SensorAct: Design and Implementation of Fine-grained Sensing and Control Sharing in Buildings

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Abstract

We present the design, implementation and deployment experiences of SensorAct[1], an open source[1] federated middleware for building management. We demonstrate two main features of our system that allows 1) Device owners to grant fine-grained privileges for sharing control and sensing infrastructure with other users and 2) Users to create and schedule simple building monitoring and control applications such as actuation and notification on occurrence of building events through an intuitive user interface.

1 SensorAct Architecture

Following is a summary of features of each layer in SensorAct which we had presented in [1].

Device layer contains sensors and actuators that interact with the physical world. A device is an abstraction for existing and newly instrumented sensors and actuators within buildings.

Virtual Personal Device Servers (VPDS) layer consists of multiple instances of VPDS. Each VPDS contains (1) guard rule engine to protect resource access (2) tasklet manager to schedule and manage tasklets (lightweight scripts) (3) database for local data storage of sensor data streams (4) profile manager for user and device management and (5) APIs for devices, users, and brokers to interact with the VPDS. A VPDS is owned by a single user and may allow other users to have controlled access to sensors, actuators and its associated data.

Broker layer acts as a mediator between users and VPDS owners for sharing resources and granting non-owners with controlled access. Each broker contains a registry of users, owners and VPDS, and APIs for interaction.

User layer consists of VPDS owners and other users. Owners can share their devices and grant controlled privileges to users. Users can access devices and sensor data shared with them using diverse end applications.

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[1] https://github.com/iiitd-ucla-pc3

2 Demonstration

We will demonstrate the following major features of SensorAct that we have implemented and deployed.

Easy setup and configuration: User can easily deploy and configure VPDS and broker instances on a laptop/plug computer/server using our virtual images. Then they can configure and register their devices to the VPDS.

Sharing access and control using guard rules: VPDS owner needs to register the VPDS on a broker to share corresponding resources (sensor data, sensors and actuators) with other users. Upon registration, VPDS instance will be verified and confirmed with its owner. Then the owner creates guard rules and associates them to devices to share fine-grained (location, access time, user group, sensor value, priority based) privileges and permissions to one or multiple users. When a user (non-owner) accesses any resource on a VPDS, corresponding guard rules allow or deny the requested operation.

Lightweight tasking framework: Owners and users can create tasklets (one-shot, periodic, event-driven, and periodic and event-driven) to perform a specific building control operation. Tasklets are submitted to VPDS and are scheduled by the Tasklet manager whenever tasklet's triggering conditions are met. Tasklets can read/write sensors/actuators and their current or historic data, perform simple computations and branching and notify (via email and SMS) the users. An example tasklet can be: *Read past 5 minutes average temperature of Room1 and turn ON the Air-Conditioner if the average temperature is above 30°C* with a triggering condition *Repeat this every 2 minutes from 10AM to 6PM only on week days*.

References

[1] ARJUNAN, P., BATRA, N., CHOI, H., SINGH, A., SINGH, P., AND SRIVASTAVA, M. B. SensorAct: A Privacy and Security Aware Federated Middleware for Building Management. In *Fourth ACM Workshop On Embedded Sensing Systems For Energy-Efficiency In Buildings*, BuildSys 2012.