Using Cloud-hosted Services on a Mobile Platform for a Smart Energy Grid

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EE657
Spring 2012

Motivation

- $120 million research grant to develop an advanced energy infrastructure for LA

- USC is the largest private customer for DWP (annual 148GWh)

- GOAL: to develop environments that can regulate themselves, balancing occupant comfort with energy use

- USC Smart Grid
  - Can measure energy usage for every building at 1 minute intervals
  - Newer buildings have room-level sensors

- Need a way to communicate vast amount of data (3TB/day) to customers

Approach

- Develop an interactive and educational mobile application, interfaced with the Smart Grid

  - More engaging and effective than web apps

  - Provides easy access to configuration and management of utilities

  - Promotes voluntary energy reduction by providing personalized incentives to conserve

- Relies on cloud-hosted backend services to measure, infer, and manipulate sensor data

- Demand forecasting to predict peak loads, then select an effective response strategy to curtail energy usage
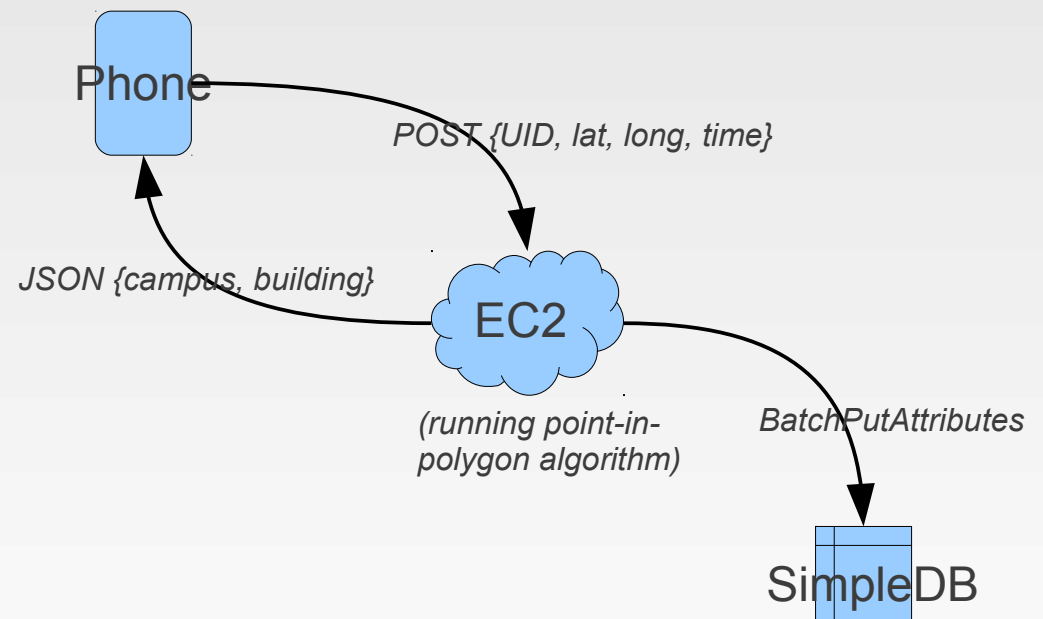
Implementation
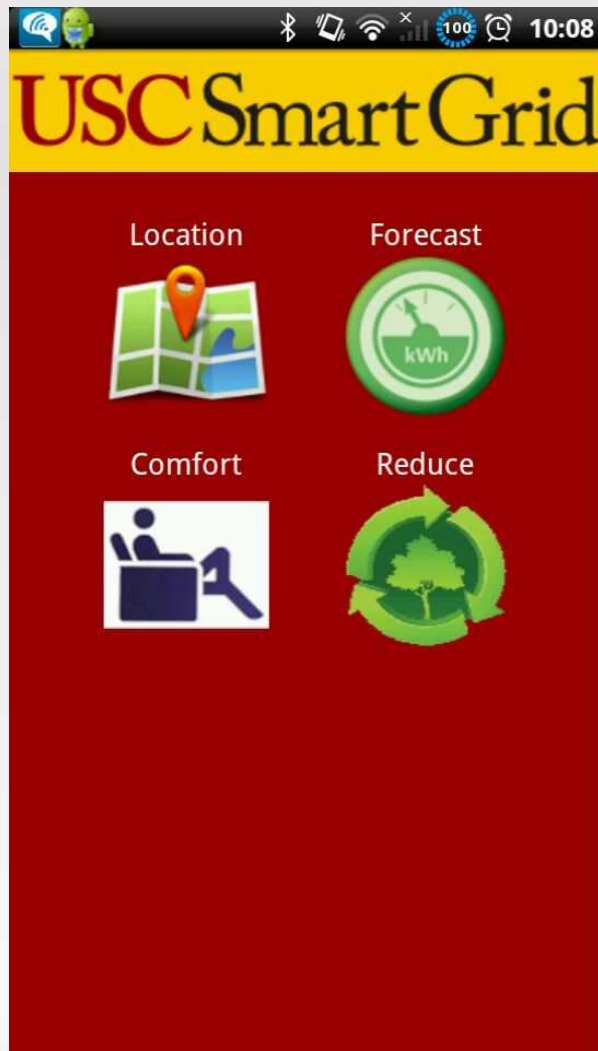
- Android OS
- AWS EC2, SDB, S3
  - Micro instance
  - 1 core, 613MB
  - SSH, HTTP ports
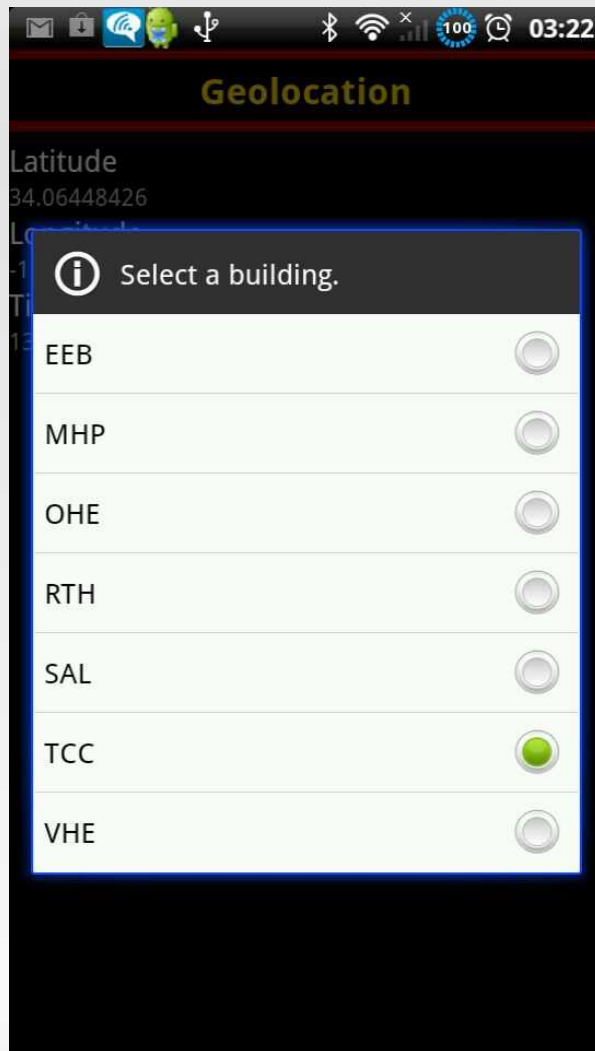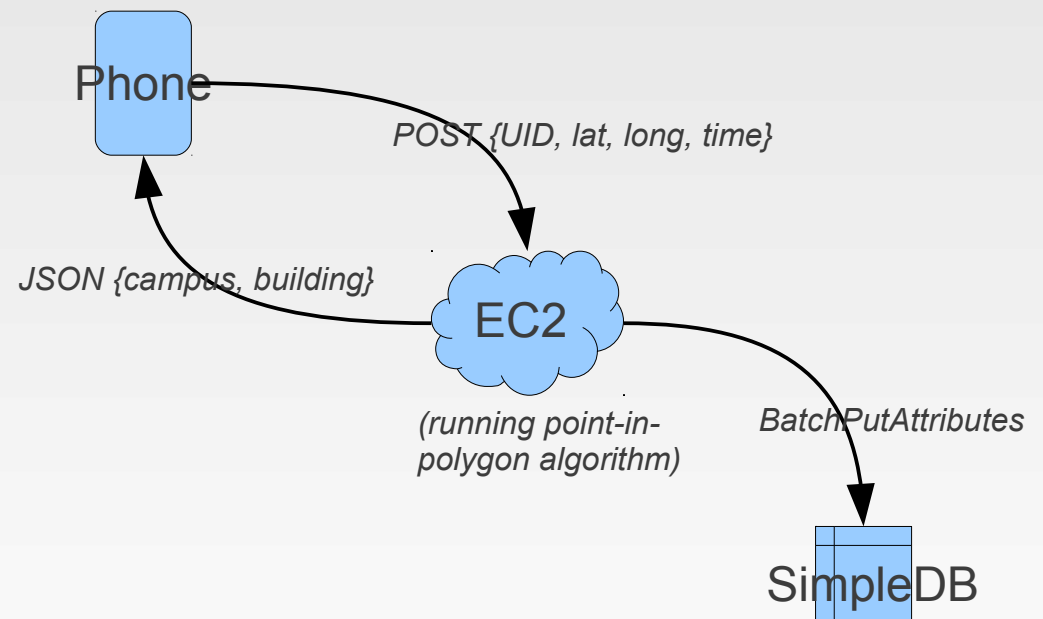 - Apache2 Webserver
  - PHP5
- Parse

Location
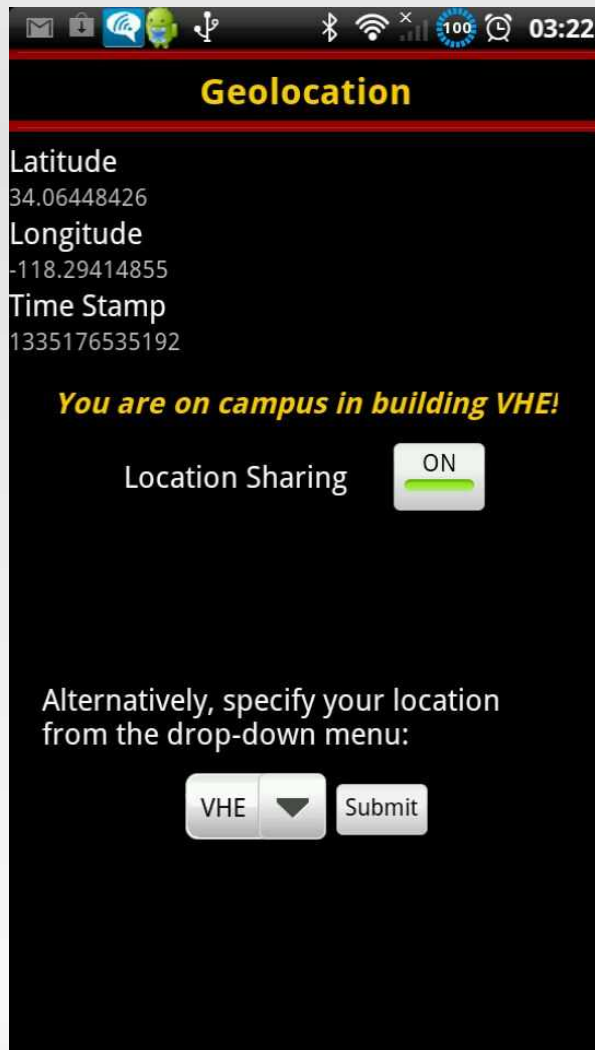
- HTTP post request with phone's GPS data
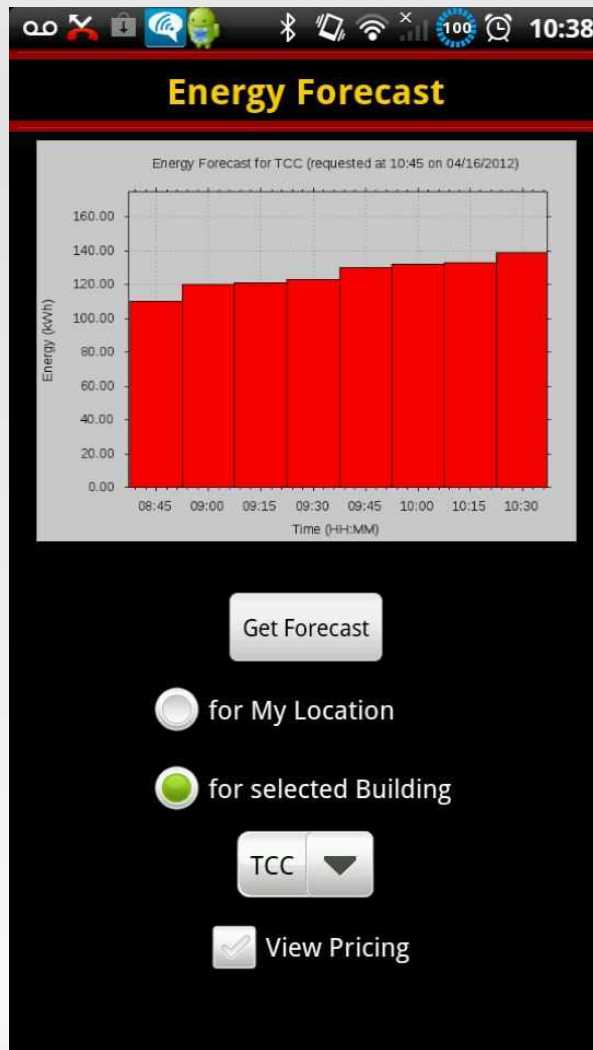- Algorithm to determine building location

Location

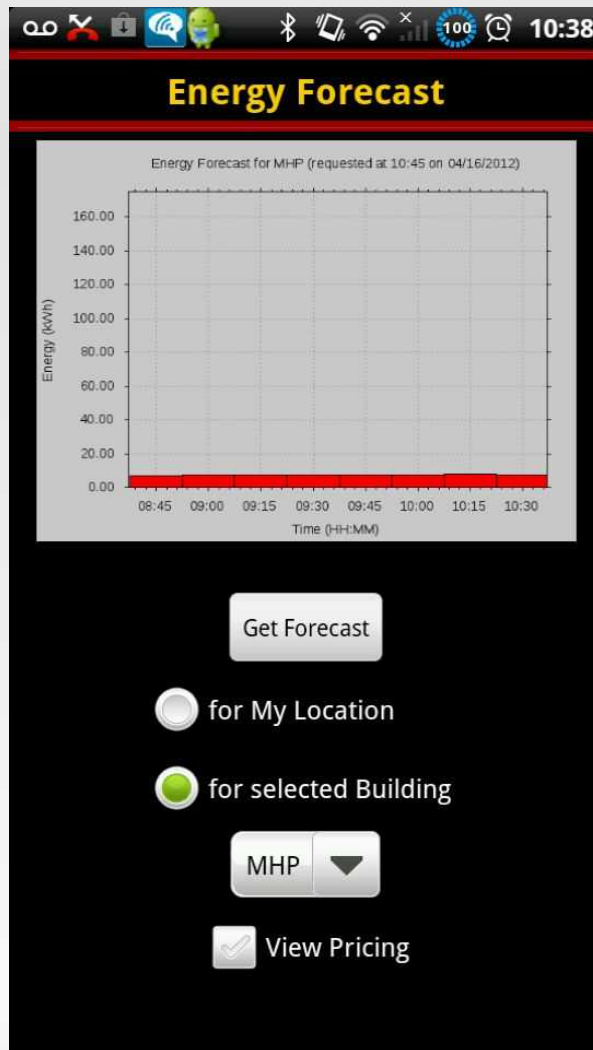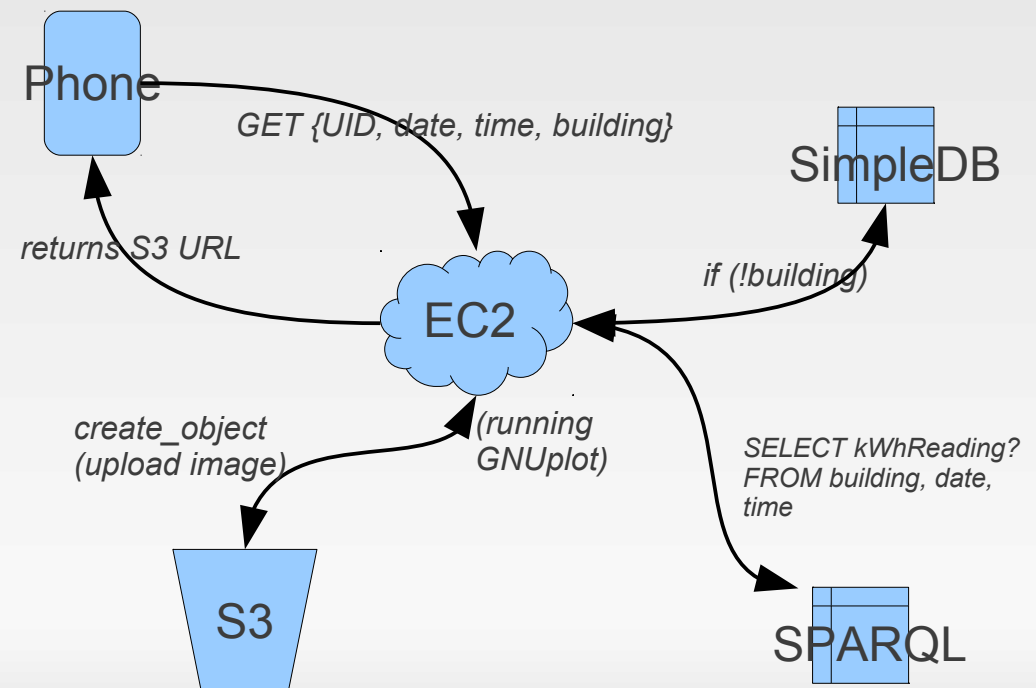- Alternatively, specify your building location and push to cloud DB

Phone

POST {UID, lat, long, time}

JSON {campus, building}

EC2

(running point-in-polygon algorithm)

BatchPutAttributes

SimpleDB

Forecast

- Queries a DB and plots real kWh readings
- Usage history/patterns, dynamic utility costs

Phone

GET {UID, date, time, building}

SimpleDB

returns S3 URL

if (!building)

EC2

create_object (upload image)

(running GNUplot)

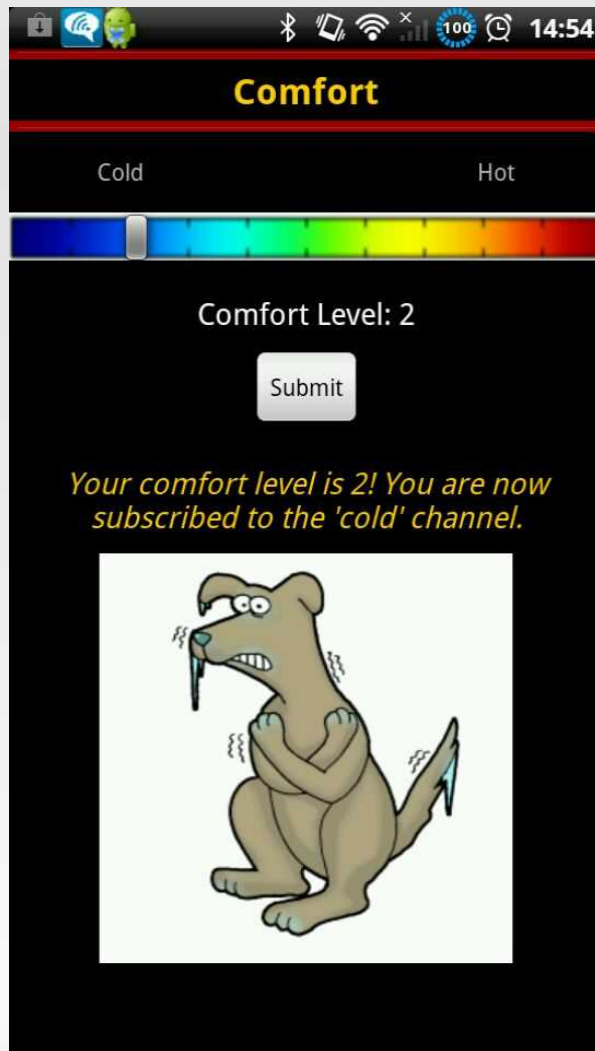SELECT kWhReading? FROM building, date, time

S3

SPARQL

Forecast

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- Usage history/patterns, dynamic utility costs

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SELECT kWhReading? FROM building, date, time
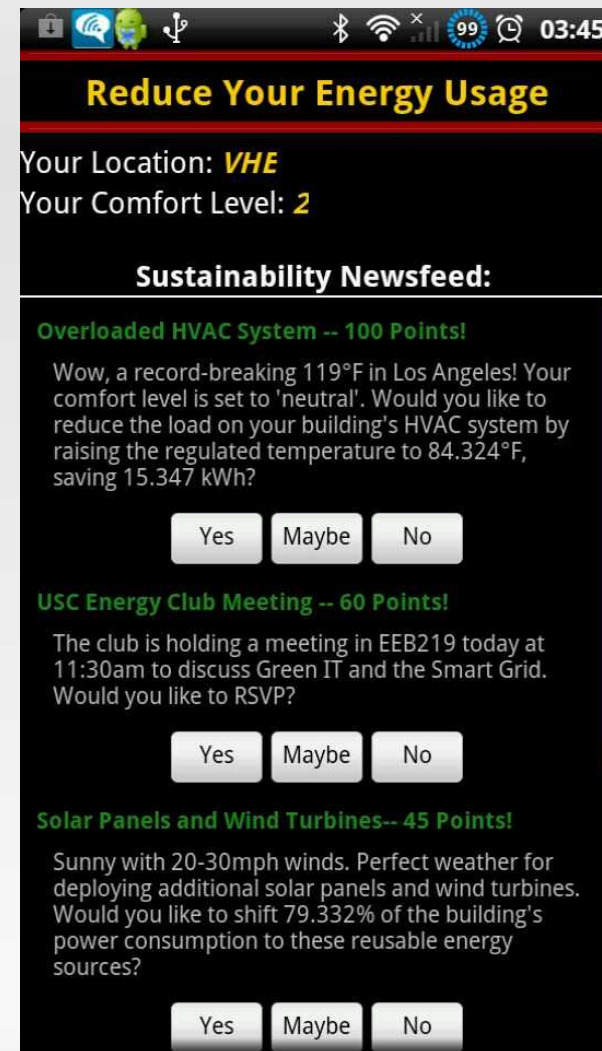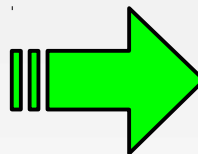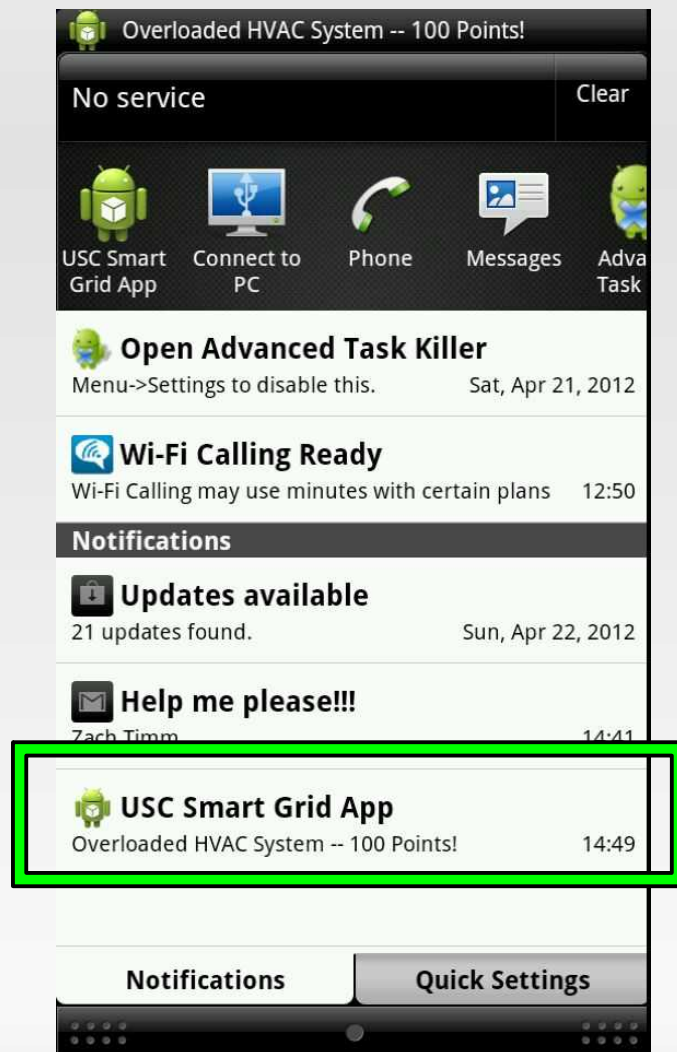
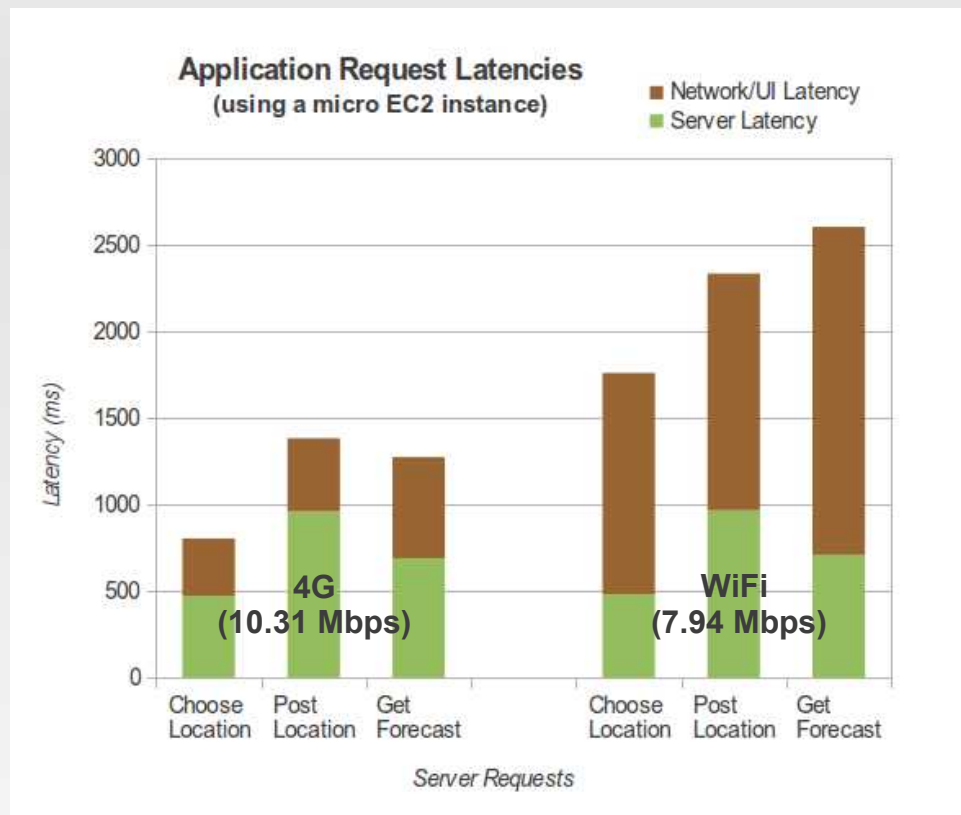**S3**

SPARQL
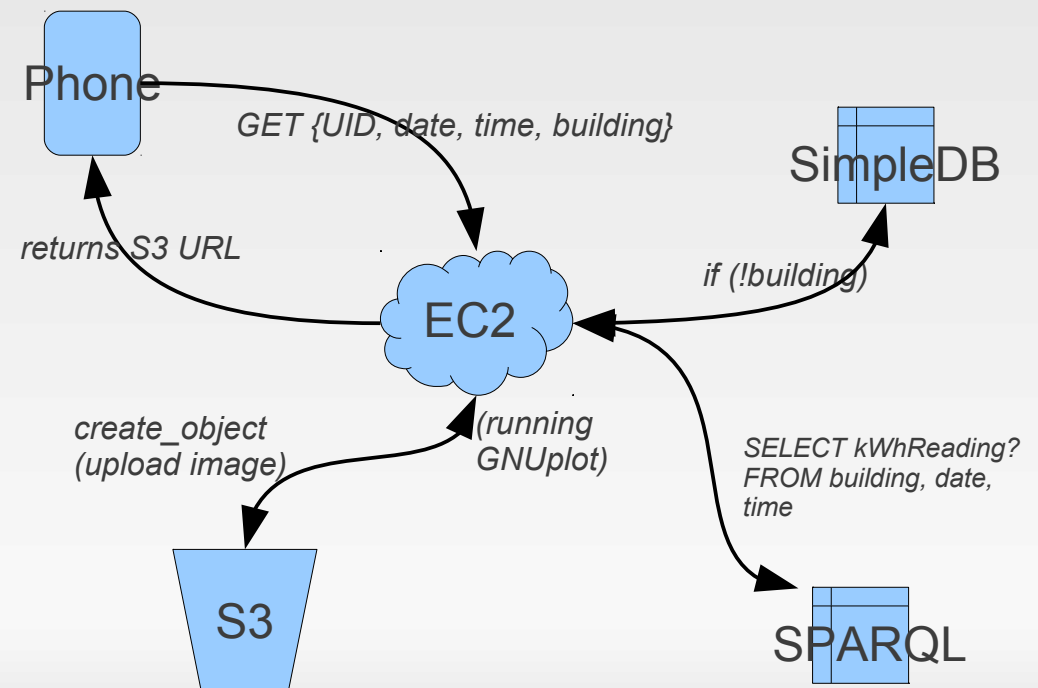
Comfort

- Allows users to save preferences to the cloud

- The Smart Grid attempts to balance user comfort and energy usage

- App subscribes to corresponding push notification channels for mass communication and personalized content delivery

Reduce

Analysis

- Scalabilty becomes an issue as the number of users increase

- Utilize cloud elasticity to handle variations in loads (server requests)

  - Launch faster or additional EC2 instances to mitigate server latency

- Network latency becomes the bottleneck!

Future Work

- Improve UI, navigation

- Implement load balancing in AWS to handle high demands and reduce latency

- Automated PUSH notifications

- Dynamic content for sustainability newsfeed

- Data privacy & security

- Enhance energy consumption monitoring

  - Room-level, device-level

  - Finer/coarser grain forecasts and history plots

  - Link with realtime cost/kWh to view and minimize utility bill

- Deploy mobile app to real users

Thank you!