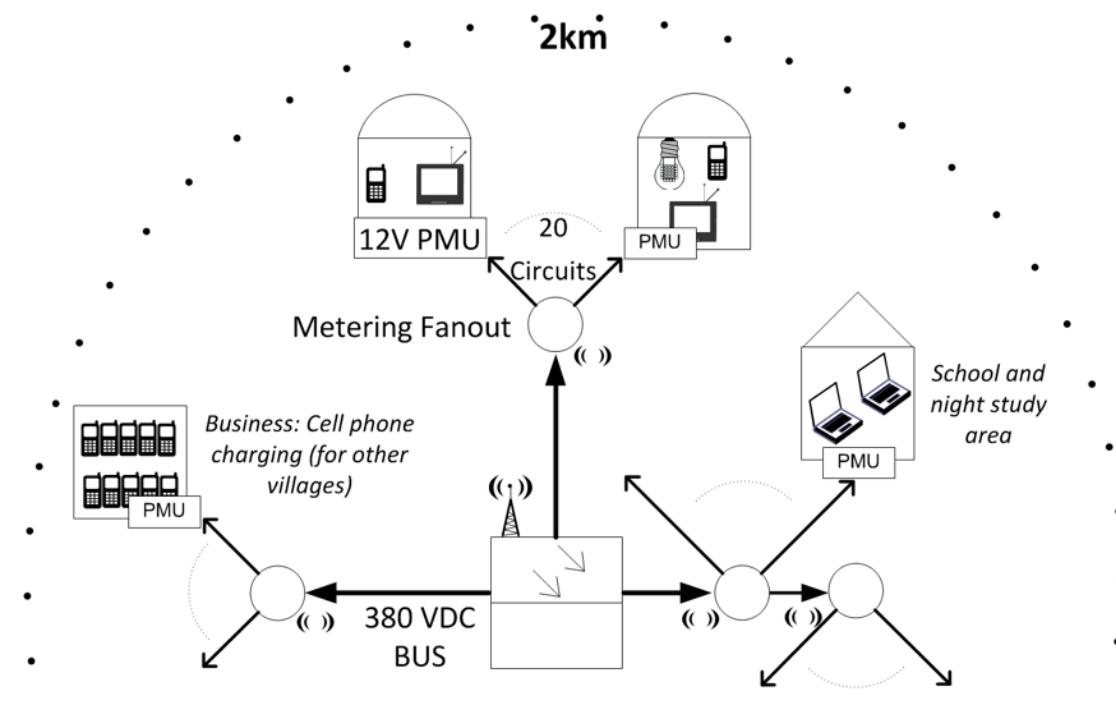


Building Sensors

CONTINUOUS AND DIRECT MONITORING

My Background

- Technology and Infrastructure for Emerging Regions (TiER)
- Power infrastructure in emerging regions
 - Centralized Solar
 - Low-cost
 - Low-energy use
 - Designed for a star-topology
 - Prepaid credit system
 - Probably a terrible business model
- No attention span



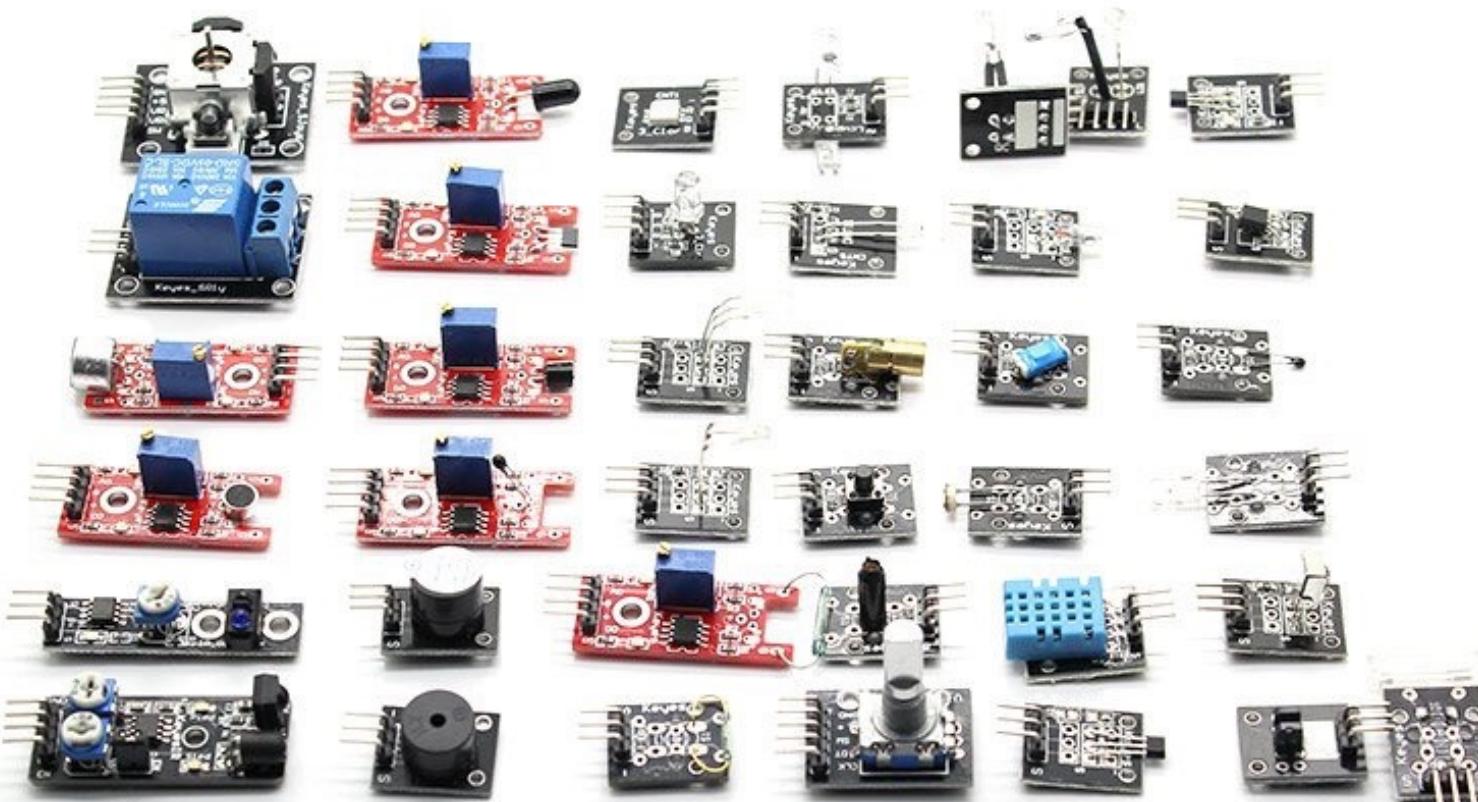
Why Sensors?

- Bias
 - Courtesy
 - Recall
 - Memory
- Direct observation at high resolution
- Continuous monitoring

Sensor Ecosystem

- Sensors
- Gateways
- Examples
- Development and Prototyping
- Data Collection
- Scaling
- Deployment
- Maintenance

Sensor Bestiary



Cell-Phones as Sensors

- Low Cost Android phones have plenty of them
 - Accelerometers
 - Compass
 - Gyroscope
 - Bluetooth
 - WiFi
 - GPS
 - Light Sensor
 - Camera
 - Capacitive Touch
 - Temperature
- Local and Non-local Communications
 - USB Port
 - WiFi
 - GSM



Motion or Activity

- Accelerometer
- Compass
- Gyroscope
- GPS
- Camera
- Sound



Motion or Activity

- Pressure
- PIR (awful)
- Distance
- Rotation
- Linear Position
- Capacitive Touch
- Bluetooth



People

- Galvanic Skin Response
- Heart Rate
- Breathing



Air

- CO₂
- Humidity
- CO
- Particle Counters
- Flame sensors
- Alcohol



Water

- Flow Rate
- Conductivity
- Level



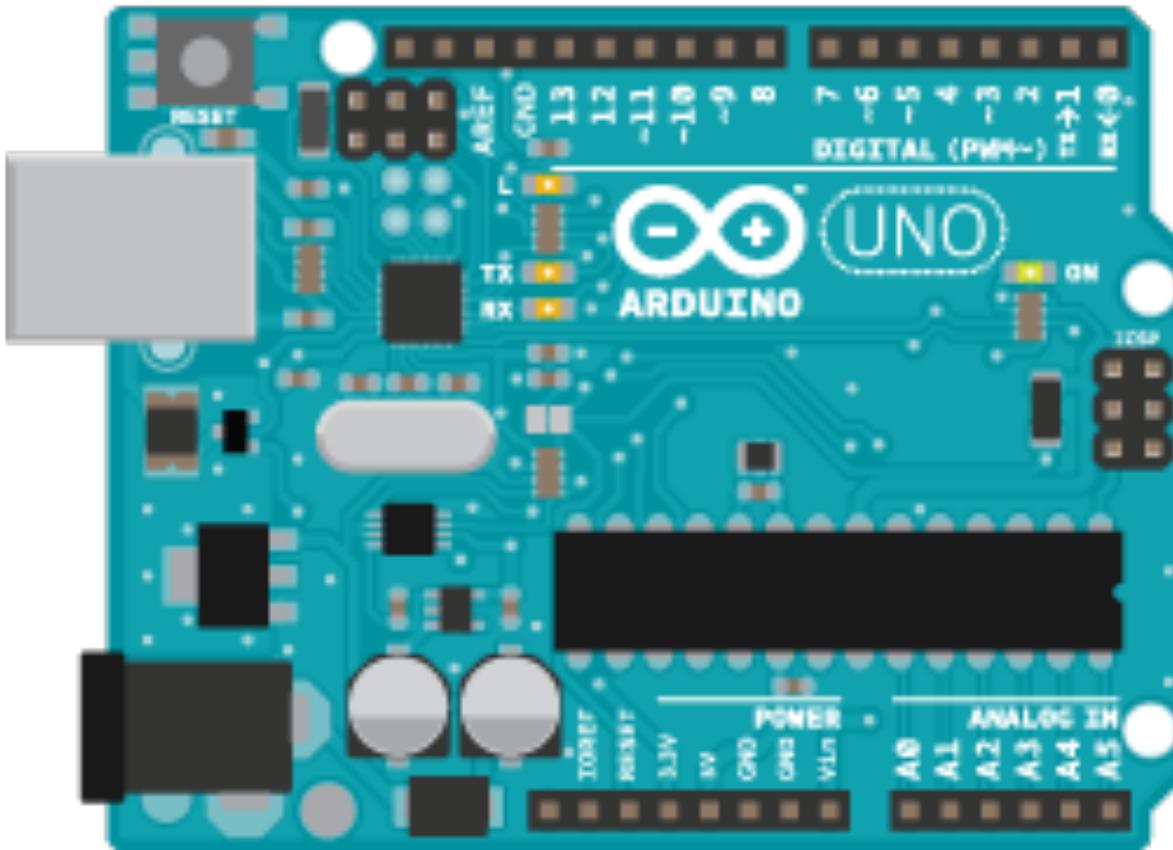
Monitoring Devices

- Switches
- Temperature
- Current

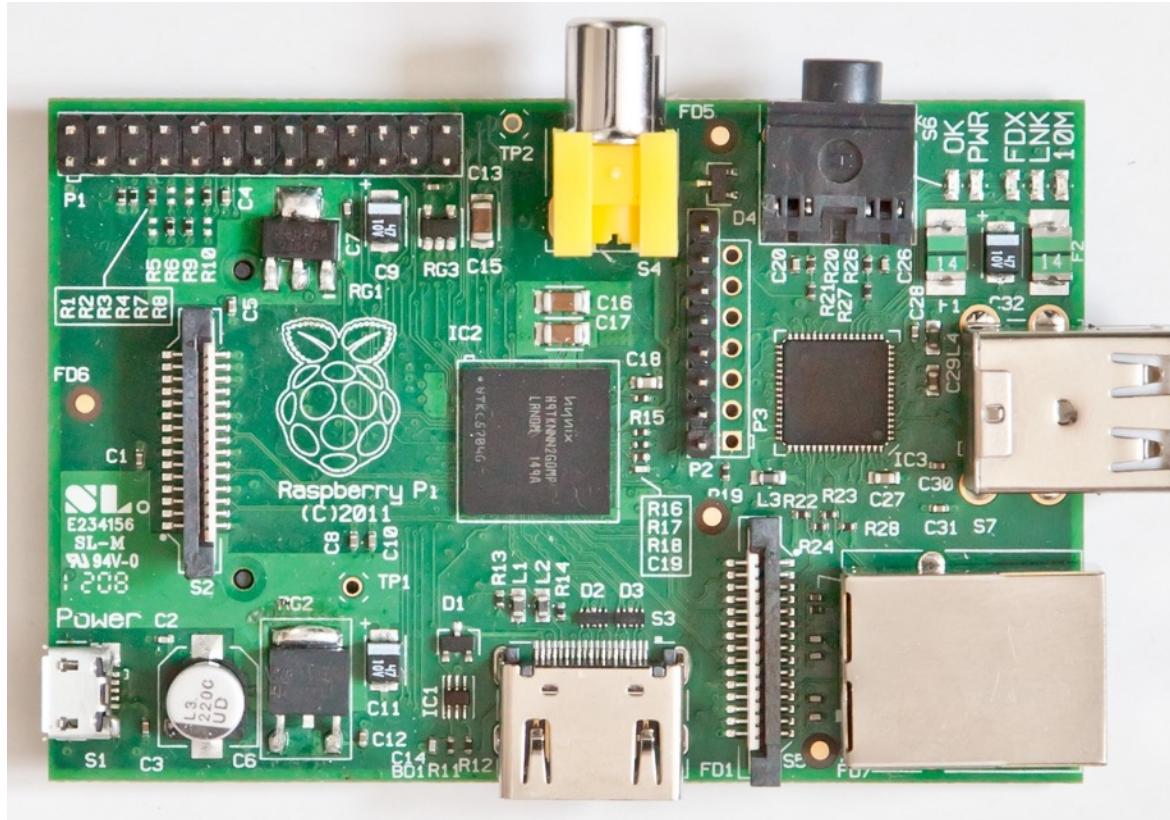


What do Italian Kings, Fruits and
Dogs have in common?

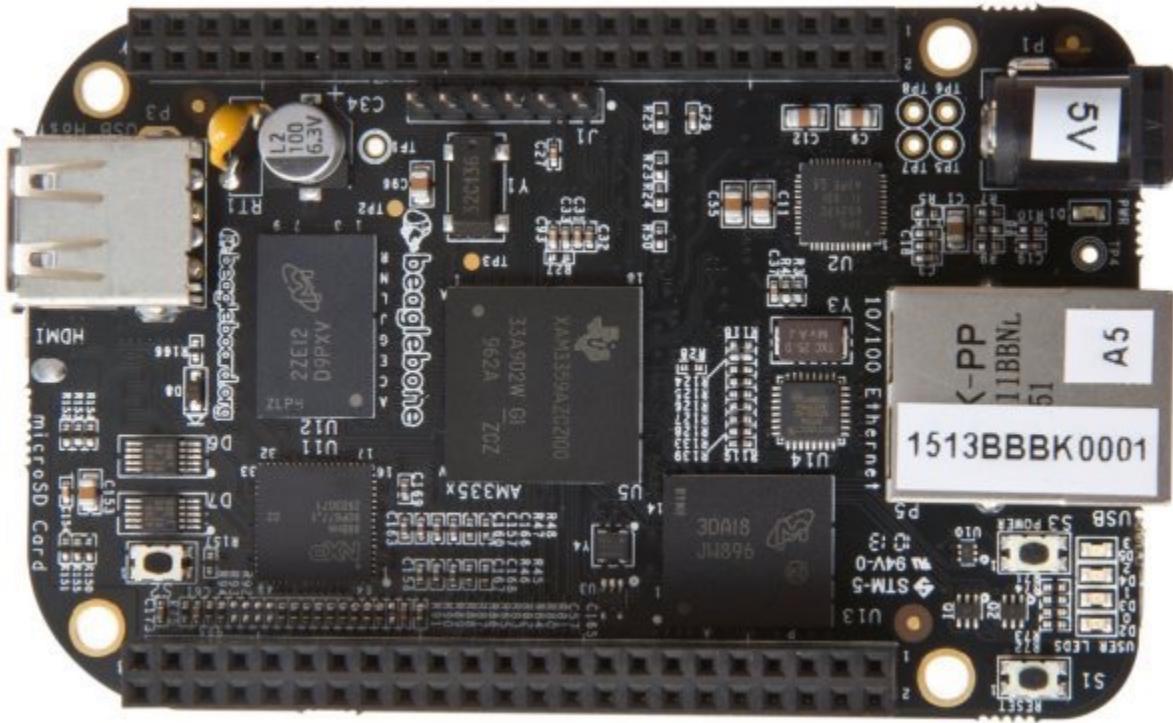
Arduino



Raspberry Pi (Version A depicted)



BeagleBone



Show and Tell

Trees have a lot of energy too

- Billions of people still burn them
- Monitoring cook stoves in Ethiopia



iButton Temperature Sensors and Stoves



+



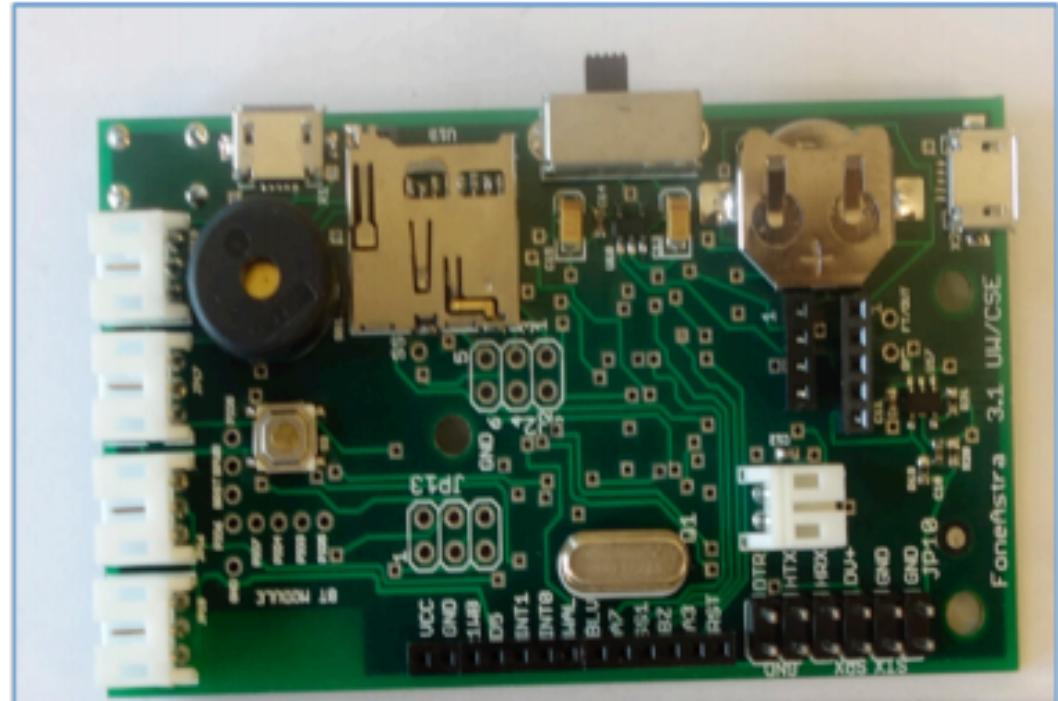
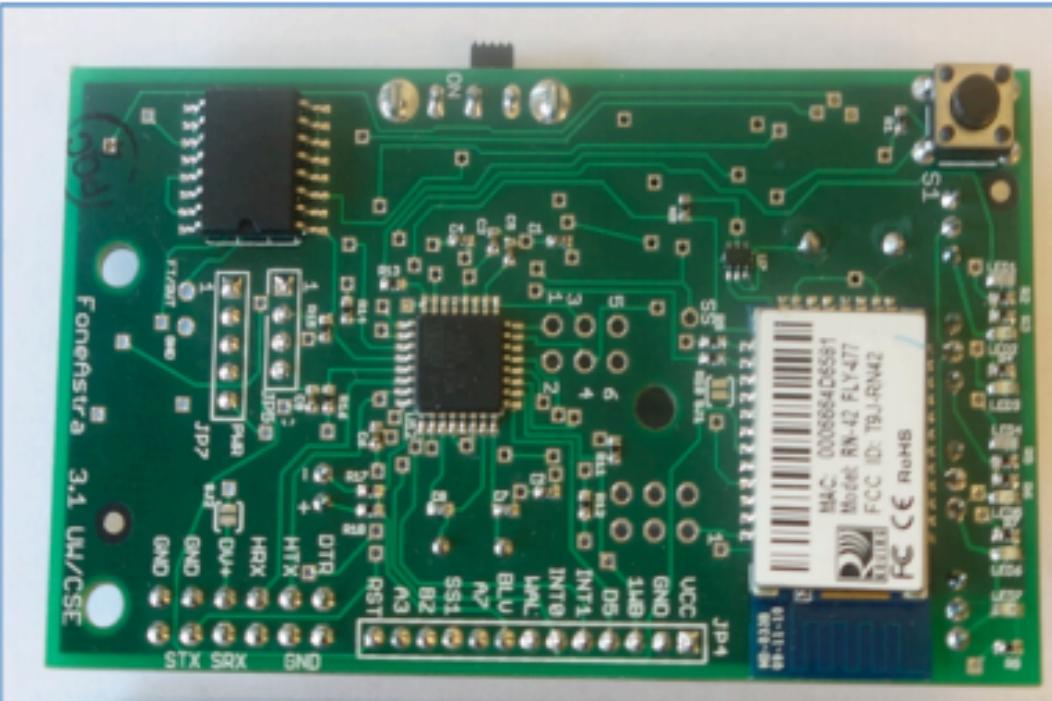
Data Collection During Surveys



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FoneAstra



Extending Sensing Capabilities and Modalities of Mobile Devices. Rohit Chaudhri. University of Washington

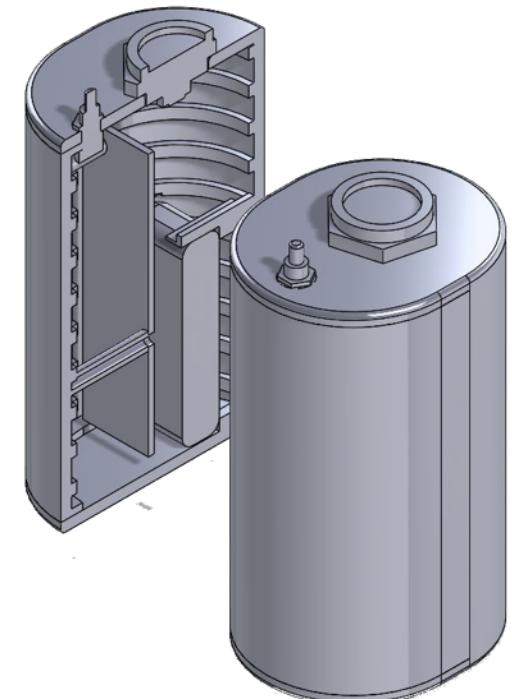
Milk Banking (ODK Sensors Project)



iButton Temperature Sensors

- University of Washington's FoneAstra
- Arduino and OneWire sensors
- Bluetooth
- Battery
- SDCard
- Real-time clock

Handheld iButton reader based off of FoneAstra



Demand Response in Nicaragua

- Monitoring freezer loads to implement supply following loads
- First collect a baseline of data for 6 months
- Then switch and control the freezers and refrigerators



Demand Response in Nicaragua

Flexbox (Flexible Load Controller) Version Wolf3D



Temperature



Temperature and Humidity



Switching

Demand Response in Nicaragua: Off the Shelf Sensors

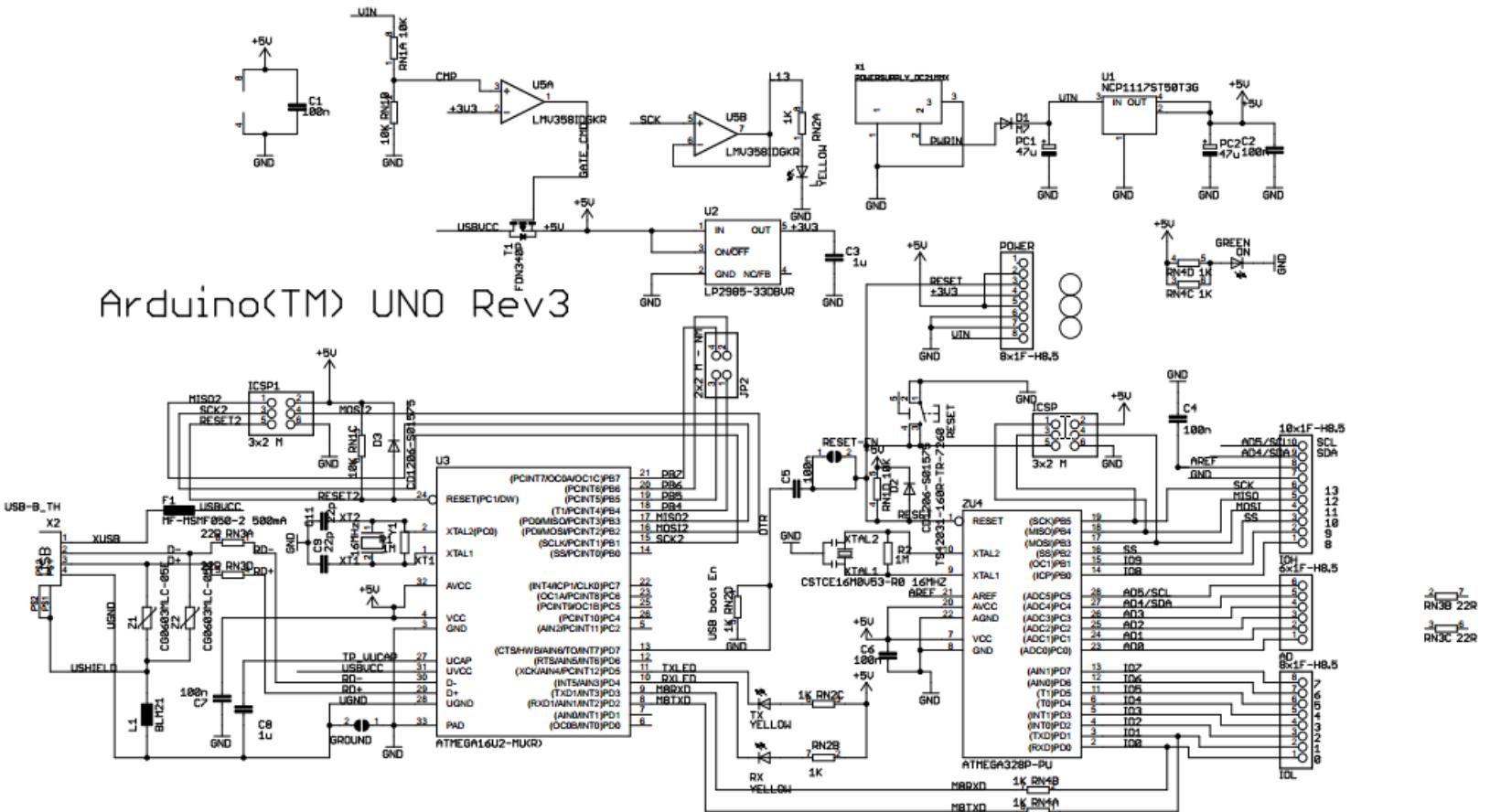
[Freezer Power and Control](#)



[Home Power Monitoring](#)

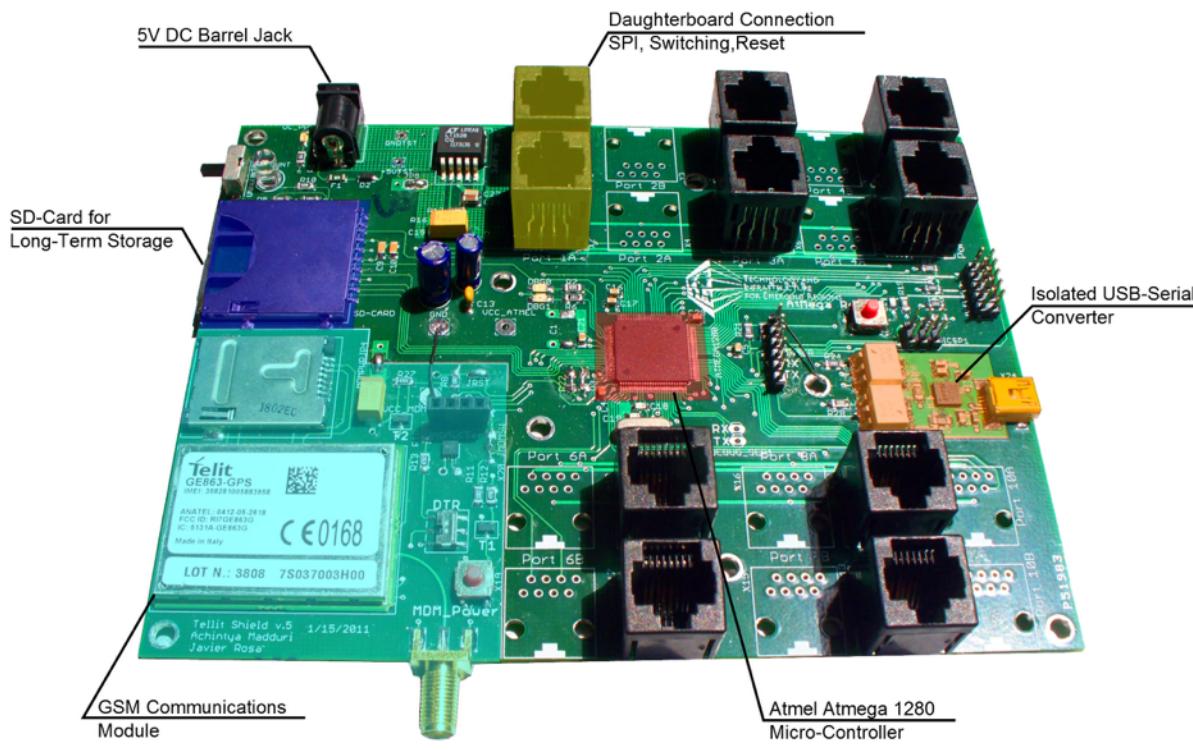


You can repackage Arduino designs

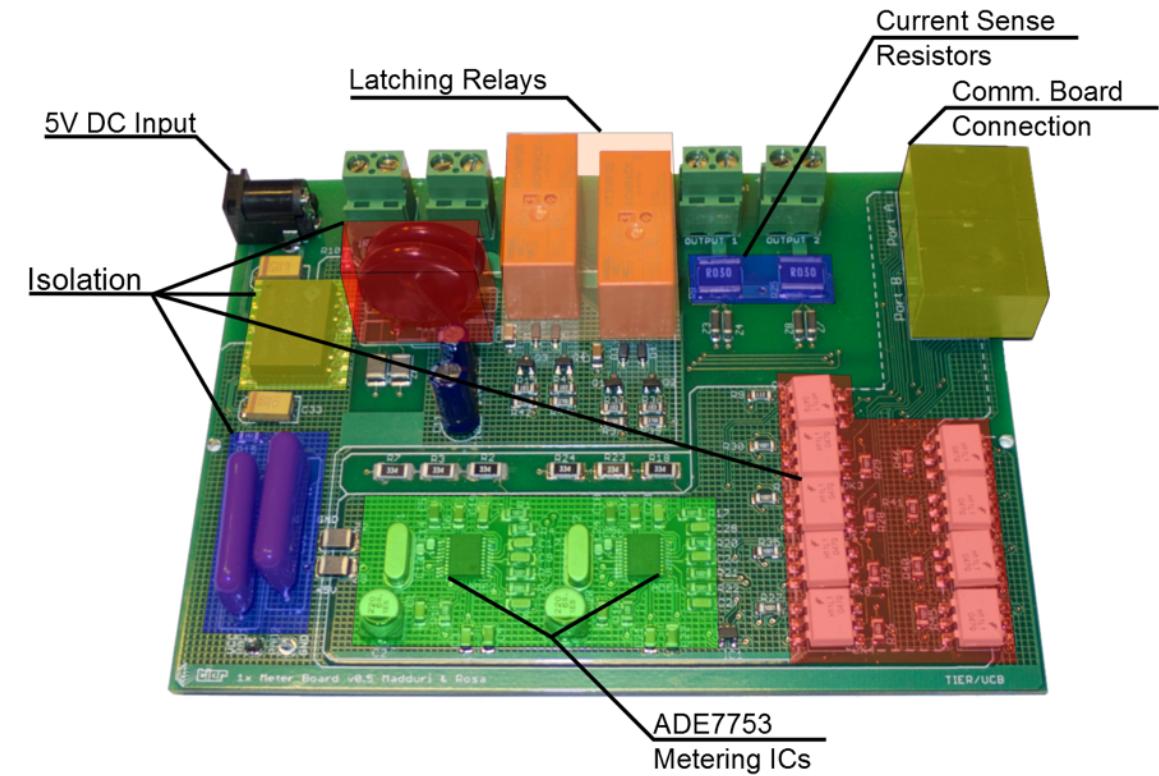


MicroGrid Metering Infrastructure

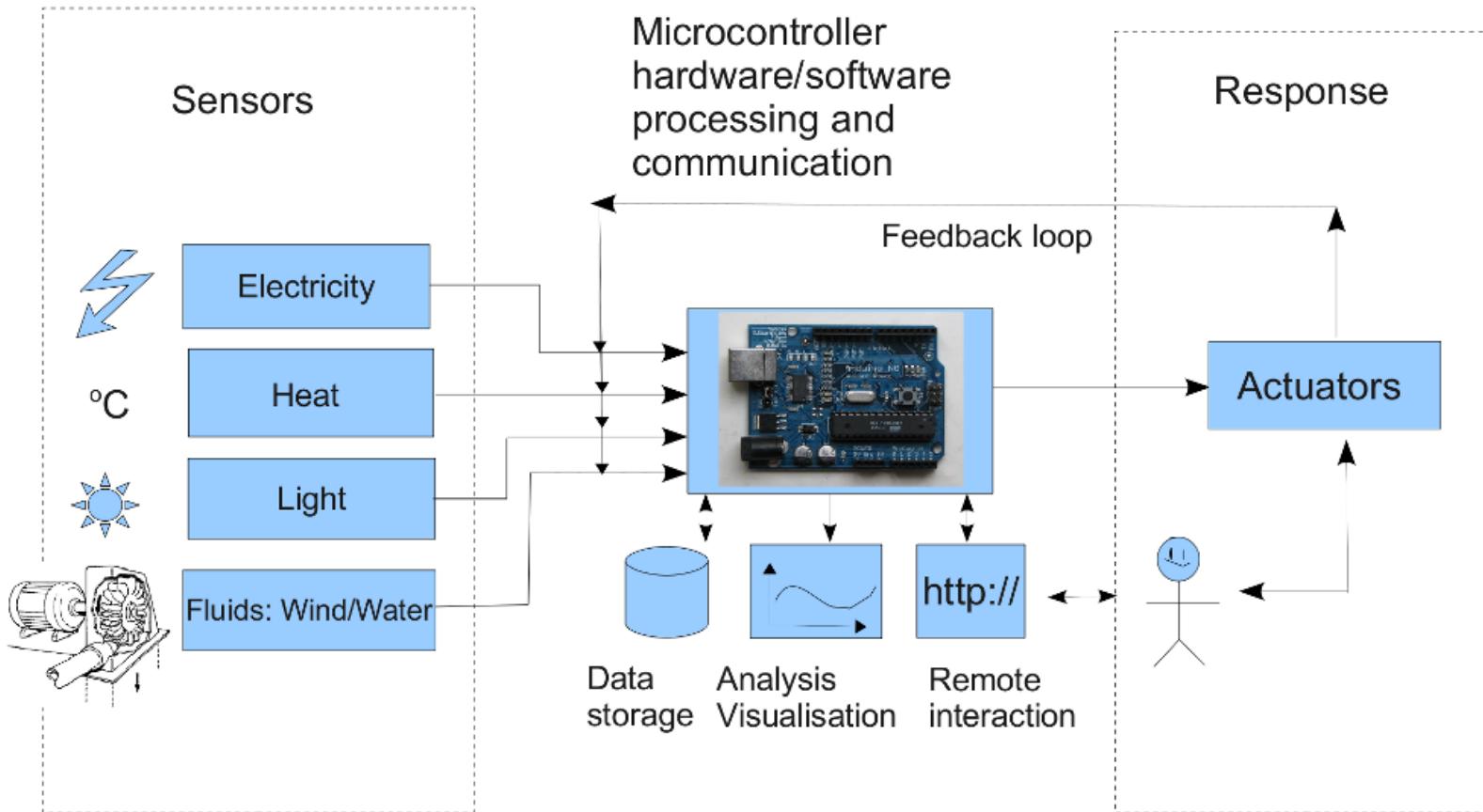
Brains Behind the Operation



MicroGrid Meter



Open Energy Monitor



Campus Resources

- I'm happy to help: javirosa@eecs.berkeley. edu
- [Invention Lab](#)
- CEGA: <http://cegadev.berkeley.edu/info/behavioral-sensing>
- Development Impact Labs: <http://dil.berkeley.edu>
- [Swarm Lab](#)
- [AMP Lab](#)
- Local Makerspaces

Coming Soon

- Next class: Building your own sensor node
- Future:
 - Data management and data collection
 - Scale-up with a consultant
 - 1984