Synergy Software Stack

- BLE, 802.15.4, brought together into a single, ultra-low-power platform
- Elegant, asynchronous userland (Lua/C) and kernel (NesC, TinyOS)
- Simple API for BLE and IPv6/802.15.4
- Rapid prototyping in Lua using full capabilities of platform through syscalls
Steven Bell

How do we program specialized hardware more effectively?

Can we generate hardware and software together, reducing development time and bugs?

I'm exploring these in the context of the Frankencamera project, building a programmable camera.

Mark Horowitz group
sebell@stanford.edu
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**Problem:**

91% of critical CVEs caused by drivers leading to serious vulnerabilities

NetUSB flaw leaves 'millions' of routers, IoT devices vulnerable to hacking

The flaw can be exploited to conduct denial-of-service attacks or remote hijacking.

**Observation:**

Devices modeled by state machines

**Our Approach:**

Guarantee device is programmed according to state machine at compile time via programming language properties
Weave: Scripting Cross-Device Wearable Interaction

A framework that provides a set of high-level APIs, based on JavaScript, for developers to easily distribute UI output and combine sensing events and user input across mobile and wearable devices.

```javascript
weave.select("showable[size='small'], touchable")
  .show(weave.getLayoutById("launchList"))
  .on("tap:li", function(event) {
    weave.select("showable[size='normal']")
      .not(event.getDevice())
      .startApp(event.getValue());
  });
```

Peggy Chi
4th-year PhD student, UC Berkeley
http://www.cs.berkeley.edu/~peggychi/

Work published at CHI 2015

Collaborator: Yang Li (Google Inc.)
eMbedded Gateway Cloud

Networking

Sensor Device
- Energy harvesting
- Records raw data
- Delta compression
- OCB encryption
- Written in C

BLE/GATT

iOS
- Log anonymous phone data
- User interaction
- Operational metrics
- Proxies data to server

HTTPS/REST

Android
- Data storage
- OCB Decryption
- End-to-end acks
- Written in Python

BLE/GATT

Metadata
- Encrypt
- Raw Data

Water Flow

Temperature

Reliable Comms.

Raw Data

End-to-end Ack

MAC

Water Flow

Temperature

Shower Data

Reliable Comms.
Synergy Hardware Stack

The power profile of a next-generation mote
The ease of use of an Arduino
The connectivity of BLE and 802.15.4
People are wearing lots of chatty radios…

They broadcast messages frequently and regularly with unique IDs

We can leverage these devices to create an accurate user-transparent room-level localization service.
Self Incentivizing Networks
Greg Hill, Keith Winston

Applications (or devices) express goals

Network compensated to serve goals
Disaggregated Flash Storage in Datacenters

Ana Klimovic

- The cloud is an emerging platform for IoT applications to store and process sensor data.

- **Goal:** efficiently manage storage to achieve:
  1. Performance guarantees for applications
  2. High utilization of hardware

- **Idea:** disaggregate (decouple) Flash storage from CPU and memory to allow flexible resource allocation according to application needs.
Today, OSs can only abstract peripherals by understanding their functionality.

Tension: sharing vs. safety vs. generality.

*This won't do for the IoT*

How do we abstract peripherals in the OS without understanding their function?

**Beetle** harnesses 3 properties of the BLE protocol to achieve this.
Enables web applications to communicate with Bluetooth Low Energy devices

Supports the MGC (eMbedded Gateway Cloud) model

Enables quick prototyping of new IoT applications
The Michigan Micro Mote
A general-purpose cubic millimeter sensor platform

Come Learn About

• The M³ Platform

• MBus, a new inter-chip communication protocol

• M-ulator, an in-circuit simulator/emulator for rapid development and prototyping
Computers should be able to synthesize embedded devices from high level specifications...

...they just need a way to capture the constraints found in embedded systems development

Functionally Defined Hardware

Rohit Ramesh
Wouldn’t it be great if programming the Internet of Things would be as easy as programming modern web applications?

Ravel, a framework for high-level description of an IoT application using a single development language and semantics.

Laurynas Riliskis, Postdoc, Stanford

06/04-2015
Privacy-Preserving Shortest Paths

getting where you want to go
but without saying where...

combines compression techniques and cryptographic primitives to obtain
city-scale, fully private real-time navigation

Joint work with Joe Zimmerman, Jérémy Planul, and John Mitchell
Summing up a Haystack

Privacy Preserving Reports for Rare Occurrences

Yan Michalevsky, Valeria Nikolaenko and Dan Boneh
The Internet of Things has a gateway problem: connectivity for IoT devices is narrow & siloed.

We can fix this…

…by creating a universal network architecture for IoT devices that leverages existing mobile infrastructure & uses phones as general purpose gateways.