Using Taint Tracking to Improve Energy Efficiency of Always-on Smartphone Apps

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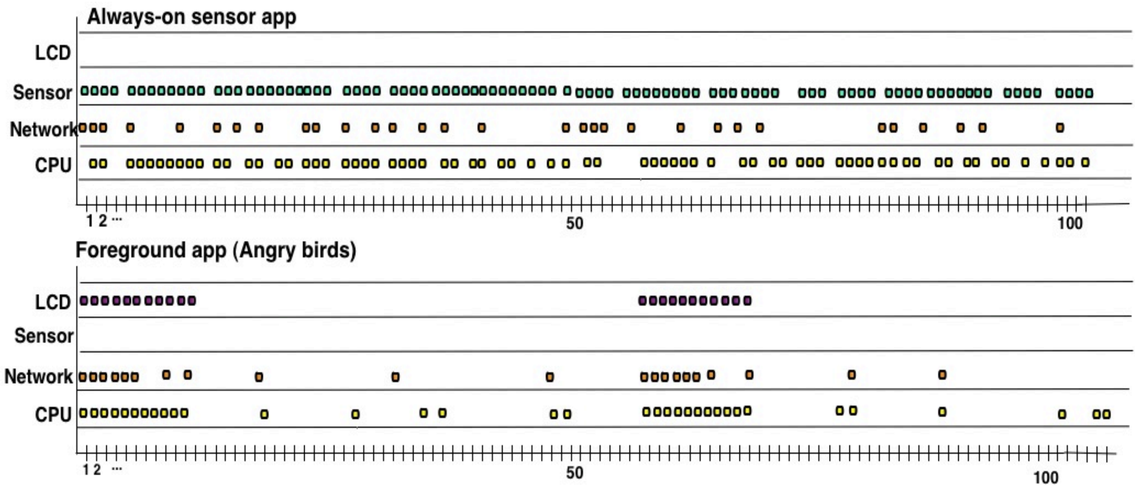


Comparing the active times of always-on sensor apps vs foreground apps. The total energy consumed is the same in both cases. The foreground app is active for 2 1-hour sessions.

Motivation

- Sensor hubs, a low cost always-on micro-controller, can collect sensor data without waking the CPU

BUT

without understanding sensor usage patterns in real apps, it's difficult to design a sensor hub architecture

Goal

- **Taint Tacking:** Understand sensor usage patterns in continuous monitoring applications

Approach: Taint Tracking

What to track

- When are sensor data collected?
- When are they needed for update?
- How often is collected data used?

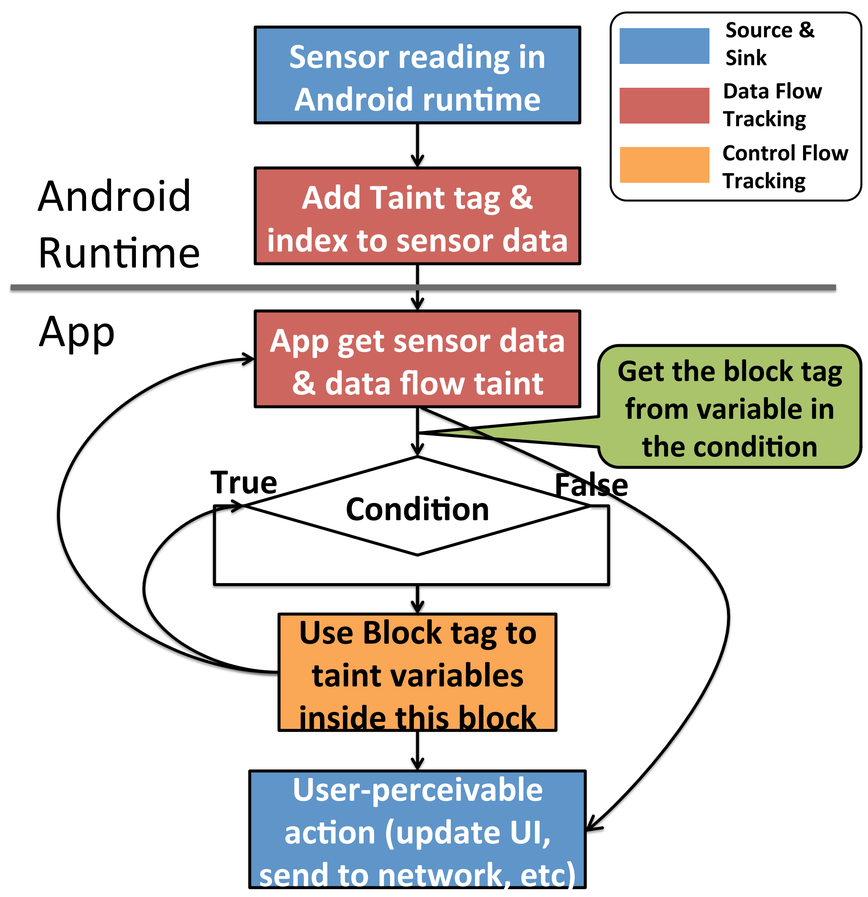
Why not static analysis?

- Difficult to analyze data and control flow in complex apps
- Runtime tracking gives us the sensor usage in real world

Challenge

- Taint tracking, used typically for privacy, only tracks data flow
- Data flow tracking alone is not sufficient to track sensor data

System Overview



* Build atop TaintDroid

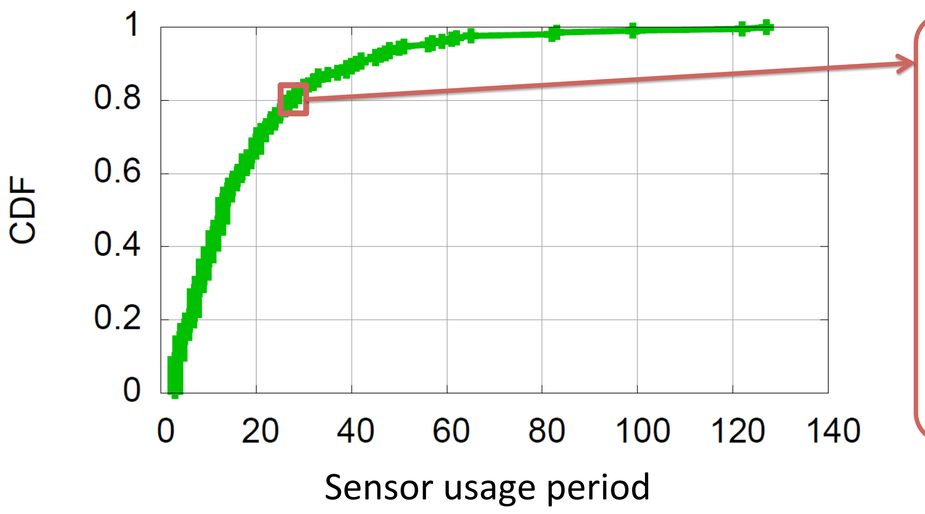
Example: Pedometer App

```
void onSensorChange(sensorEvent)
{
  val = sensorEvent.val;
  direct = signal(val);
  blockTag = getTag(val) |
getTag(direct) | getTag(lastDirect);
  if (val > THRESHOLD &&
      direct != lastDirect)
  {
    stepCounter++;
    Taint(stepCounter, blockTag);
    lastDirect = direct;
    Taint(lastDirect, blockTag);
  }

  // every 10 seconds
  updateUI(stepCounter);
}
```

Result

Using our taint tracking tool to analyze the sensor usage of the Pedometer application.



20% of the time, the app only updates once in a user-perceivable manner after 30 contiguous sensor readings.

The figure shows the Pedometer app update after how many sensor readings

Future Work

- Automatically instrument the application
- Analyze many popular off-the-shelf sensor applications
- Understand the energy implications of different sensor hub tasks

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