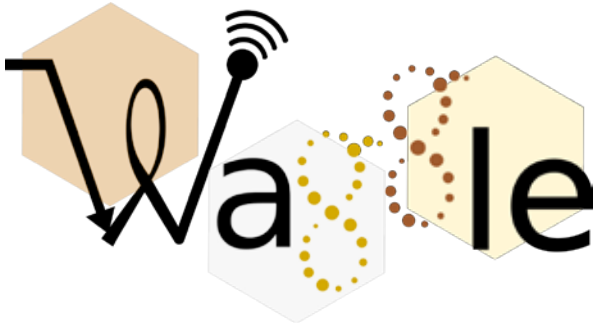
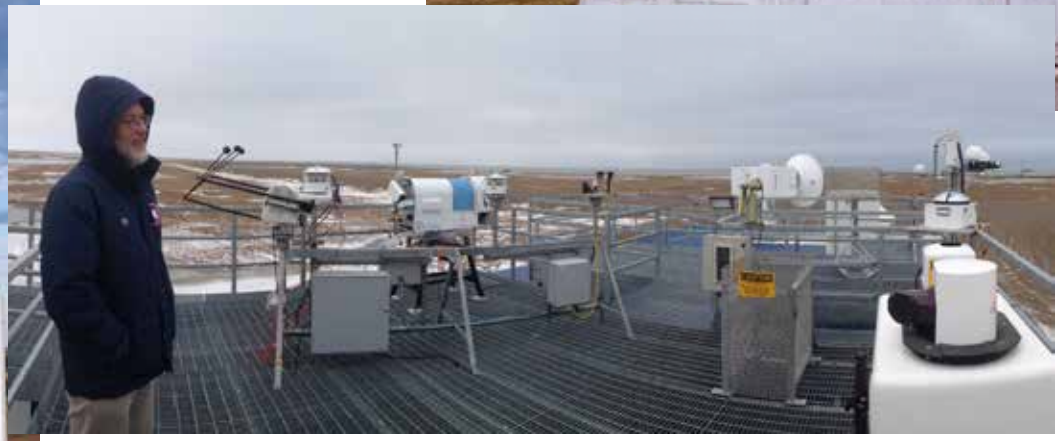


WaggleVision

Pete Beckman, Charlie Catlett, Rajesh Sankaran, Nicola Ferrier, Rob Jacob, Mike Papka, and more….

Big Sensor Science



Big, Expensive, Precise, Few

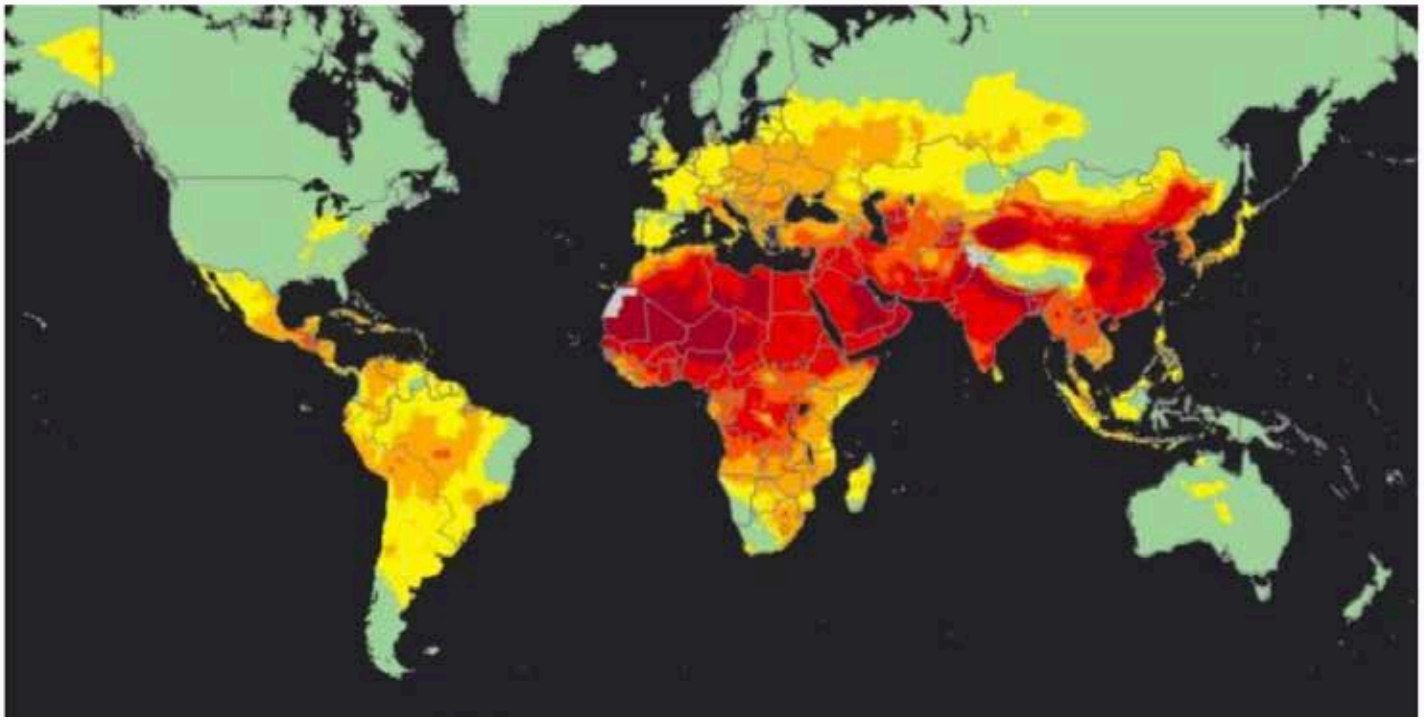
Little Sensor Science

Small, Cheap, Imprecise, Many

Polluted air affects 92% of global population, says WHO

27 September 2016 | Health

Share



Waggle: An Open Platform for ***Intelligent*** Sensors

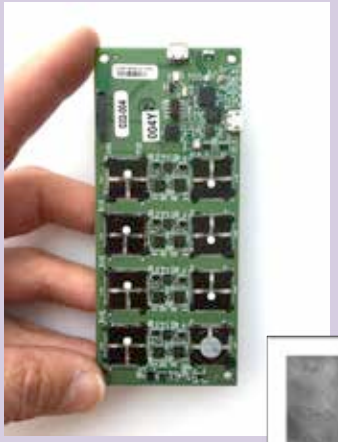
Exploiting Disruptive Technology, *Edge Computing*, Resilient Design

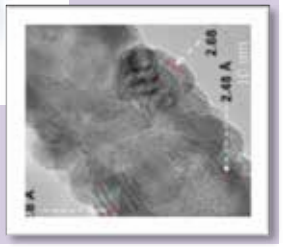
Machine Learning

Computer Vision

Novel Sensors

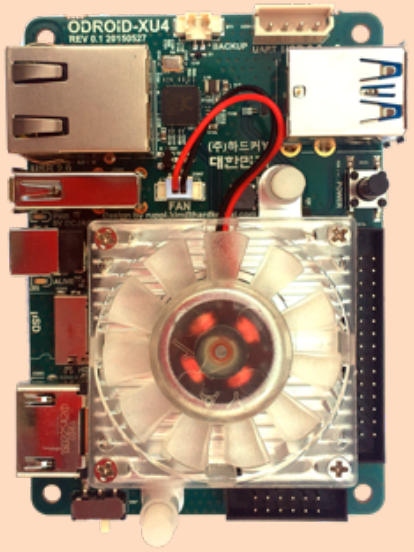
Nano / MEMS

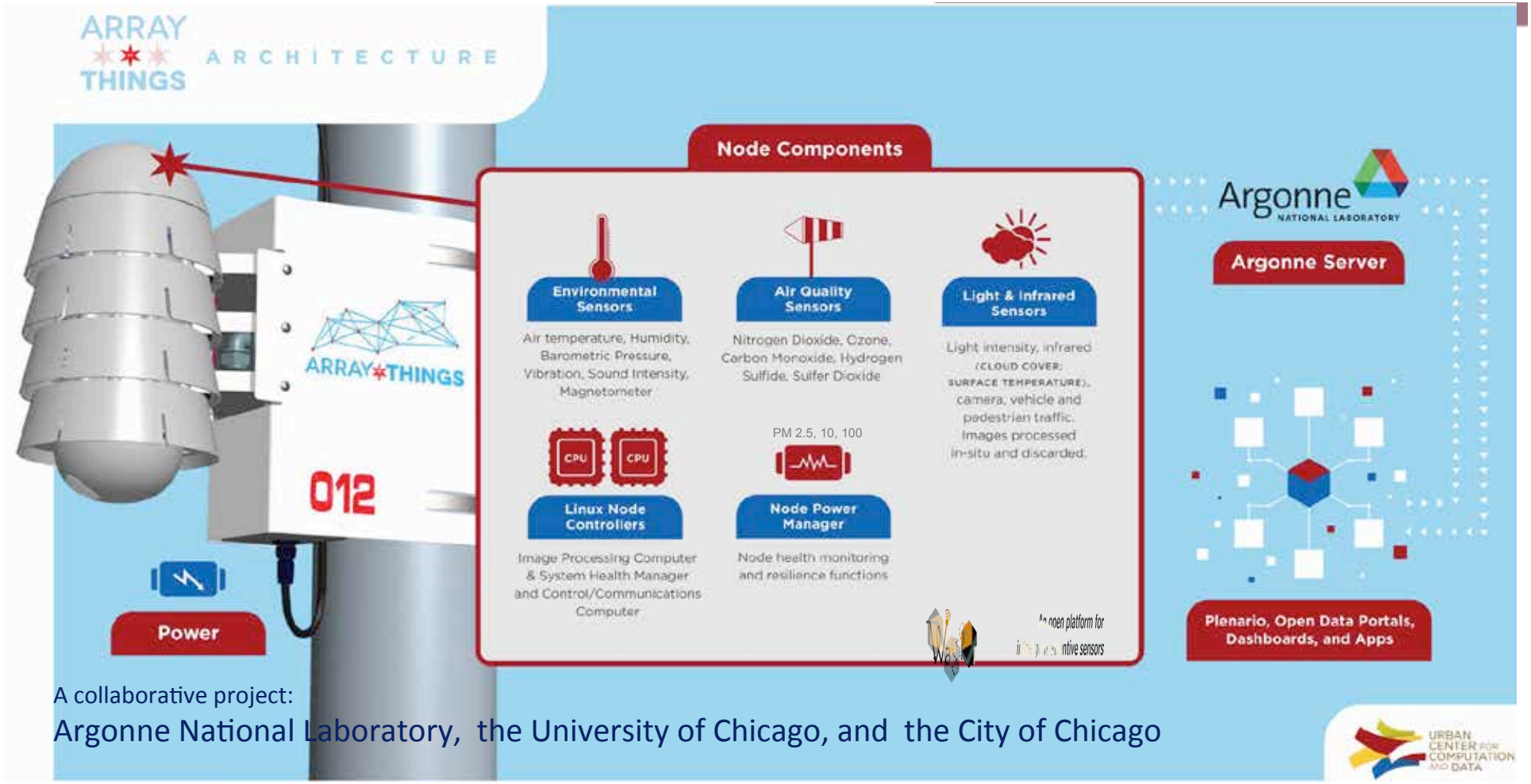




Low Power CPUs

GPU / Smartphones





A collaborative project:

Argonne National Laboratory, the University of Chicago, and the City of Chicago

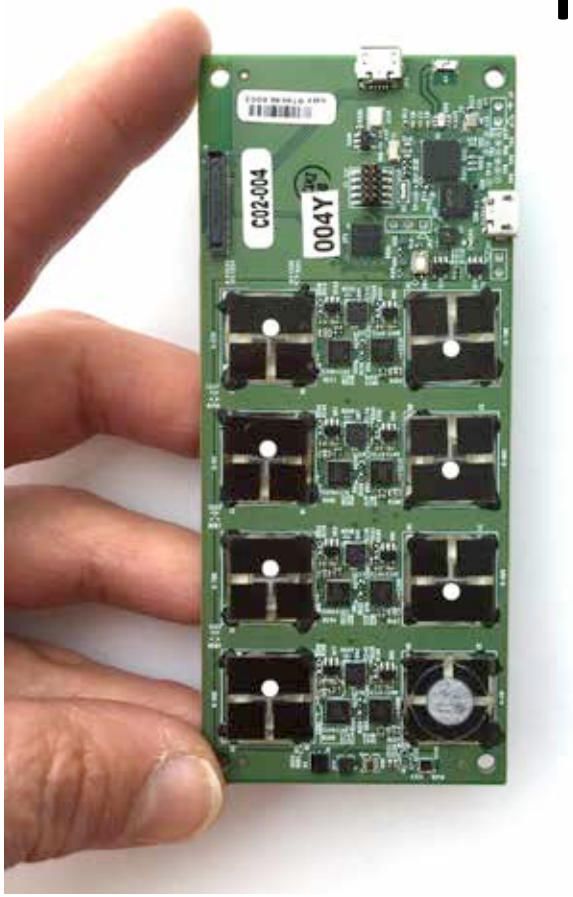
Supported by collaborating institutions and the U.S. National Science Foundation.
Industry In-Kind partners: AT&T, Cisco, Intel, Microsoft, Motorola Solutions, Schneider Electric, Zebra

CDOT

N State St

New Advanced Sensors

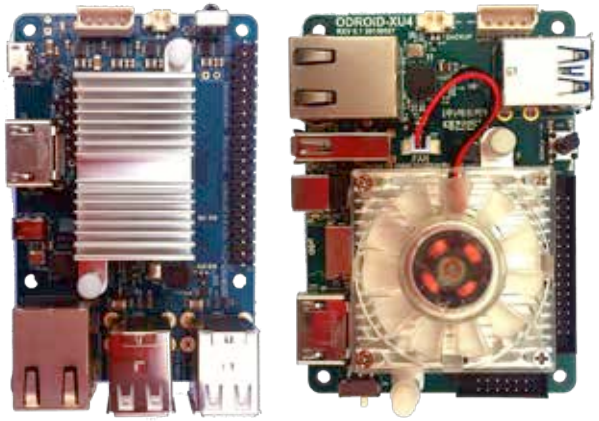
(via a partnership with Intel & SPEC)



- NO2 (Nitrogen Dioxide): <2 ppb
- O3 (Ozone) < 5 ppb
- CO (Carbon Monoxide) < 1 ppm
- SO2 (Sulfer Dioxide) < 15 ppb
- H2S (Hydrogen Sulfide) < 2 ppb
- TOX (total oxidizing index) < 1 ppm CO equiv
- TOR (total reducing index) < 2 ppb NO2 equiv
- Future:
  - HCHO (Formaldehyde)
  - VOC (Volatile Organic Compound)
  - CH4 (Methane)

Resilient & Hackable + “Deep Space Probe” Design

Multiple boot media (µSD / eMMC)

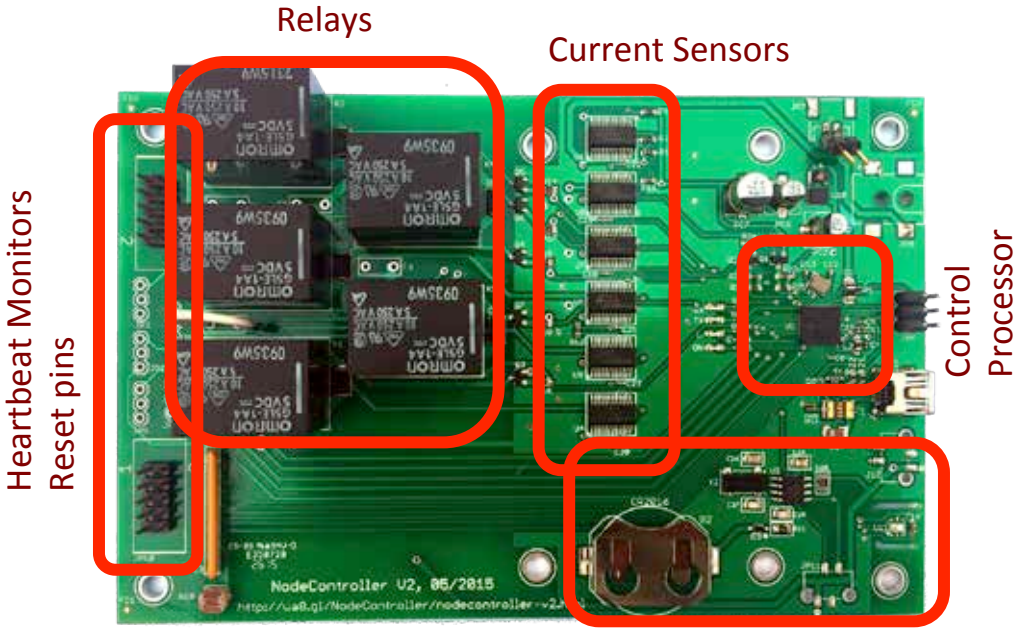


4-core ARM

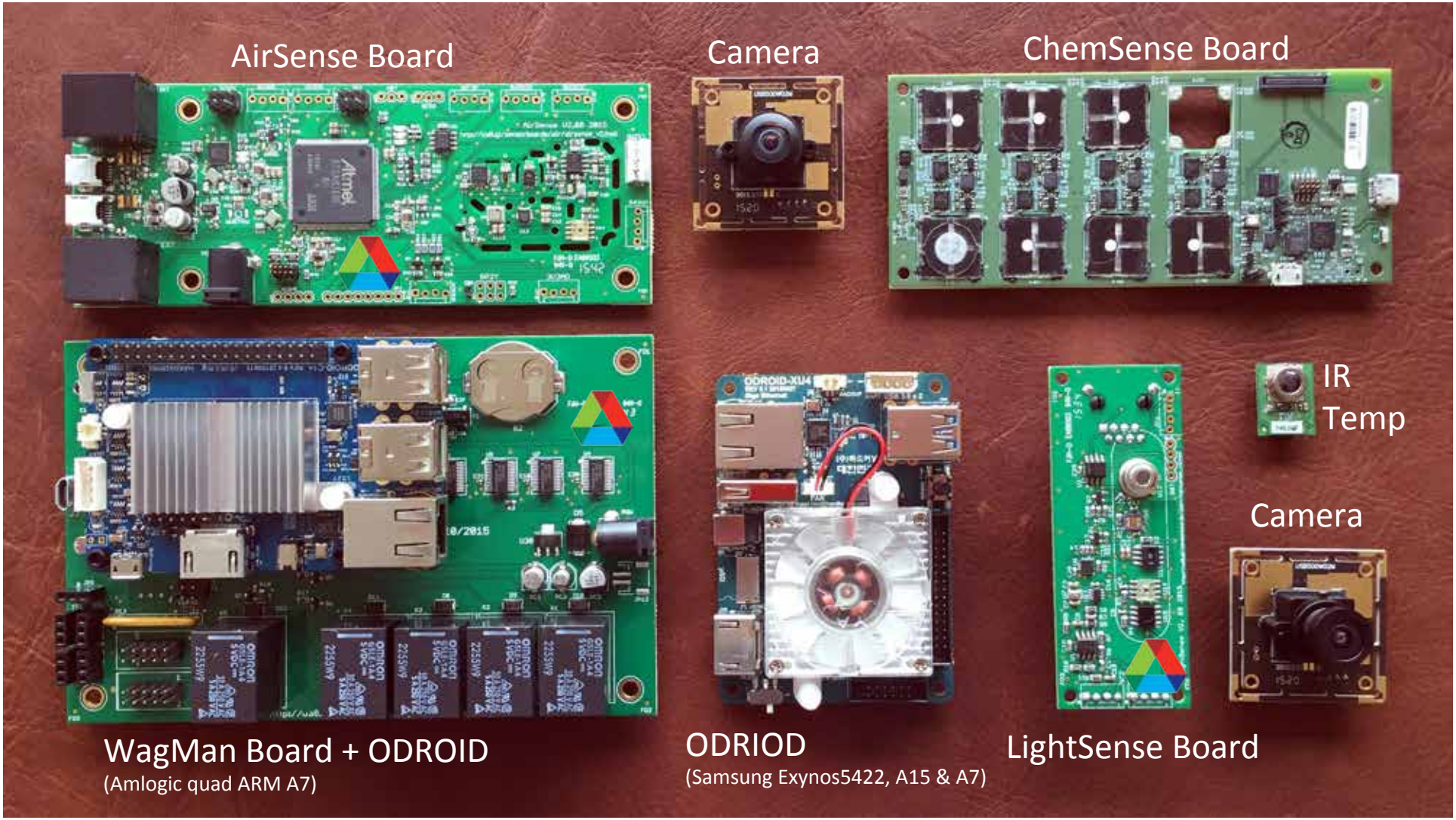
4-core ARM
8-core GPU

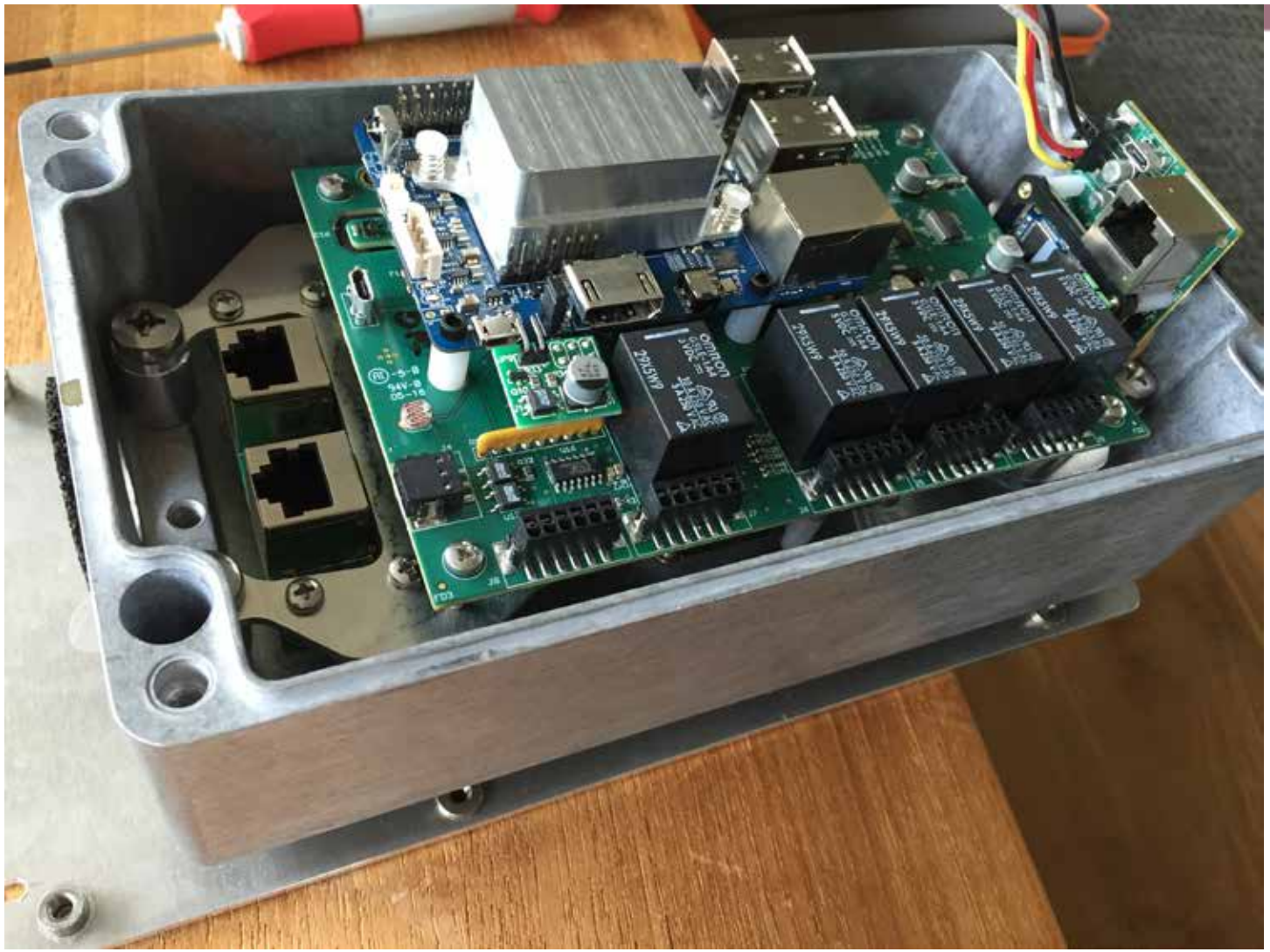
Node Control &
Communications

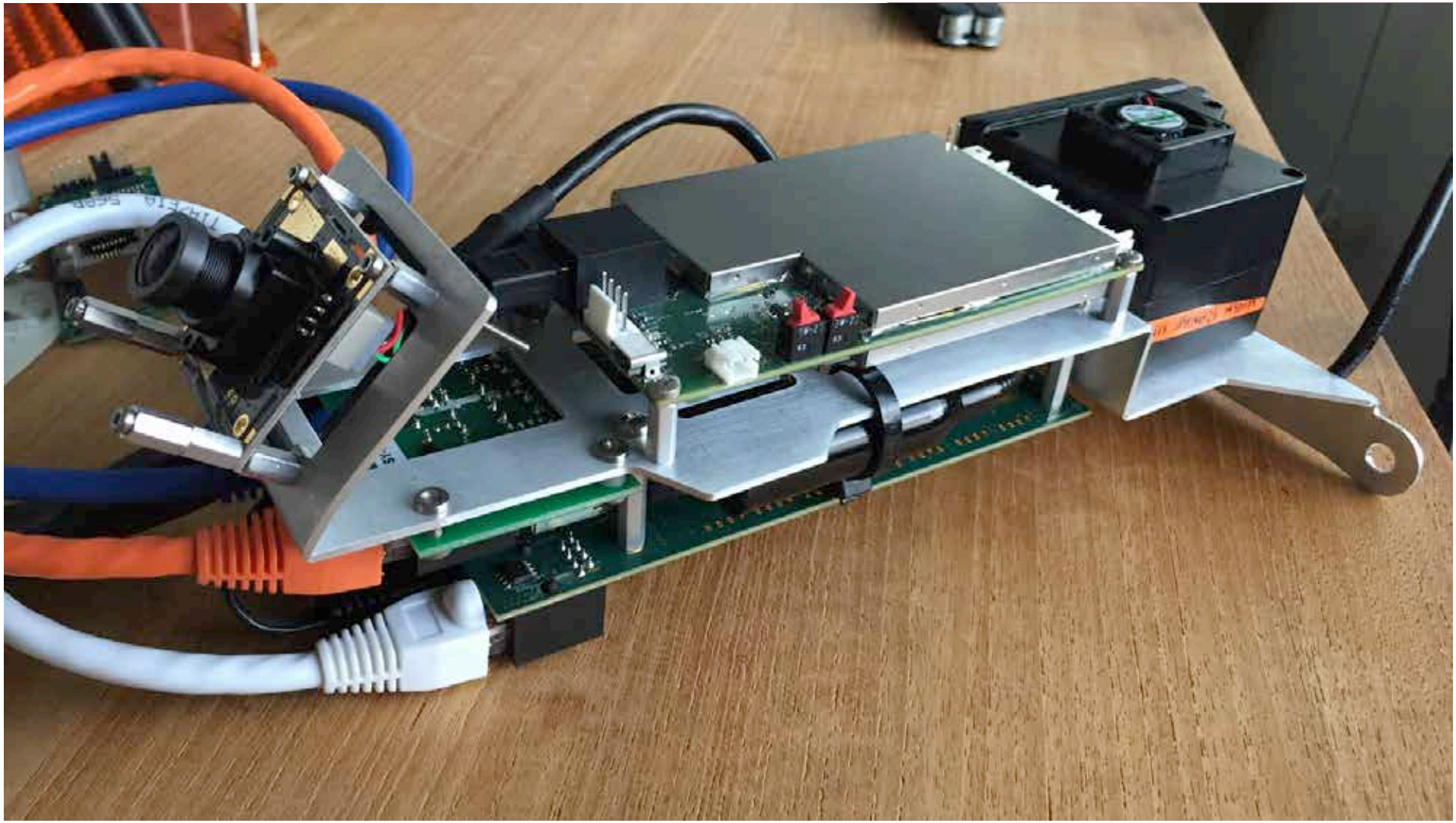
In-Situ Processing

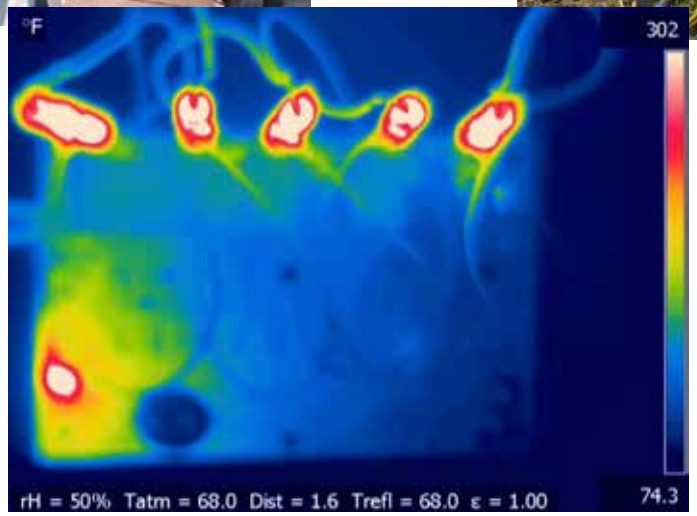


Real time clock
Internal sensors


AirSense Board
Camera
ChemSense Board
IR
Temp
Camera
WagMan Board + ODROID
(Amlogic quad ARM A7)
ODRIOD
(Samsung Exynos5422, A15 & A7)
LightSense Board

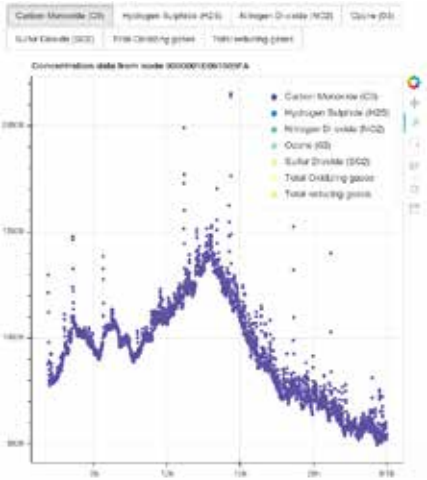


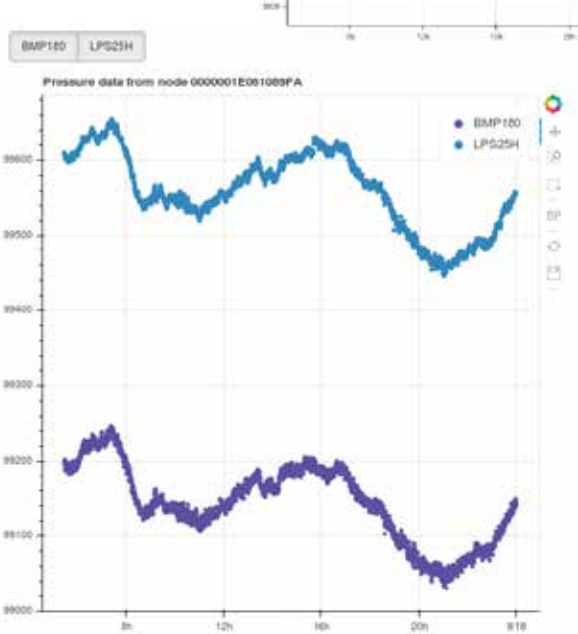


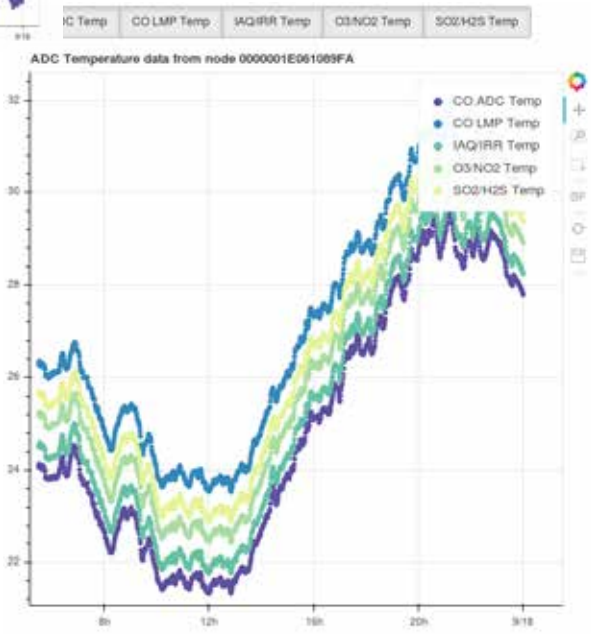


Waggle / AoT
Robust Testing

Exploring the Data

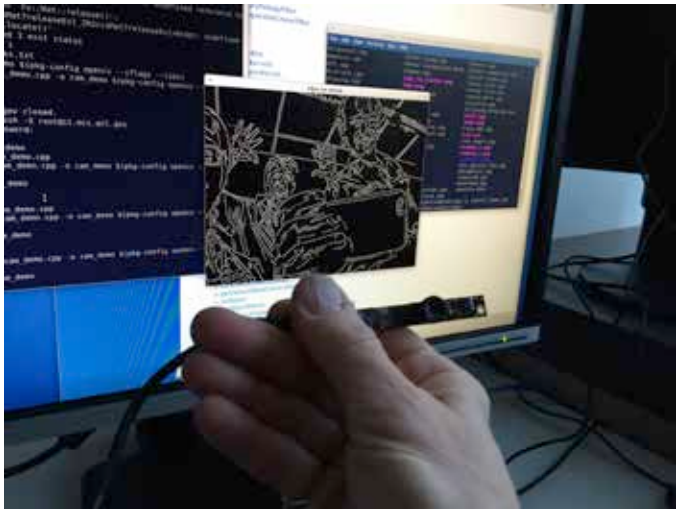




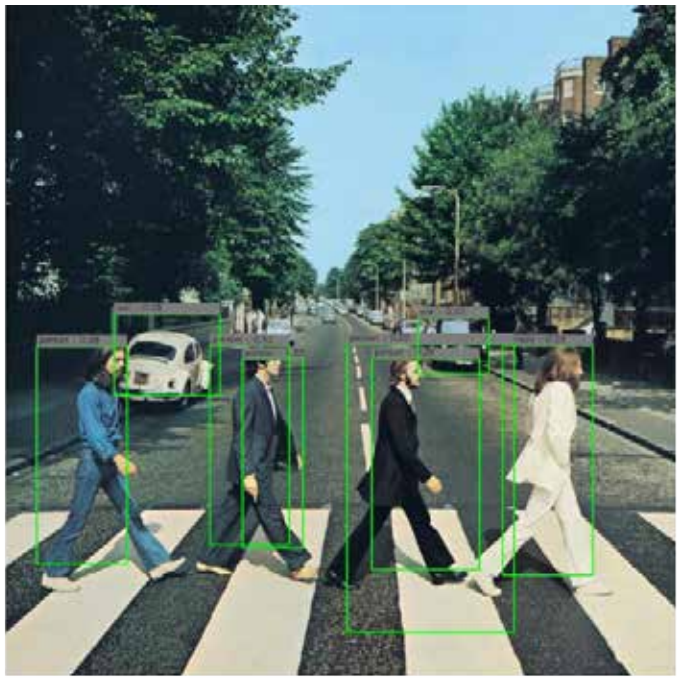


In-Situ/Edge Computing
Analysis and Feature Recognition

- Parallel Computing
- Open Platform
- Deep Learning

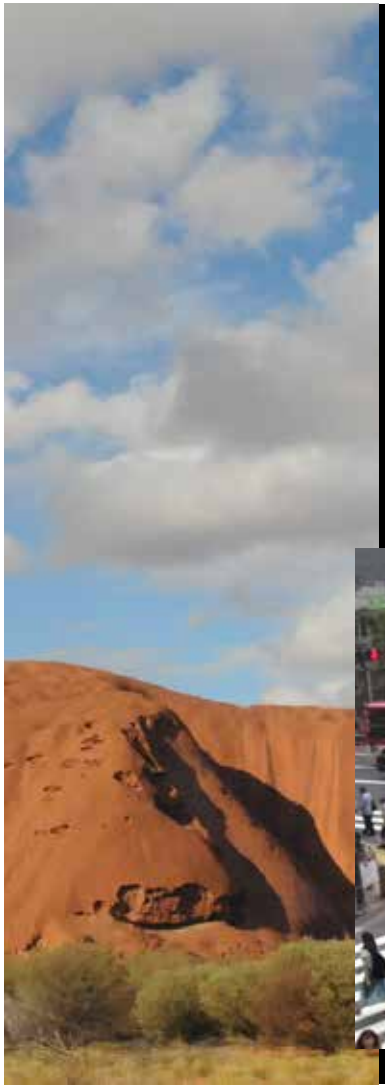


Waggle Machine Learning & Edge Computing



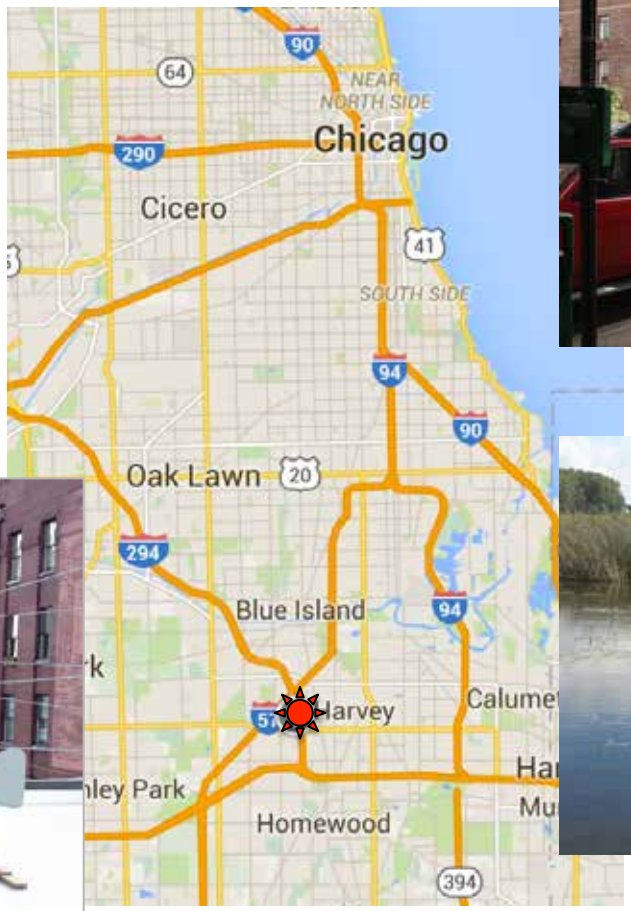
https://waggle-sensor.slack.com/files/noaholsman/F243LQL66/output.jpg

- We are exploring Caffe & OpenCV
  - Convolutional Neural Networks
- Training will be done on systems at Argonne
- Classification on Waggle



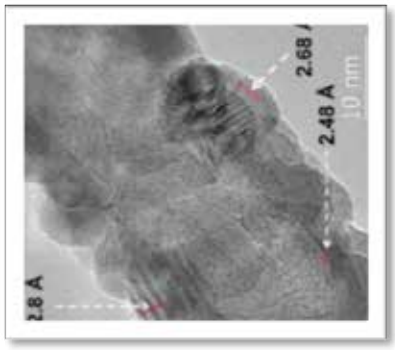
9 FT 6 IN

Testing and Learning



Waggle: A Platform for Research

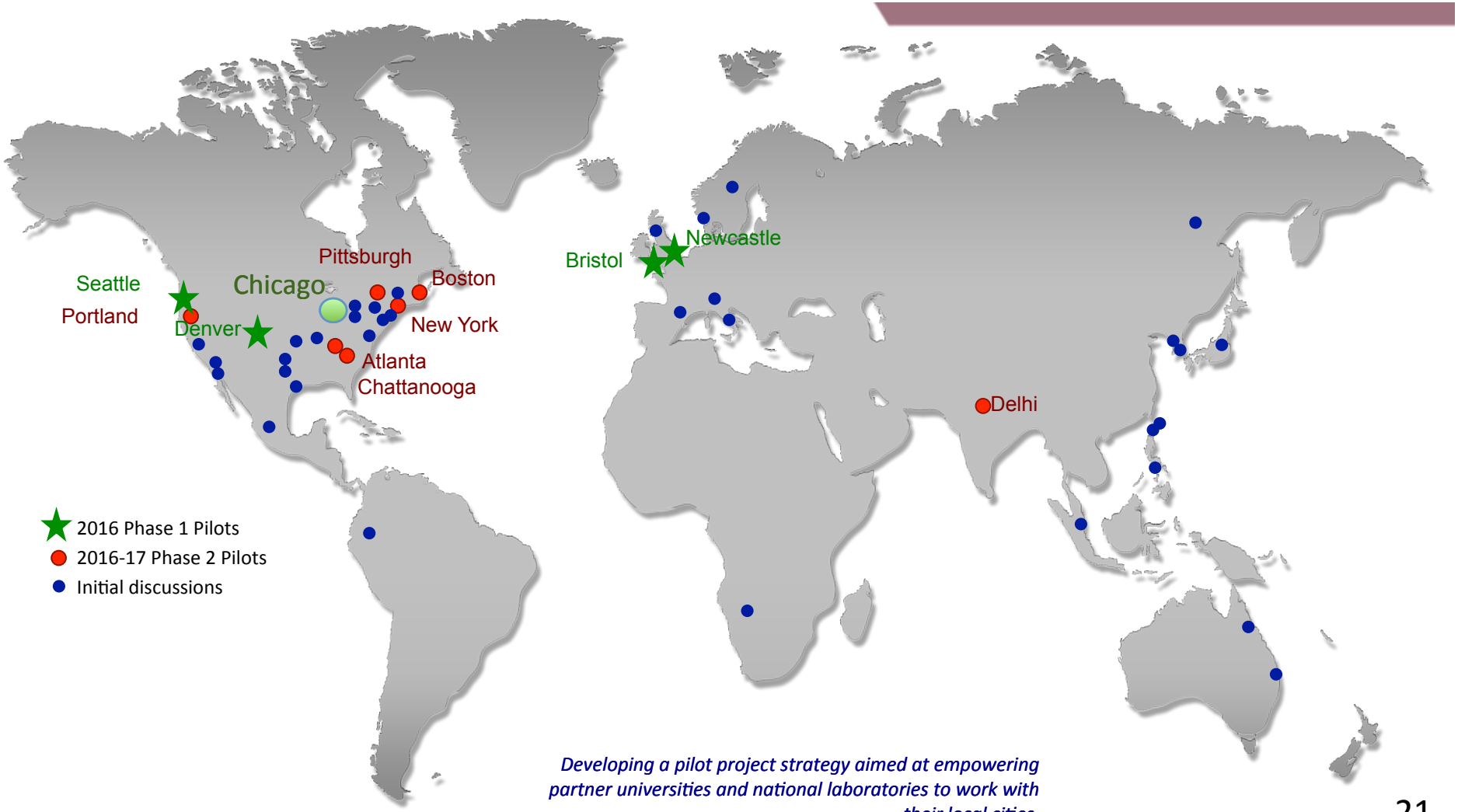
- **Machine Learning: Computer Vision**
  - Data must be reduced in-situ
- **Novel Sensors**: Nano / MEMS / Graphene
  - Explosion of nano/MEMS & imaging tech
- **Low-Power CPUs**: GPU / Smartphones
  - Powerful, low-power, smartphone CPUs
- **Open Source / Open Platform**
  - Reusable, extensible software communities



CNM carbon nanotube methane sensor

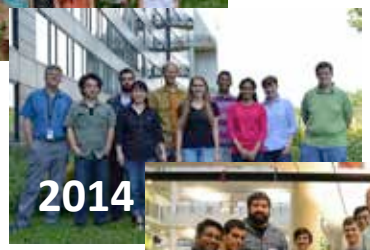
Opportunity: Big Data + Predictive Models

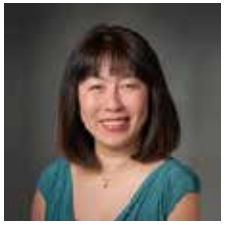
Smart Sensors + Supercomputers/Cloud Computing = predictions and analysis



Developing a pilot project strategy aimed at empowering partner universities and national laboratories to work with their local cities.

Team & Collaborators

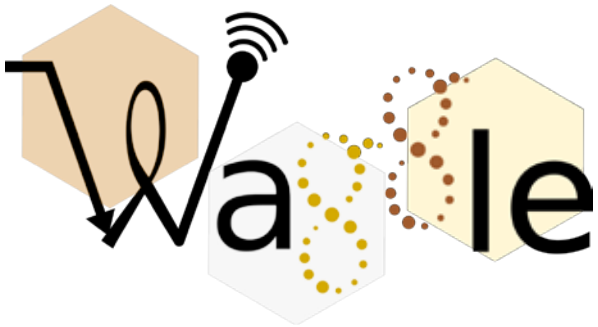




Why HPC Geeks Should Care

- New sensors are ***programmable* parallel computers**
  - Multicore + GPUs & OpenCL or OpenMP
  - New algorithms for in-situ data analysis, feature detection, compression, deep learning
  - Need new progmod for "stackable" in-situ analysis (for sensors and HPC)
  - Need advanced OS/R resilience, cybersecurity, networking, over-the-air programming
- 1000s of nodes make a **distributed computing "instrument"**
  - New streaming programming model needed
  - New techniques for machine learning for scientific data required
    - Both for within a "node" and collectively across time series
- How will **HPC streaming analytics and simulation** be connected to live data?
  - Can we trigger HPC simulations after first approximations? (weather, energy, transportation)
  - Unstructured database with provenance and metadata for QA/collaboration
- Use novel HPC hardware to solve power issue?
  - Can we use neuromorphic or FPGAs to reduce power for in-situ analysis & compression?
- We are trading precision & cost for greater spatial resolution: What is possible?

Questions?



http://www.wa8.gl

http://arrayofthings.github.io