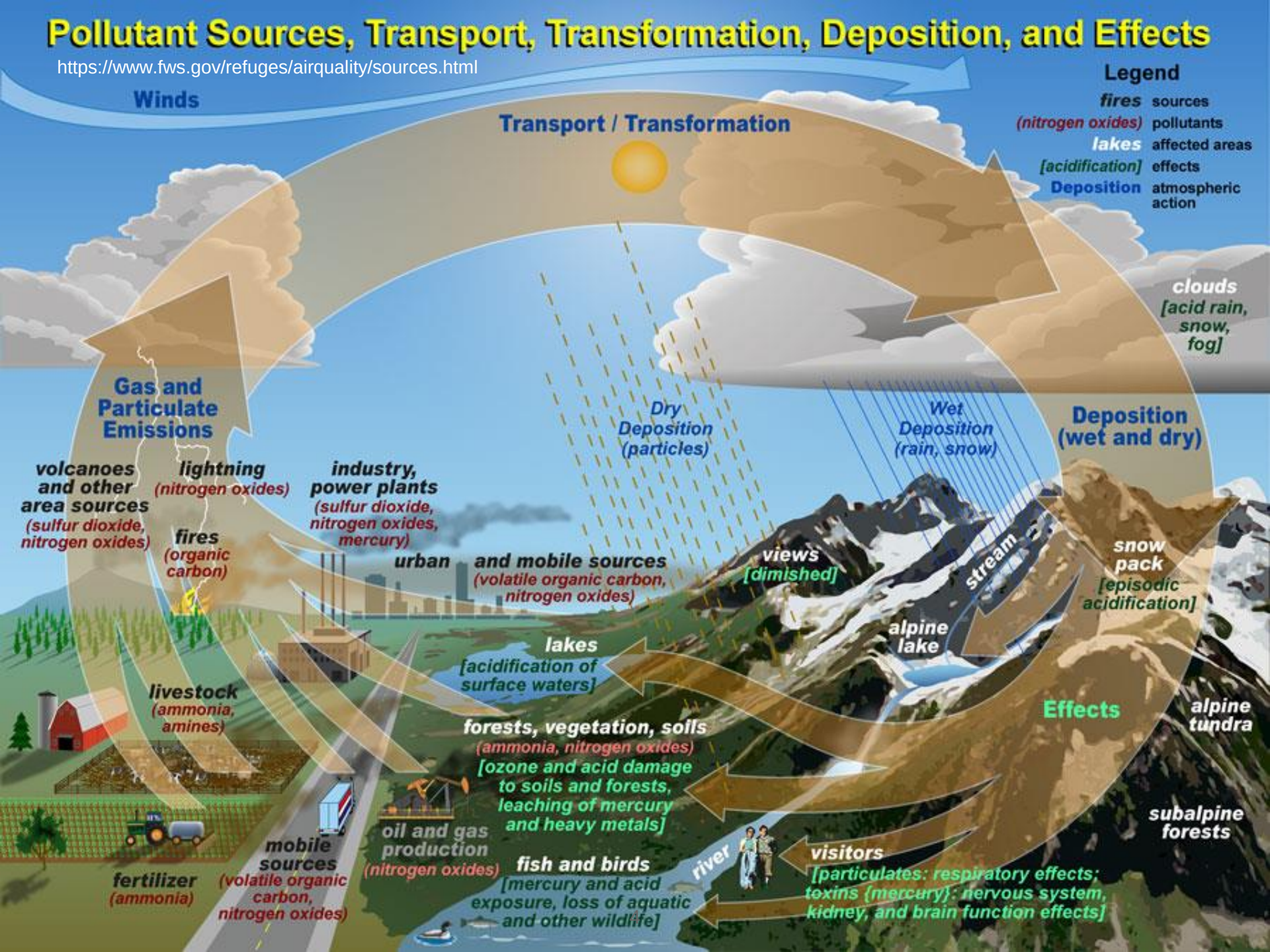
Discussion Topics
Introduction to the Lafayette Engagement and Research Network (LEaRN)
LEaRN about Air Quality
Kinota™: Data Management Backend
Air quality sensor siting
Sensor fabrication and STEM education

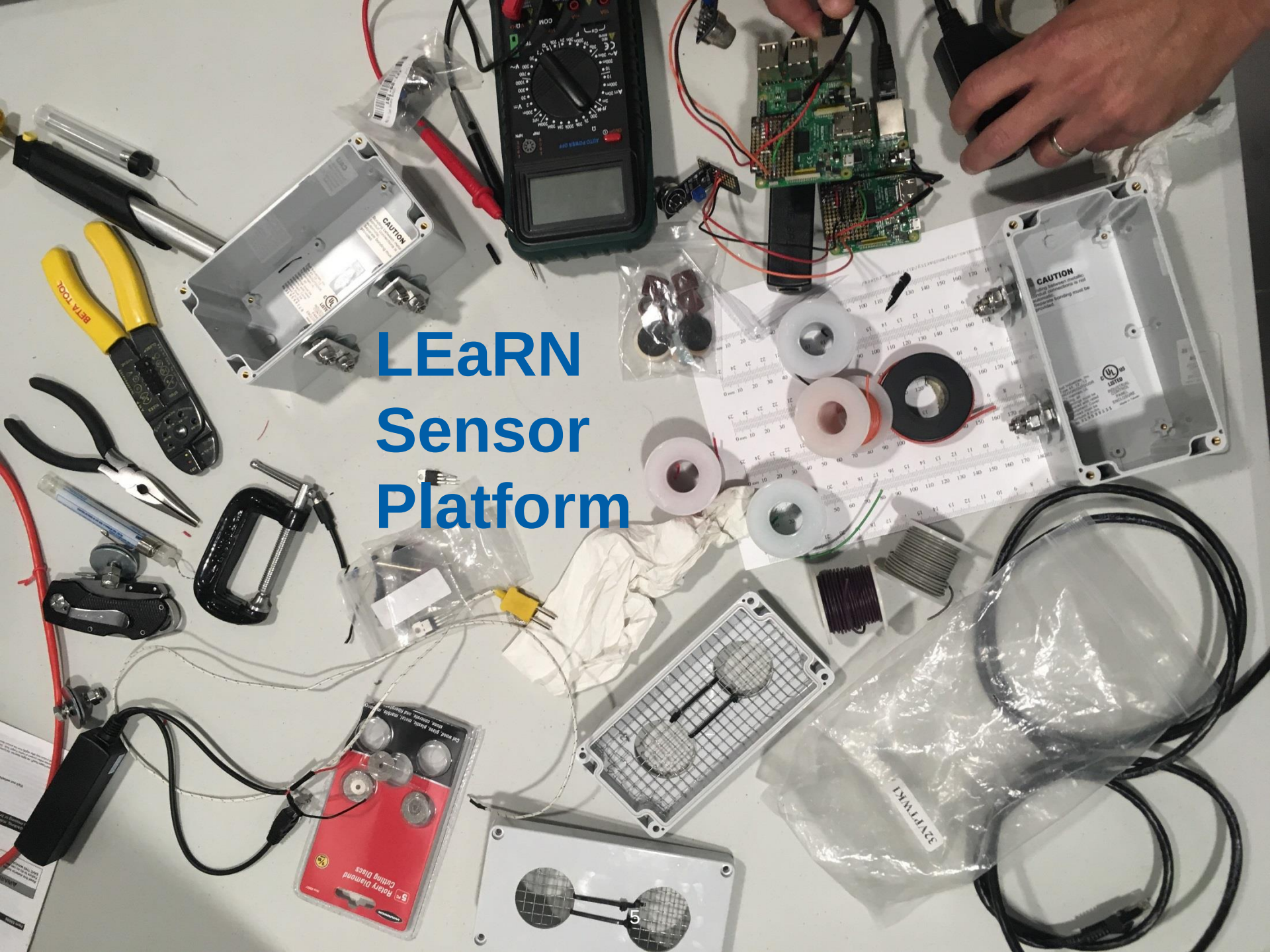
LEARN
Lafayette Engagement
& Research Network

Introduction to LEaRN

- Formed in response to U.S. EPA Smart City Air Challenge: Fall 2016
- Two cities awarded $40,000: Lafayette and Baltimore
- Deploy 250 to 500 air quality sensors in a community
- Community involvement in purchasing and using the sensors
- Identification of partners and project sustainability
- Be transparent: open data and sharing data management plans
- Data is for local purposes and non-regulatory in nature

Lafayette Engagement & Research Network


Pollutant Sources, Transport, Transformation, Deposition, and Effects
https://www.fws.gov/refuges/airquality/sources.html
Winds
Transport / Transformation
Legend
fires sources
(nitrogen oxides) pollutants
lakes affected areas
[acidification] effects
Deposition atmospheric action
clouds [acid rain, snow, fog]
Gas and Particulate Emissions
Dry Deposition (particles)
Wet Deposition (rain, snow)
Deposition (wet and dry)
volcanoes and other area sources (sulfur dioxide, nitrogen oxides)
lightning (nitrogen oxides)
fires (organic carbon)
industry, power plants (sulfur dioxide, nitrogen oxides, mercury)
urban and mobile sources (volatile organic carbon, nitrogen oxides)
views [dimished]
stream
snow pack [episodic acidification]
alpine lake
lakes [acidification of surface waters]
livestock (ammonia, amines)
Effects
alpine tundra
forests, vegetation, soils (ammonia, nitrogen oxides) [ozone and acid damage to soils and forests, leaching of mercury and heavy metals]
oil and gas production (nitrogen oxides)
mobile sources (volatile organic carbon, nitrogen oxides)
fertilizer (ammonia)
fish and birds [mercury and acid exposure, loss of aquatic and other wildlife]
river
visitors [particulates: respiratory effects; toxins {mercury}: nervous system, kidney, and brain function effects]
subalpine forests


LEaRN
Sensor
Platform

LEaRN Sensor Platform “Things”

Thing type	Sensors	Amount
Small Thing	• Ozone • Sainsmart MQ-131 ($)	175

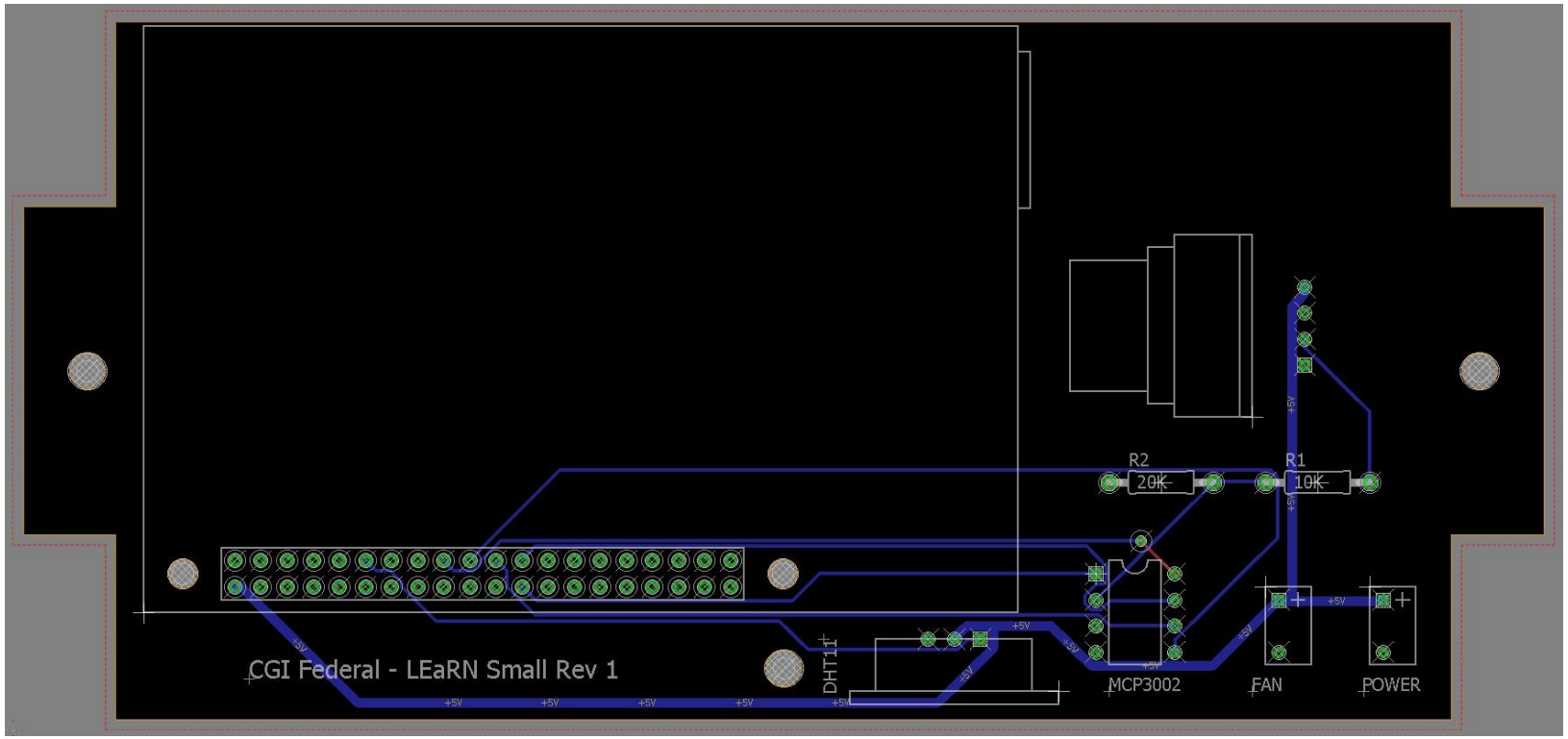
Large Thing 1	• Ozone
	  • Sainsmart MQ-131 ($)
	  • Aeroqual SM50 LZAA ($$$)
	• PM
	  • DF Robot SEN 0177 ($$)
		50

Large Thing 2	• Ozone
	  • Sainsmart MQ-131 ($)
	  • Aeroqual SM50 LZAA ($$$)
	• PM
	  • Alphasense OPC-N2 ($$$)
		25

Total		**250**

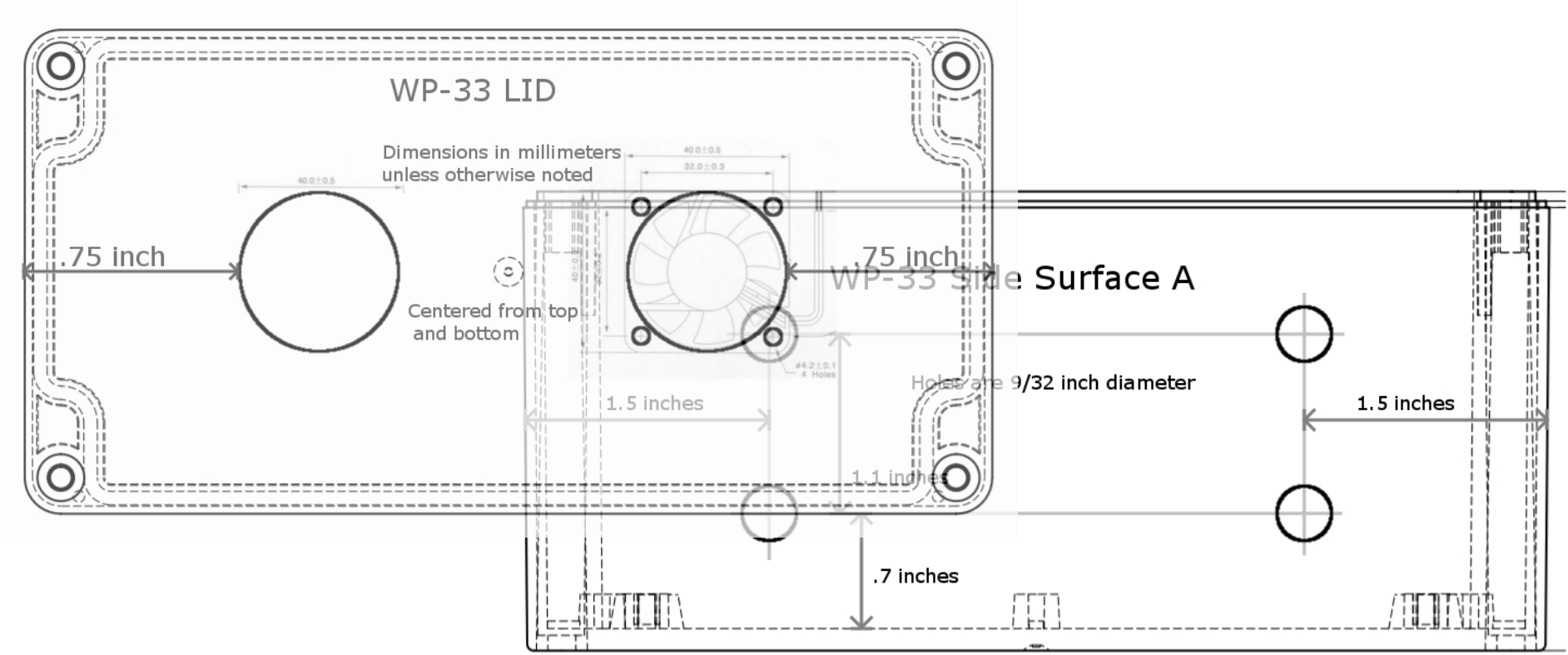
*** All have a temperature and humidity sensor (DHT11)**

LEaRN Sensor Platform



Power Control Board (PCB) design

LEaRN Sensor Platform



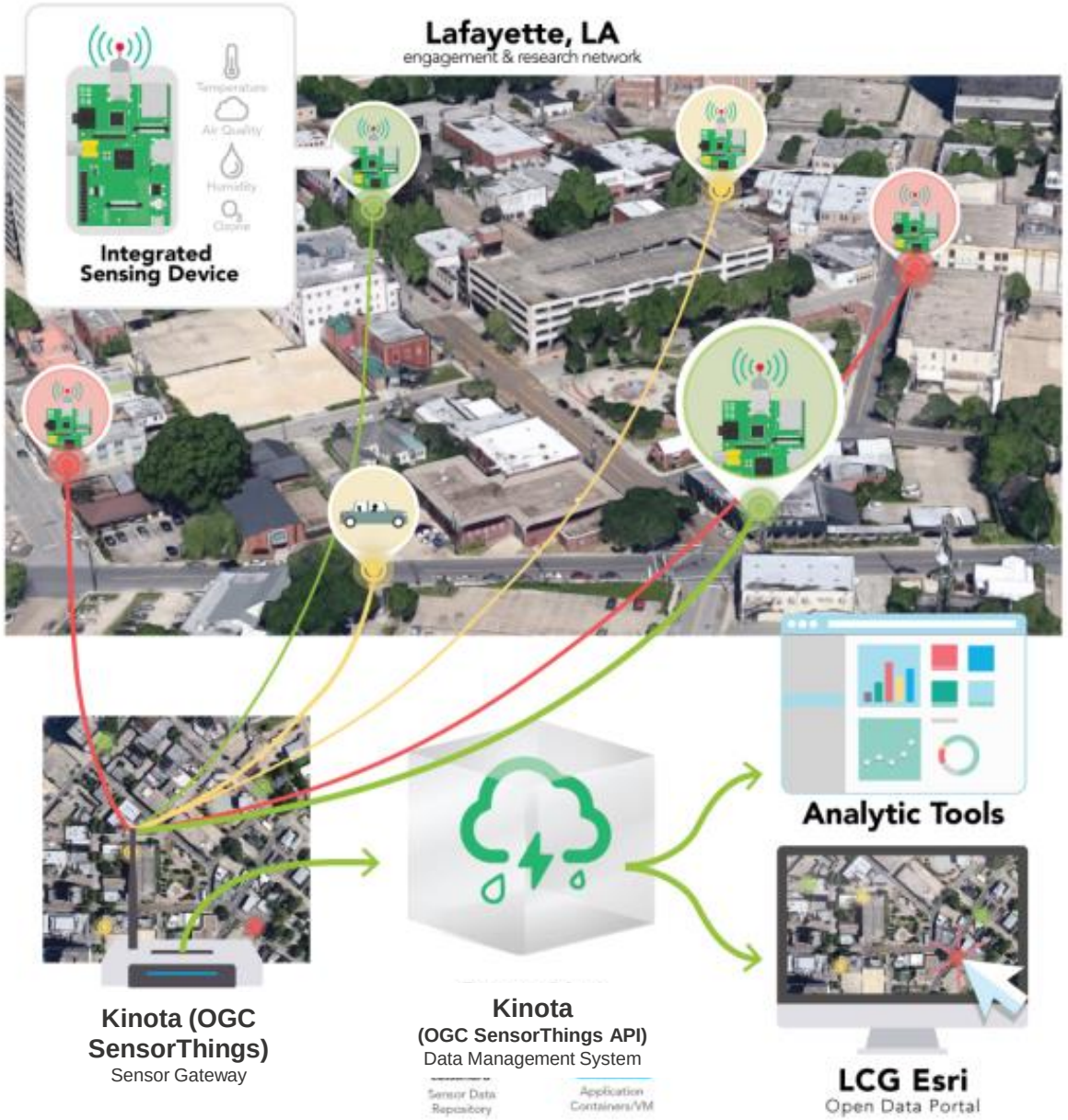
Small Enclosure machining drawings

Sensor validation/calibration methodology

- Place all sensors at LDEQ AQ station for 7-14 days
- Compare data during calibration period, building calibration curve
- Apply calibration curve to raw data to produce QA/QC'ed datastreams

Kinota

Open data management for real-time collection and analysis of IoT sensor data



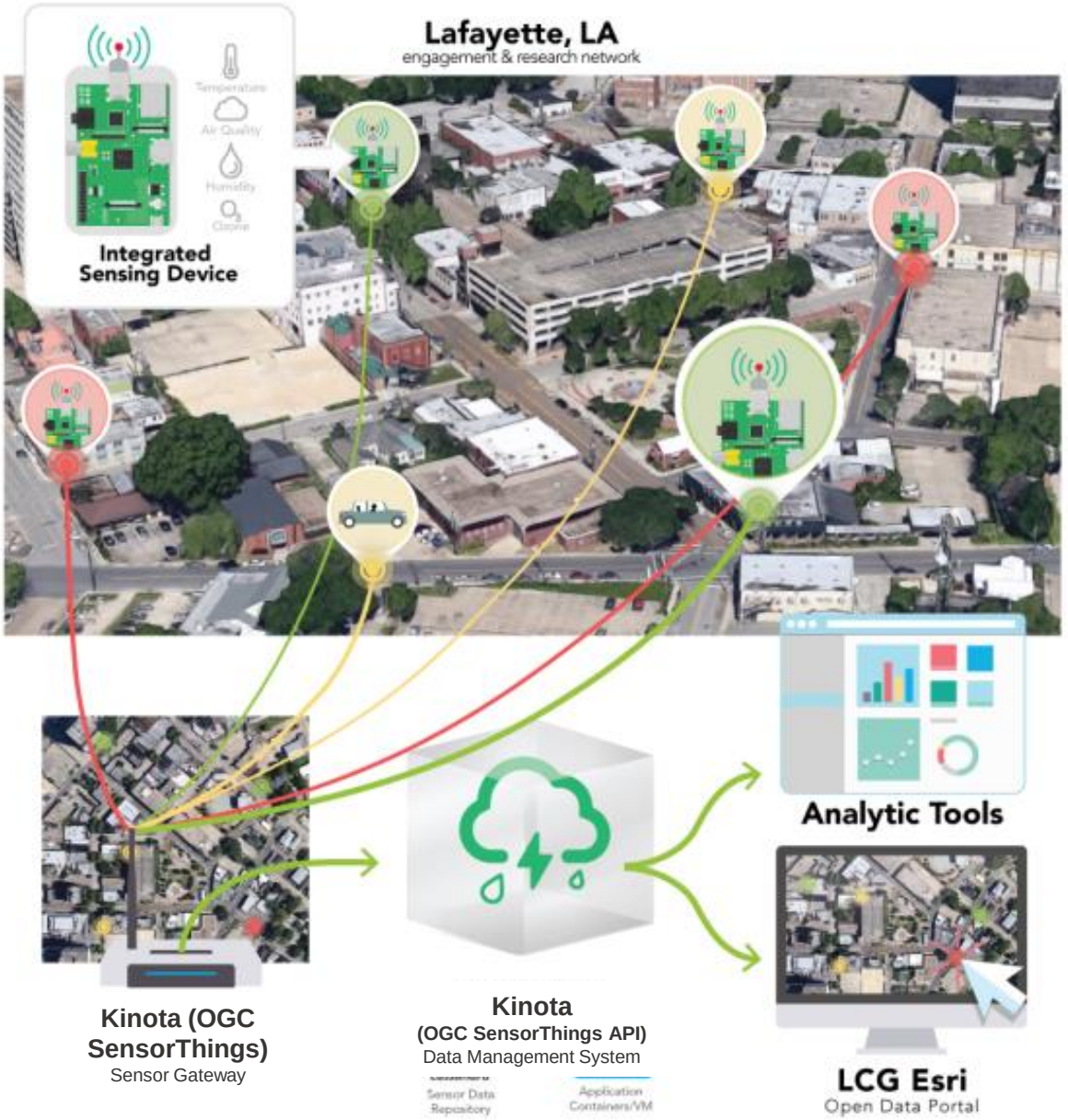
Kinota: Open source implementation of OGC SensorThings API

Part 1: Sensing

- LGPL v3
- Java 8

Prioritizes:

- Standards compliance
- Modularity
- Security



Why choose SensorThings?

- Provides a robust, standardized, domain-agnostic data model

- Builds on over a decade of OGC IoT standards
  - Even though SensorThings is new, it is based on experience-tested technology

- Provides a rich query capability making it easier to build analytics tools
  - *e.g. Download all observations from temperature sensors within 1km of a location during the month of August 2018 where the temperature was greater than 100 degrees.*

- Developer-friendly
  - Uses a simple JSON encoding (no ugly XML)

- Supports both HTTP and MQTT transports
  - HTTP provides REST interface
  - MQTT supports real-time applications

Sensor validation/calibration methodology

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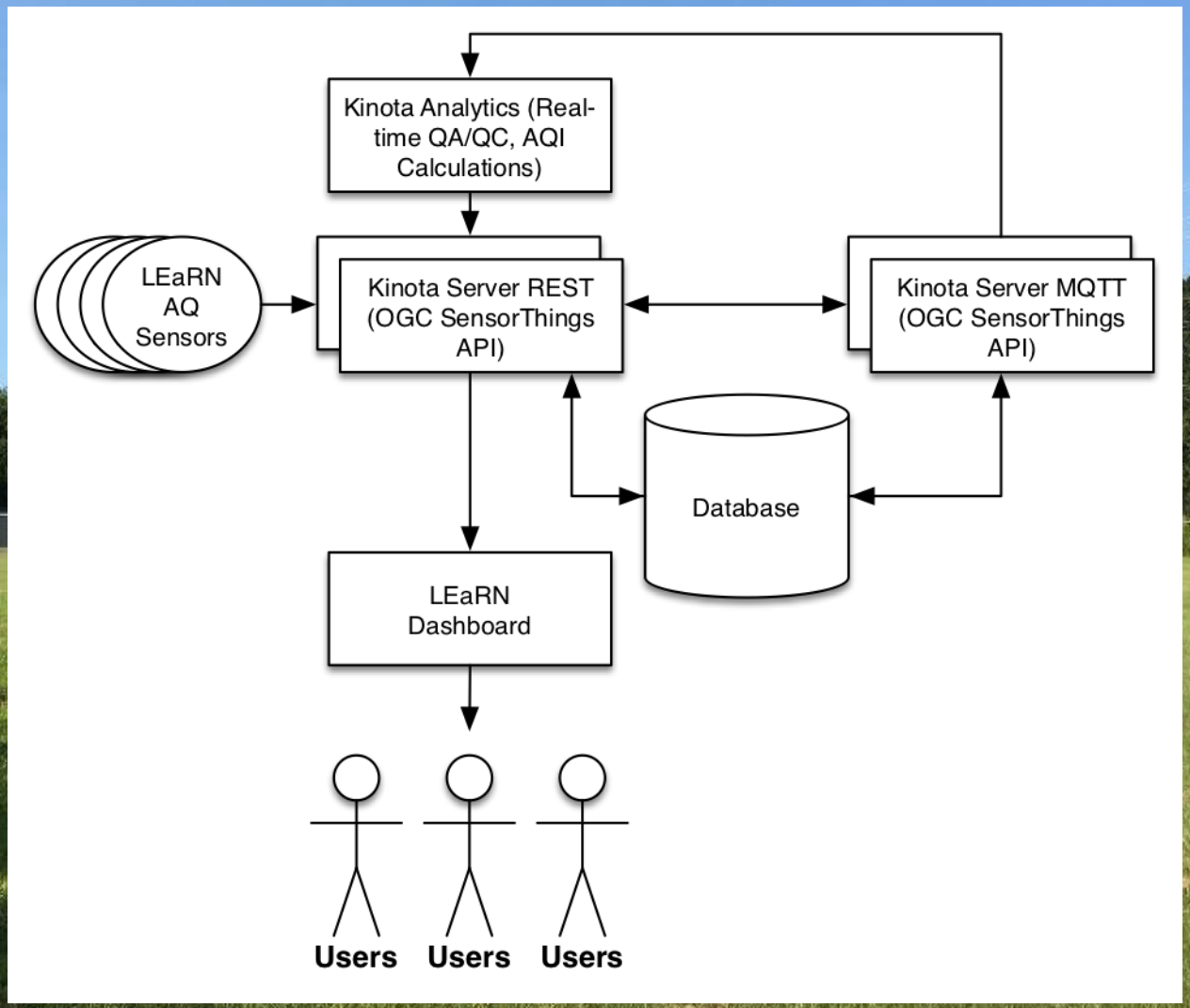
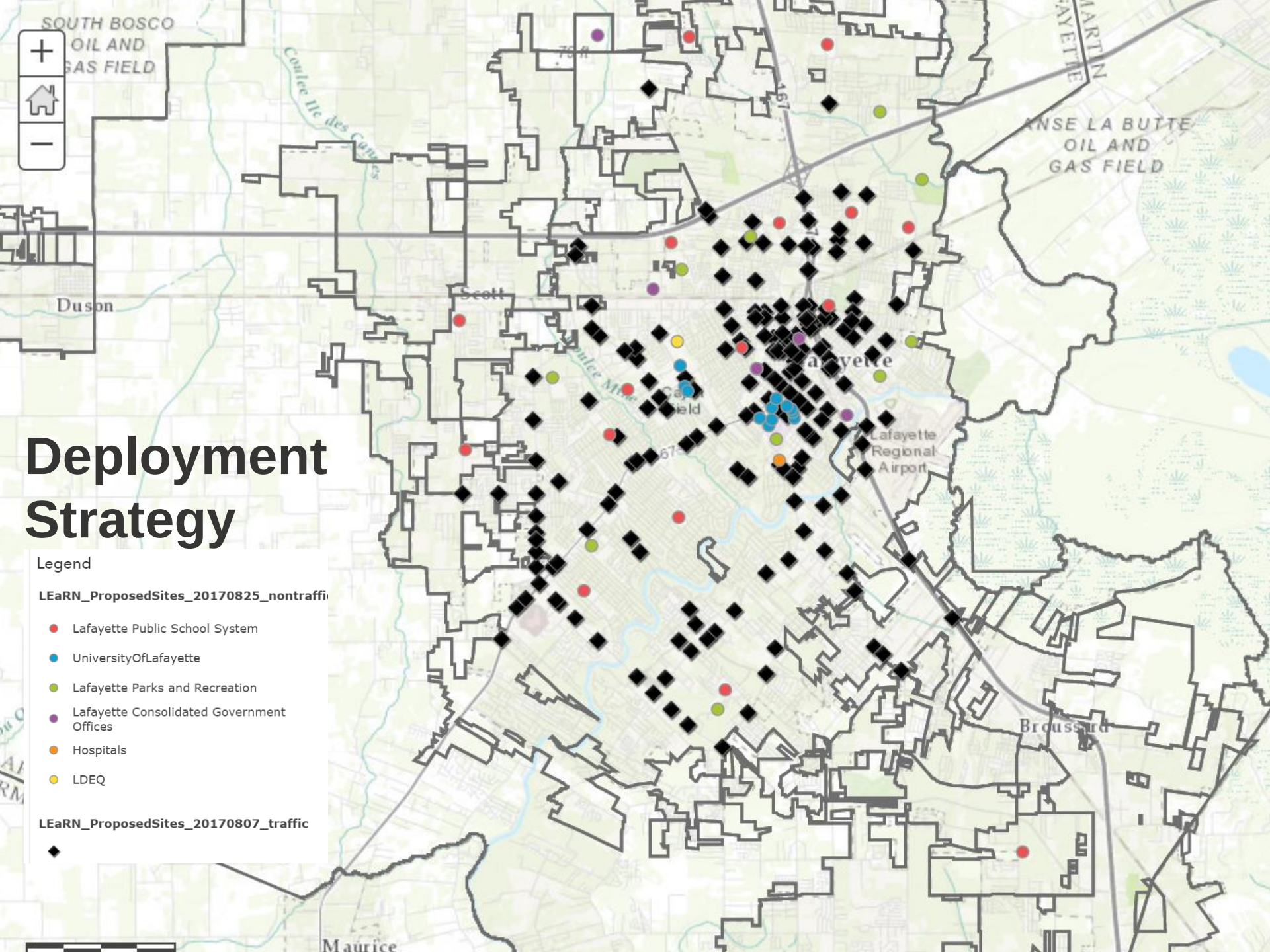



SOUTH BOSCO
OIL AND
GAS FIELD
Duson
Scott
Lafayette
Lafayette
Regional
Airport
ANSE LA BUTTE
OIL AND
GAS FIELD
Broussard
Maurice
Deployment
Strategy
Legend
LEaRN_ProposedSites_20170825_nontraffi
Lafayette Public School System
UniversityOfLafayette
Lafayette Parks and Recreation
Lafayette Consolidated Government
Offices
Hospitals
LDEQ
LEaRN_ProposedSites_20170807_traffic

- Leveraging partner sites
- Uniform spatial distribution of sensors
- Include a range of land uses
- Leverage existing fiber network
- Strategically target longer term community IoT grid

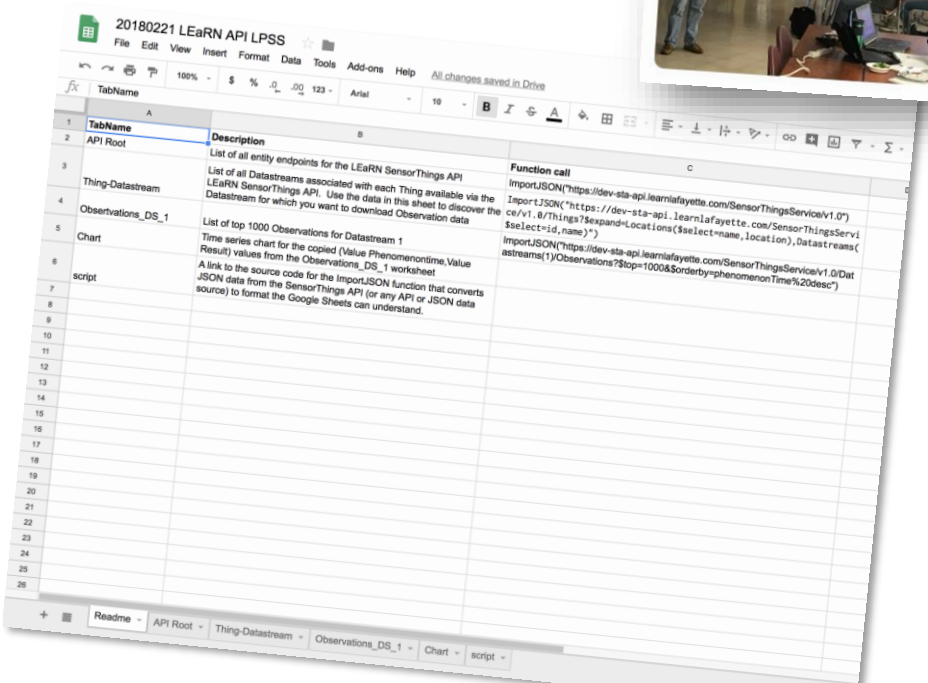
Sensor fabrication and STEM education

- LEaRN partner Lafayette Public School System lead sensor fabrication
- Middle and High School students from David Thibodaux STEM Magnet Academy fabricated most of our things
- Past students have participated in robotics competitions, and had an experiment flown on the International Space Station (ISS)
- Building LEaRN sensors will give a new class of students practical experience with electronics theory and skills (e.g. circuit design, soldering, etc.)

DAVID THIBODAUX
STEM MAGNET ACADEMY

Sensor fabrication and STEM education

- Led workshop with LPSS teachers
- Goal: integrate data from the LEaRN sensor network into middle- and high-school curriculum
- Teachers were given equipped with lessons to teach students how to use a spreadsheet to download and analyze sensor data



Discussion / Questions

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