The Signpost Platform for City-Scale Sensing

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A city-wide sensing platform that is deployable, scalable, and driven by applications.

Key Research Themes

1. Energy-proportional computing: Sensing and communication must scale to current harvesting conditions and adjust to energy variability.
2. Modular system design: Hardware and software interfaces need to support a wide variety of module implementations.
3. Distributed applications: The platform must balance Signpost-local resources, communication bandwidth, and cloud interactions.
4. Private by design: Do not collect what must be kept private. Filtering done at the hardware level can help ensure that no identifying data is sent to the cloud.

Signpost provides power, networking, storage, compute, time, location, isolation, and installation to sensor modules through a standardized interface.

Shared Resources. Providing power, networking, storage, location, and high-performance computation lowers the bar to building and deploying a module.

Hardware Interface. Sensor modules are added to the platform through a standard electrical and mechanical interface. The interface is designed to provide the necessary features we envision for modules.

Isolation. Integrated mechanisms for physical isolation, electrical isolation, and fair distribution of resources ensure reliability and security.

Software Interface. Providing a standard library for accessing system resources supports application developers. Serializing commands over the data bus allows for easy interoperability between many software architectures.

Current Applications

- Ambient Sensing: Temperature, Light, Pressure, & Humidity
- Platform Control
- Audio Analysis
- Radar Motion Detection
- Air Quality Monitoring
- Energy Monitoring
- Spectrum Monitoring
- RF Spectrum Analysis
- LoRa Platform Radios: GSM, LoRa, & BLE
- Platform Energy Metering & Distribution
- Platform Backplane
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Variability in Harvesting. Emphasizing the ability to deploy Signposts facing any direction leads to increased variability in harvested energy.

Differences in direction, season, and weather lead to instantaneous power varying between 0 Watts and 12.9 Watts, with average daily power ranging from 0.09 Watts to 2.7 Watts. The Signpost platform needs to be able to adapt to varying energy availability, capitalizing in times of plenty and conserving in times of famine.

Energy Adaptivity in Practice. Adjusting to platform energy variability requires software primitives to support energy awareness and adaptivity.

Energy on the system is allocated to modules as “virtual batteries”, ensuring that each module gets a fair share. Incoming energy is distributed evenly between modules. In the future, these could become priority based allocations.

Shown at left, modules can request to be duty-cycled at particular rates in order to operate continuously (1), ignore energy constraints altogether and run only when energy is available (2), or dynamically adapt to current conditions (3).

Technology Transfer. Signpost has been demonstrated at the Terraswarm Annual Review (2016), the 14th ACM Conference on Embedded Networked Sensor Systems (SenSys 2016), and at Intel (2017). A demo paper has been published at SenSys’18: “Demo Abstract: The Signpost Network”.

Signpost is an entirely open-source project, dual licensed under MIT/Apache-2.0.

All source files are available on Github: https://github.com/lab11/signpost
https://github.com/lab11/signpost-software