The Signpost Platform for City-Scale Sensing

Joshua Adkins, Branden Ghena, Neal Jackson, Pat Pannuto, Samuel Rohrer, Bradford Campbell, Prabal Dutta

Presented by: Pat Cody

The Urban Planner’s Dilemma

- The urbanism trend is increasing- the UN projects that 66% of the world will live in a city by 2050, up from 50% now
- Growing interest in making cities healthier, cooler, cleaner, more sustainable, etc.
- How can we do that in an educated manner?

Cities... of the FUTURE

- We have smart cars, fridges, doors...why not cities?
- If we have more data about a city, we can make more educated decisions about how and when to respond to situations
  - Route planning that takes air pollution into account
  - Noise pollution monitoring
  - Automatic emergency response

Sensor Deployment Considerations

- Power source
- Data transmission medium
- Location

Option 1: Static Deployment

- Have been used to monitor things like air quality, road conditions, noise, etc.
- Many are not long term installations
- Power sources are limiting
- No real infrastructure, usually just “proof-of-concept”

Option 2: Mobile Phones

- Mobile phones can be used to measure data like air quality, noise pollution, or traffic conditions
- Cars can also host the sensor array
- Scales well
- Financing is hard
- Incentivizing is hard

Option 3: Generic Sensing Platforms

- Ideal solution for long-term deployments, as it’s a full platform rather than a one-off sensor
- Existing options have a variety of logistical issues
- Dependency on wired power and networking limits deployment locations

The Ideal Solution

- A **platform** that is:
  - Not dependent on wired power
  - Not dependent on wired networking
  - Easy to deploy
  - Allows for well-distributed data collection

The Ideal Solution

- Has a familiar programming environment (e.g. Linux)
- Multiple application support

Enter: Signpost, *the Platform*

Why Signpost? Deployability

- Uses solar power and wireless communication to prevent dependency on wired connections
- Attaches to signposts

Why Signpost? Accessibility

- Mostly-reliable energy delivery
- Suite of communication protocols depending on need (2g and 3g cellular, LoRaWAN, BLE)
- Intel Edison for co-processing
    - Allows for batch processing and use of languages/libraries that can’t be ported to a microcontroller
- Software APIs for writing programs

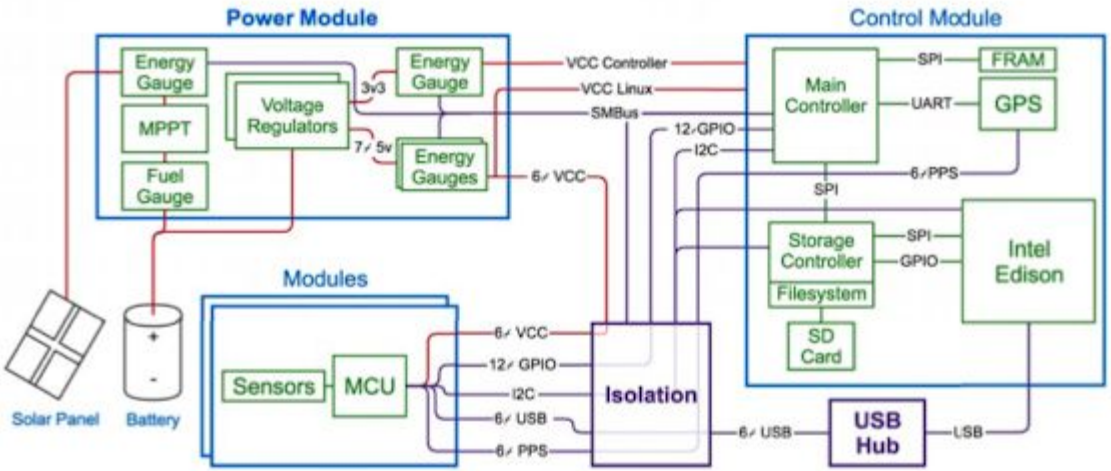
Why Signpost? Modularity

- Provides a standard interface for modules with 5V power and a shared I2C bus, I/O lines to control module, Pulse-Per-Second signal, and USB slave connection

Why Signpost? Multi-Tenancy

- Modules can each run multiple applications
- Energy availability should be predictable and fairly distributed
- Applications can communicate over the messaging API or to other Signpost installations

Signpost Design



Evaluation Metrics

- Deployability
- Energy use
- Supported Applications

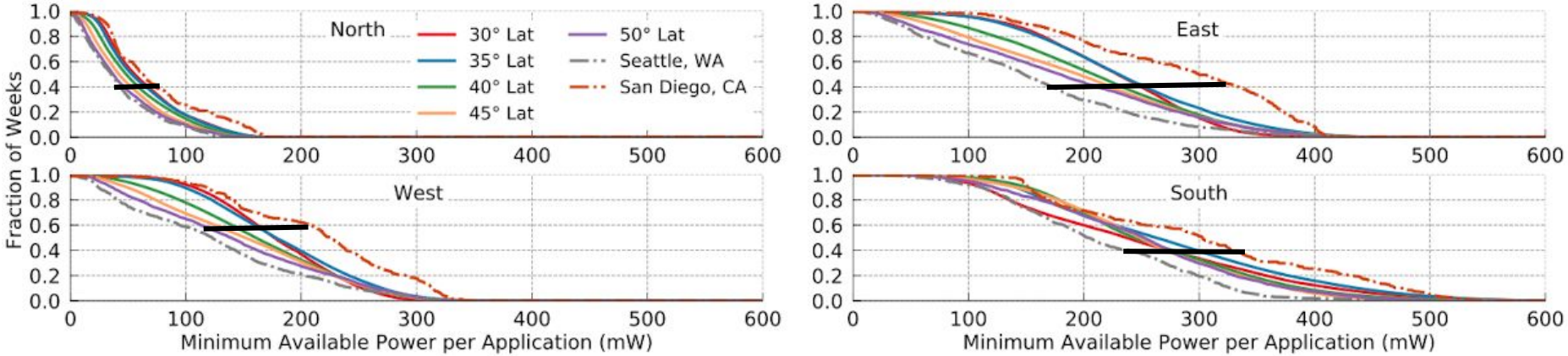
Deployability

- “Two students can deploy a single Signpost in less than five minutes”
- 12 installations around UC Berkeley took less than 90 minutes, and devices have not experienced theft/vandalism
- “We believe that the platform is unobtrusive and blends in with other city infrastructure”

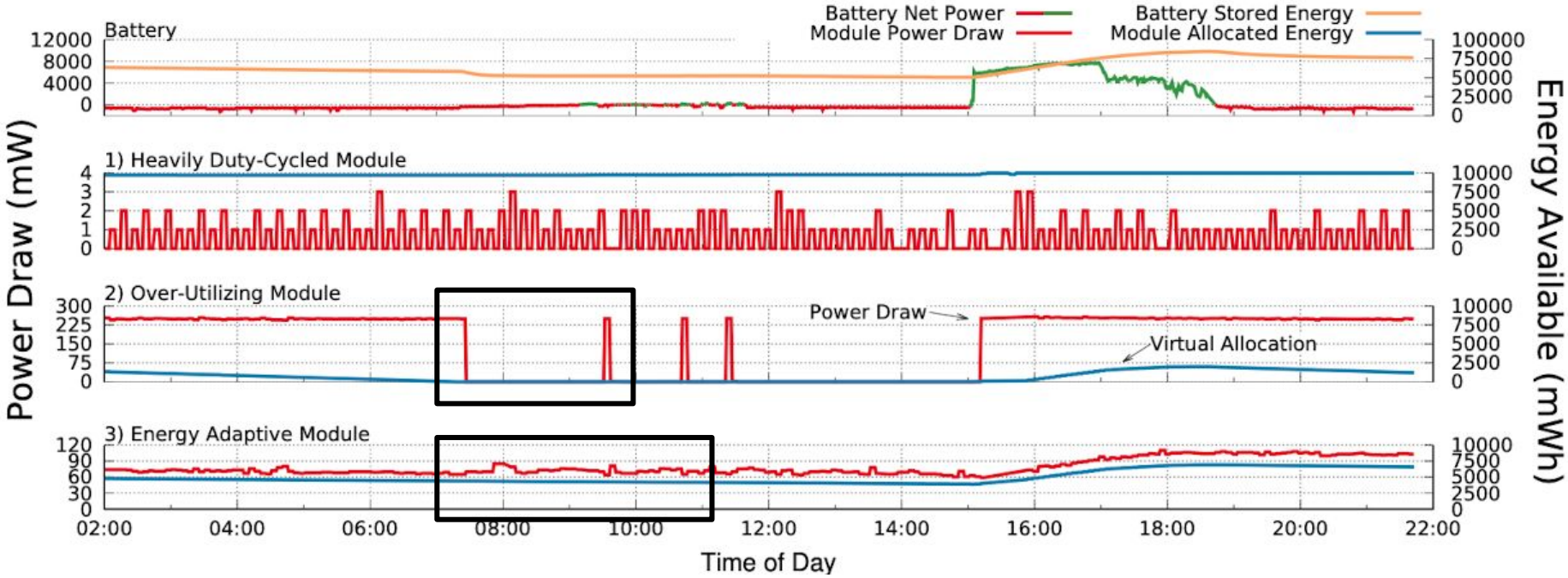
Energy- Platform Overhead

- Platform has some overhead- 16mW, or <2% of 50th percentile power budget and 6-18% of 95th percentile budget
- Control module provides power management, time, location, storage, and processing
- Energy drawn from Control Module services (such as the Intel Edison) count towards the modules that use them

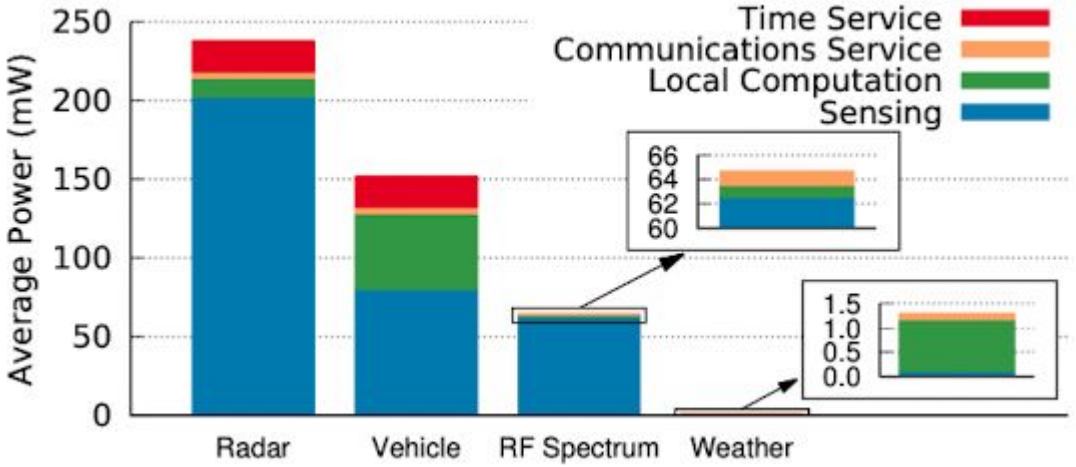
Energy- Solar Harvesting



Energy- Module Power Drain



Supported Applications / Multi-Tenancy



How could Signpost help a city? Discuss!

Critique

- Very small section about privacy, with conclusion of it is “an area of active research”
  - Security implications- what happens if we stick cameras, or long-range microphones on these?
- Solar power analysis doesn’t really discuss the scenario of “not enough power”
  - We need to change our programming models to deal with this scenario
- Physical security and vandalism possibility
  - See: the scooter problem
- Cost is quite high

Conclusions

- Platform is modular and solar-powered, making it easily deployable
- Designed to be adaptive
- Signpost creates a platform that optimizes for developer experience- developers can focus on building modules and writing code

Github Questions / Critiques

- @lrshpak Lily Shpak, Comprehensive: Will cities need to hire more technically experienced employees to maintain system?
- @grahamschock Graham Schock, Critical: How do we authenticate signposts?
- @samfrey99 Sam Frey, Critical: Could communication be improved with the advent of 5G?
- @mjhegarty Michael Hegarty, Comprehensive: Is the inclusion of the Intel Edison worth the additional power, versus handing off the computation to an edge node?
- @rachellkm Rachell Kim, Critical: Is the energy provided for each module dynamically allocated or equal for each module?
- @rebeccc Becky Shanley, Comprehensive: What can be done to prevent nefarious use of collected data?