Demo Abstract: Applications on the Signpost Platform for City-Scale Sensing

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ABSTRACT

City-scale sensing holds the promise of enabling deeper insight into how our urban environments function. Applications such as observing air quality and measuring traffic flows can have powerful impacts, allowing city planners and citizen scientists alike to understand and improve their world. However, the path from conceiving applications to implementing them is fraught with difficulty. A successful city-scale deployment requires physical installation, power management, and communications—all challenging tasks standing between a good idea and a realized one.

The Signpost platform, presented at IPSN 2018, has been created to address these challenges. Signpost enables easy deployment by relying on harvested, solar energy and wireless networking rather than their wired counterparts. To further lower the bar to deploying applications, the platform provides the key resources necessary to support its pluggable sensor modules in their distributed sensing tasks. In this demo, we present the Signpost hardware and several applications running on a deployment of Signposts on UC Berkeley's campus, including distributed, energy-adaptive traffic monitoring and fine grained weather reporting. Additionally we show the cloud infrastructure supporting the Signpost deployment, specifically the ability to push new applications and parameters down to existing sensors, with the goal of demonstrating that the existing deployment can serve as a future testbed.

1 SIGNPOST PLATFORM

The Signpost platform, presented at IPSN 2018 [1], is designed to enable fined-grained, city-scale sensing by embracing deployability and providing the key services necessary for generic sensing tasks. The use of solar energy-harvesting and wireless networking allow Signposts to be placed throughout a city using a simple, two-bolt attachment mechanism. Sensor modules, which plug into any of the five generic sensing slots, are provided with power and can access networking, storage, time, location or local Linux processing through a standard software API. As shown in Figure 3, the library which provides access to these resources supports common embedded computing platforms such as Arduino, Mbed, or Tock, and can easily be ported to support other software environments.

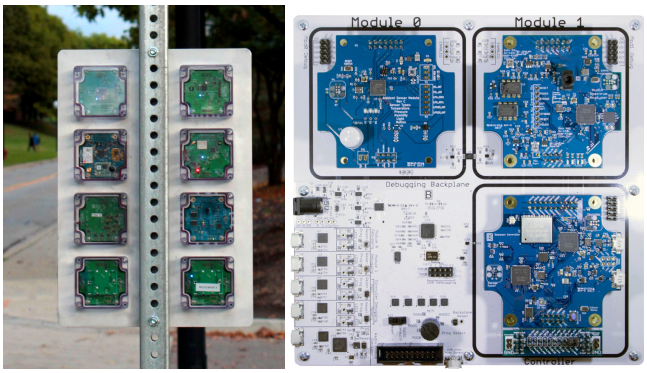

Figure 1: Left: A deployed Signpost. Right: Desktop development kit. The Signpost can be easily installed on sign posts throughout a city. It provides power to its pluggable sensor modules through solar energy harvesting and makes other services available through a standard software API. The desktop development kit emulates a Signpost, allowing for easy development of new sensor modules and city-scale sensing applications.

While the combination of multiple sensor modules and constrained resources creates problems with service availability, the Signpost platform includes mechanisms for measuring resource usage and isolating sensor modules that use over their fair share of available resources. Additionally, API calls are provided to help sensor modules adapt to the varying amounts of harvested energy.

1.1 Development Platform

To facilitate the bring-up of modules before deployment, we introduce a "desktop" development version of Signpost that enables the emulation of constrained resources and provides more traditional debugging aides. The desktop version is designed to represent the conditions experienced by modules on a deployed Signpost, such as limited energy and network bandwidth budgets.

1.2 Cloud Infrastructure

In addition to local resources, the Signpost API also provides a standard way of interfacing with deployed sensor modules from the cloud. The API exposes a generic pub/sub interface, and users can subscribe to sensor module topics (if they have proper permissions) for further data storage and processing. The internals of this API

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Software and hardware is open source at github.com/lab11/signpost

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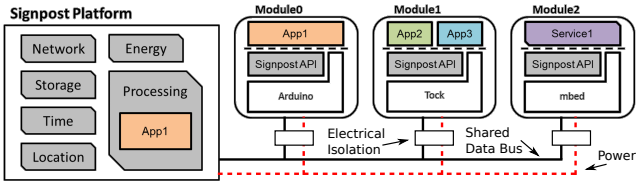

Figure 2: Signpost software architecture. Sensor modules on the Signpost platform are provided with power, networking, storage, time, location, and local Linux processing. These services are available through a standard software API over a shared (I^2C) data bus. Currently the API supports Arduino, Mbed and Tock programming environments. Signpost includes mechanisms to measure resource utilization and electrically isolate sensor modules using over their fair share of platform resources.

automatically select the best networking interface based on current connectivity and power constraints.

Application installation and updates are also enabled by this API, and Signpost uses its on board storage and dedicated control module to ensure reliability during the update process. We believe these considerations will allow the Signpost platform to enable a future city-scale sensing testbed.

2 DEMO

In addition to showing several running Signposts and desktop development modules, we will demonstrate a deployment of 20 Signposts on UC Berkeley's campus. These Signposts will be running several applications including traffic flow monitoring using the audio-volume sensor and periodic weather reporting based on the environmental sensor. Further, we will show how these applications can be distributed across the deployment and how they can adapt to save energy with little compromise on sensing ability.

We will also show the features of the cloud infrastructure, focusing on how a user of the system would update a Signpost with new applications and collect data from published sensor streams.

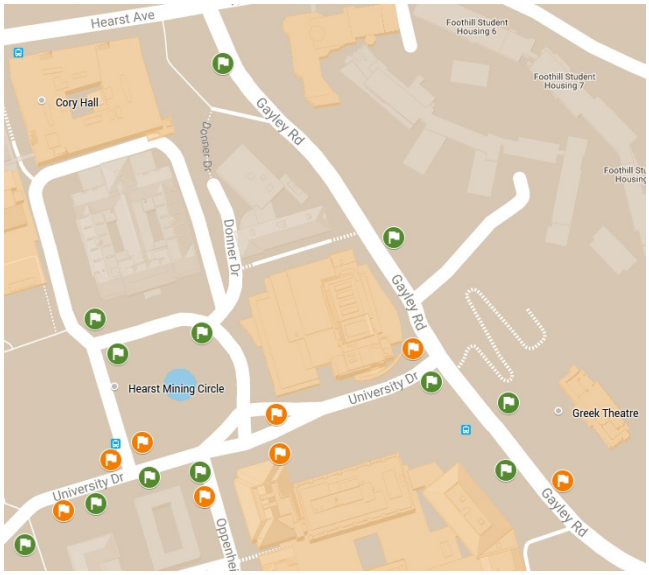

Figure 3: Signpost Signpost Deployment Locations. The current (darker green) and proposed (lighter orange) deployment locations for the Signpost platform on UC Berkeley's campus. We will use these signposts to demonstrate several applications including energy-adaptive traffic flow monitoring and individual weather reporting.

3 ACKNOWLEDGMENTS

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REFERENCES

[1] Joshua Adkins, Branden Ghena, Neal Jackson, Pat Pannuto, Samuel Rohrer, Bradford Campbell, and Prabal Dutta. 2018. The Signpost Platform for City-Scale Sensing. In *The 17th ACM/IEEE Conference on Information Processing in Sensor Networks (IPSN'18).*