End to end testing and benchmarking of appliance disaggregation

Nithin Saji
2010B5A7536P

BIDGELY

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An End to End Test runner that tests Bidgely's whole software and hardware pipeline and generates comparisons with past perfomance as well as ground truth.

What does Bidgely do ?

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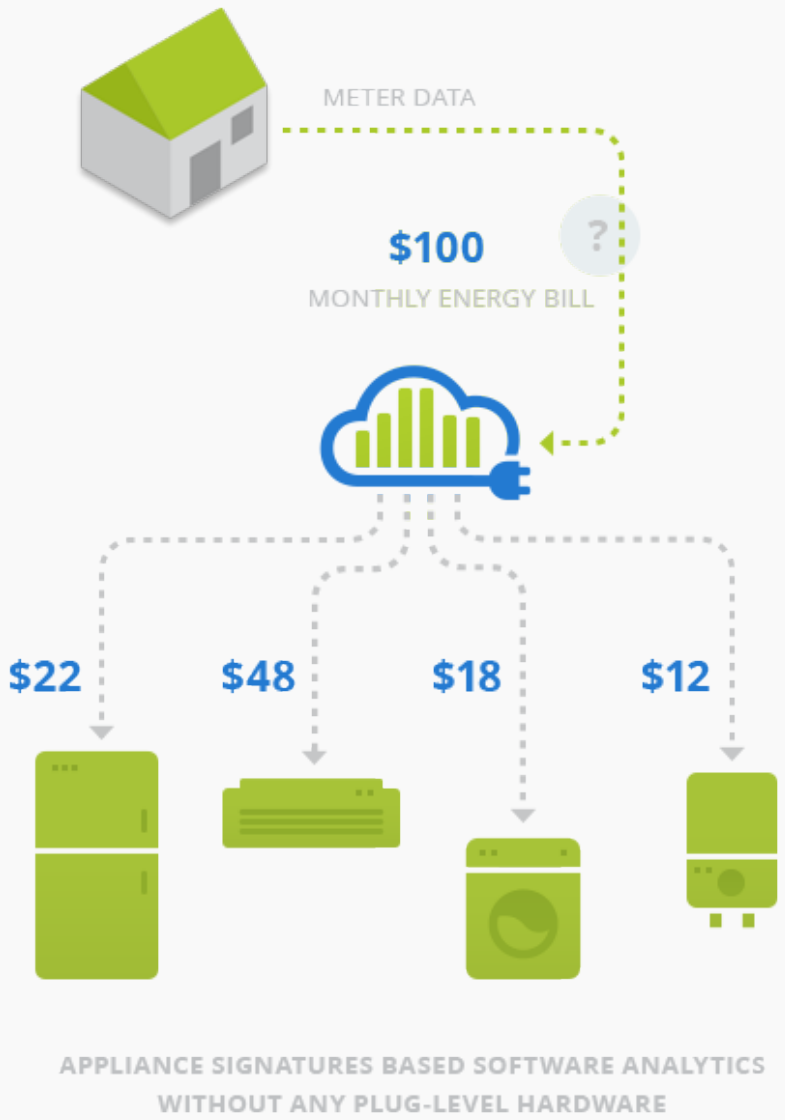


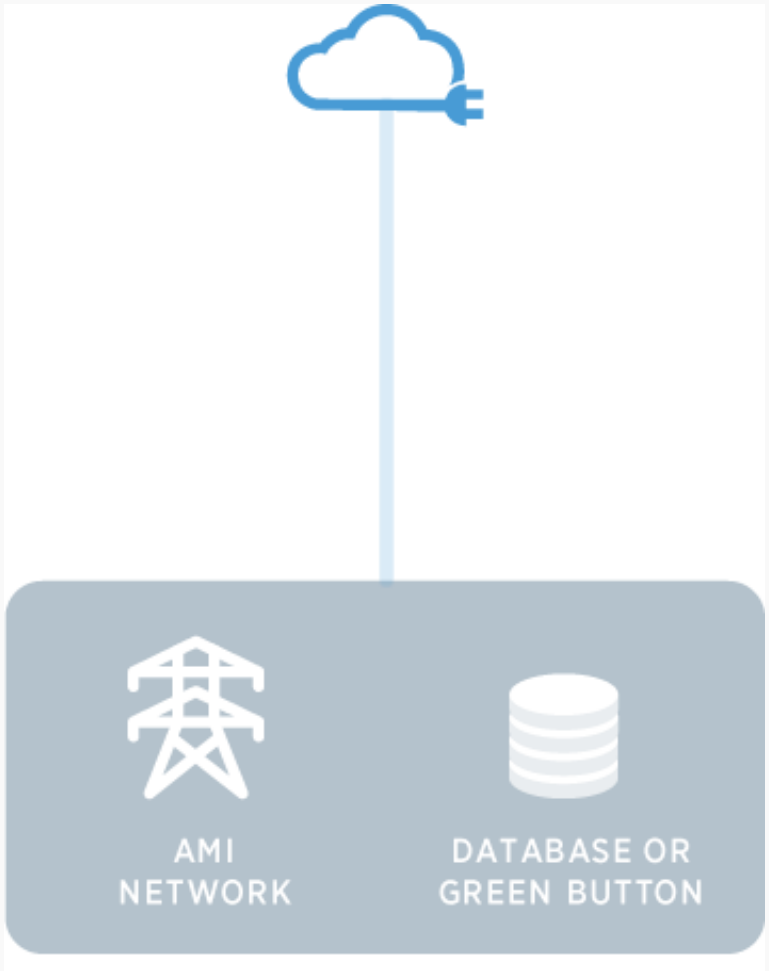
What is Disaggregation?

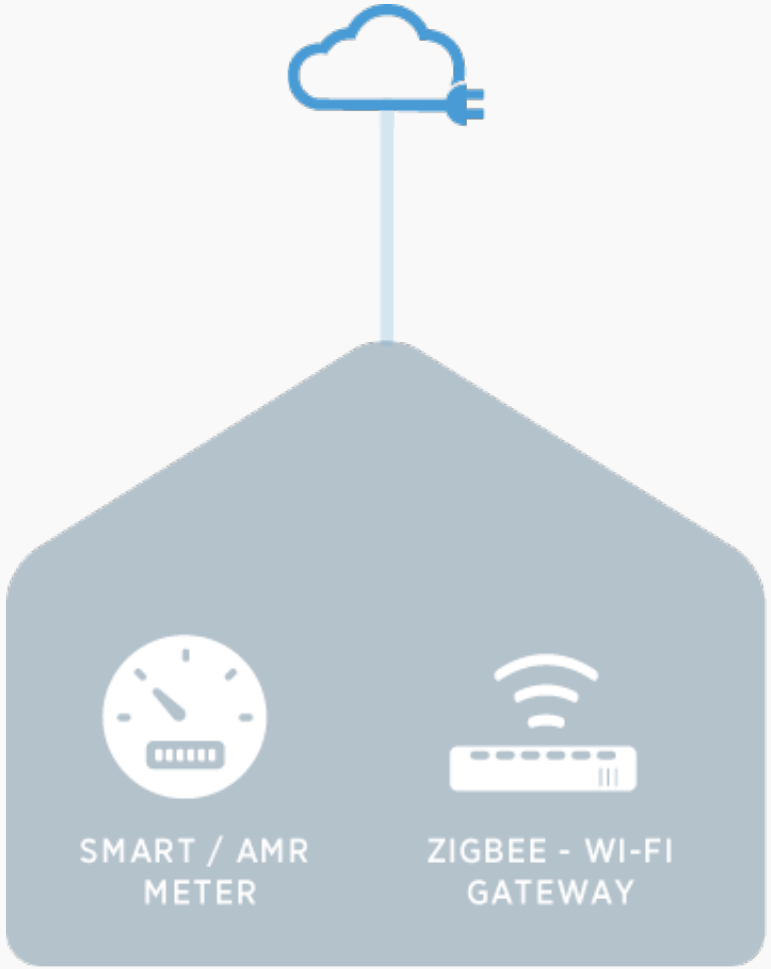
The process of analyzing changes in consumption of a home to deduce the appliances used and the individual energy consumption.

- Input: a data stream of household electricity usage from a single point (e.g.smart meter data, gateway)
- External input: Weather, temperature etc.
- Output: Amount of consumption of each major Appliance.

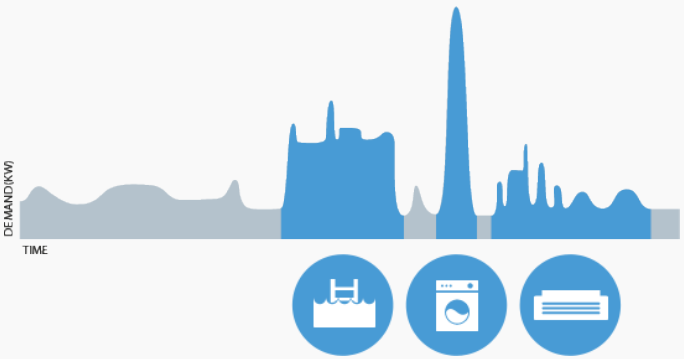
How does that work?

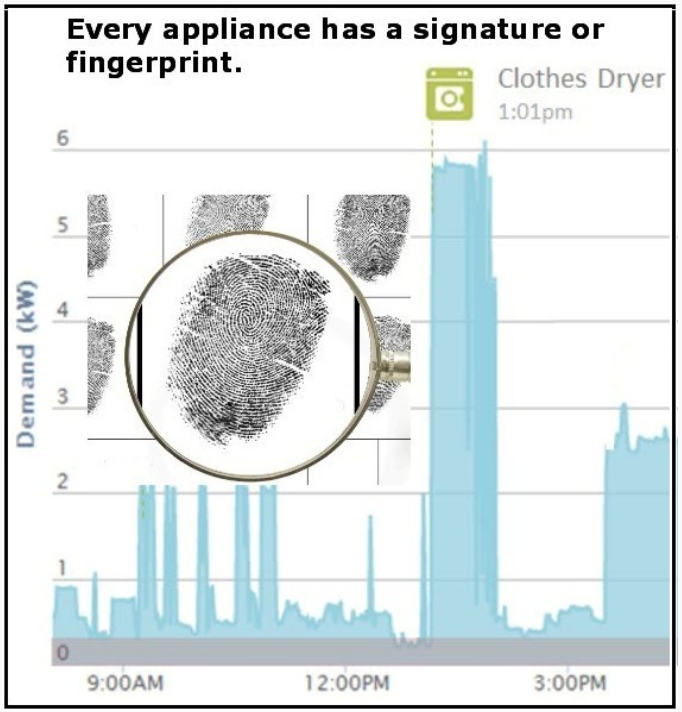
Collect Data





Learn from Data

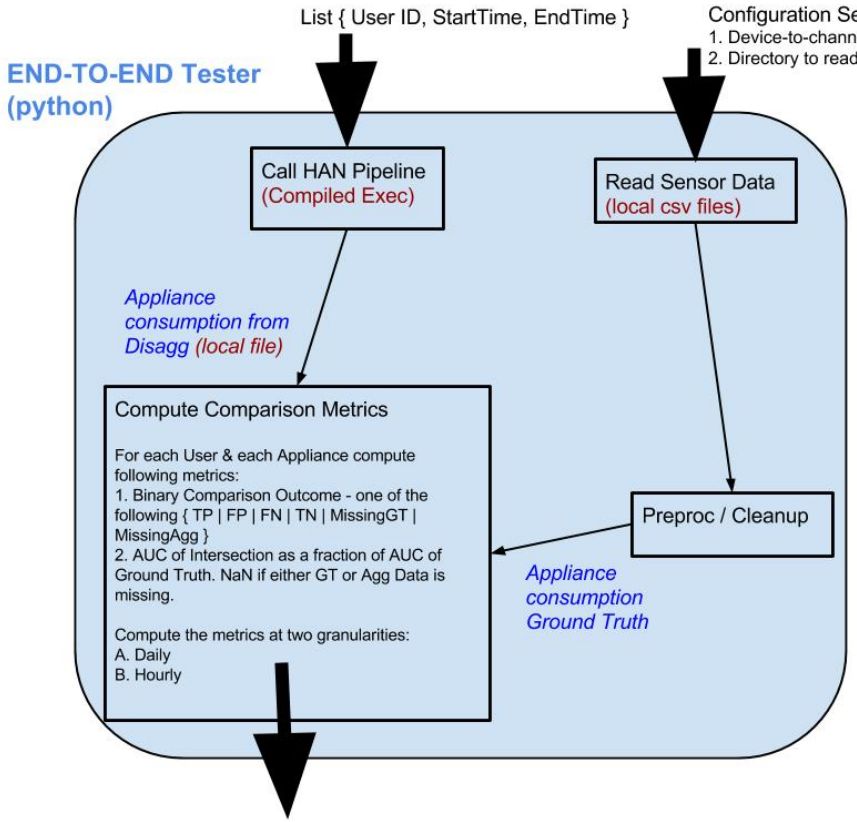




How to test and benchmark?

An end to end tester for comparing results and ground truth.

End to End Tester



Output: A set of CSV files

Two CSV files per user: one for daily, another for hourly.

Name of the csv file: <User id>_<StartTime>_<EndTime>_<daily | hourly>E2Emetrics.csv

Format of the csv file:

-- One row per epoch (epoch = day | hour)

-- Columns: Appliance Name, epoch timestamp, and the metrics listed above

Use-cases

1. Be able to quickly see disagg results for Pilots training data (with sensors)

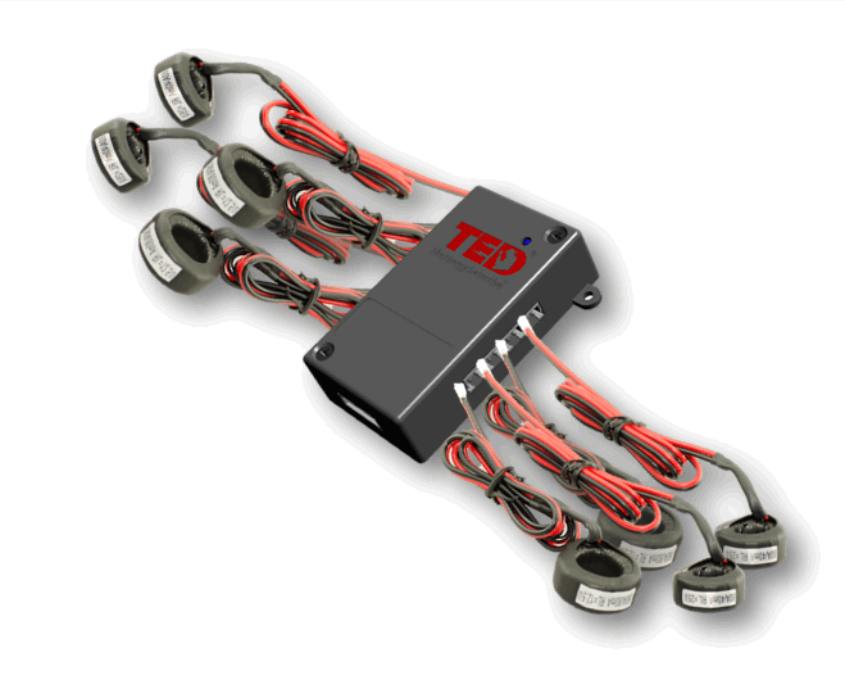
2. Have this run on-demand on a new version of algorithm, for a quick sanity-check, or for quickly getting disagg results on a set of users.

3. Have this run as a daily cron-job to create a disagg end-to-end accuracy report with the latest development branch. Goal is to catch early on any surprises that new features / bug fixes might create. A separate cron-job can create the executable from HEAD of development branch and put it in the location where this tool expects it to be.

How HAN works

Figure : Smart Energy Meter and Gateway Device

Plug level Sensors



End to End Tester design

- The tool accepts csv with the user id's and the timestamp to run the tests
- sensor vs han pipeline exec output
- sensor vs disagg from api
- hanpipeline exec output vs disagg from api
- hanpipeline exec output vs hanpipeline exec output
- disagg api vs disagg api

Syncing data

```
→ redesign git:(master) ✗ clear

→ redesign git:(master) ✗ python sync_data.py -h
usage: sync_data.py [-h] [--sync_raw] [--run_han] [--sync_ground_truth]
                    [--cluster CLUSTER] [--output OUTPUT] [--env ENV]
                    [--sync_disagg_api]
                    input_csv

Fetches data for running qa experiments from various sources, stores data in
outputdir

positional arguments:
  input_csv             Input file with uuid, tstart, tend

optional arguments:
  -h, --help            show this help message and exit
  --sync_raw, -sr       Sync raw data by first creating a sync job in dev
                        machine and copying the results back to
                        DISAGG_BASE_DIR
  --run_han, -rh        Run hanpipeline for the users, expects data to be
                        available on DISAGG_BASE_DIR
  --sync_ground_truth, -sg
                        syncs sensor data for the ground truth channels
  --cluster CLUSTER, -c CLUSTER
                        dev/prod cluster, use with sync_dissagg_api
  --output OUTPUT, -o OUTPUT
                        override output directory set in conf
  --env ENV, -e ENV     dev or prod column, use with sync_dissagg_api
  --sync_disagg_api, -sd
                        sync disagg data from cassandra
→ redesign git:(master) ✗
```

Generating metrics

bidgely@Bidgely-HP-Pavilion-15-Notebook-PC... × bidgely@Bidgely-HP-Pavilion-15-Notebook-PC... ×

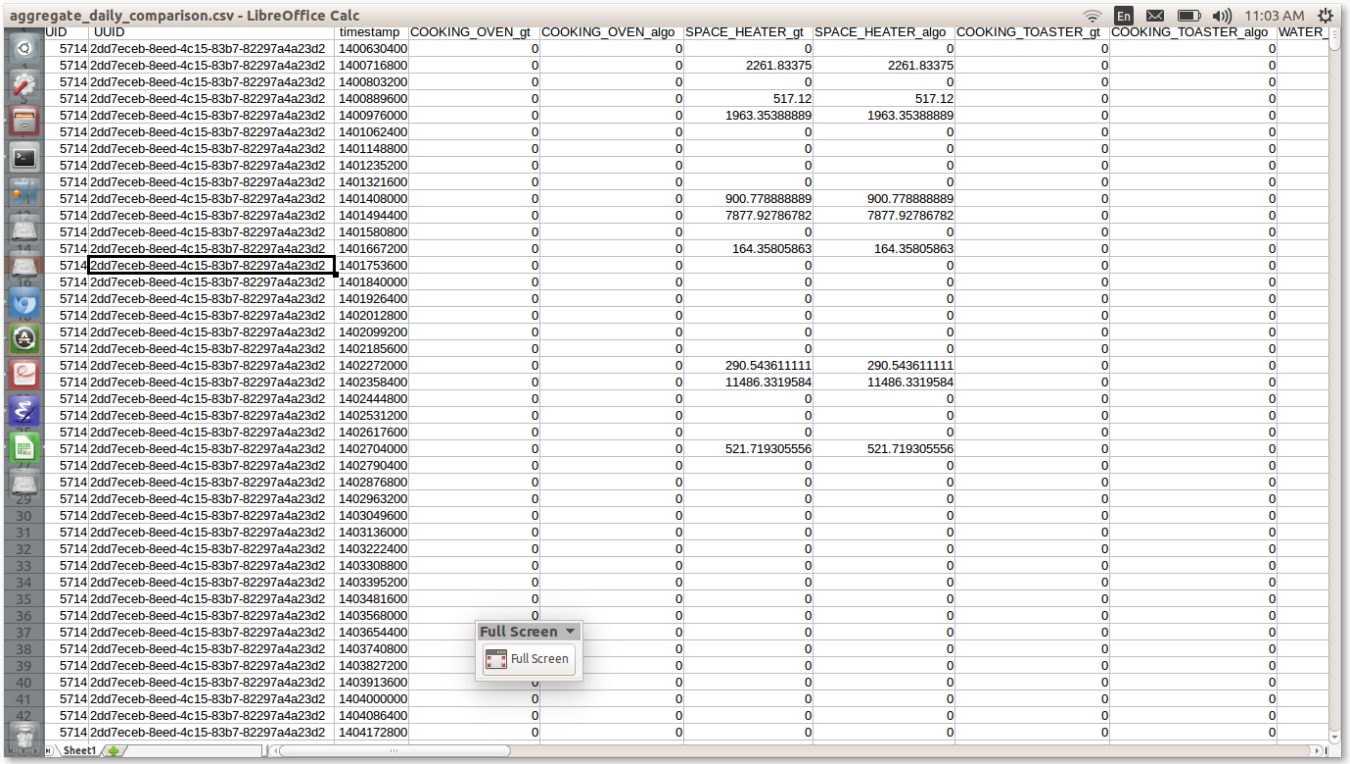
```
→ redesign git:(master) ✗ python generate_metrics.py -h
usage: generate_metrics.py [-h] [--output OUTPUT]
                           input_csv source1 source2 form

Runs the hanpipeline, converts to intermediate csv and also generates qa
metrics for dissag comparing with sensor data. keys: 1: sensor vs han pipeline
exec output 2: sensor vs disagg from api 3: hanpipeline exec output vs disagg
from api 4: hanpipeline exec output vs hanpipeline exec output 5: disagg api
vs disagg api

positional arguments:
  input_csv             Input file with uuid, tstart, tend
  source1               source against which you are comparing, reference
  source2               the source which you are going to compare against the
                        refference
  form                  a key stating what kind of comparison is going to
                        happen, check help for keys

optional arguments:
  -h, --help            show this help message and exit
  --output OUTPUT, -o OUTPUT
                        override output directory set in conf
→ redesign git:(master) ✗
→ redesign git:(master) ✗
```

Results



	UID	UUID	timestamp	COOKING_OVEN_gt	COOKING_OVEN_algo	SPACE_HEATER_gt	SPACE_HEATER_algo	COOKING_TOASTER_gt	COOKING_TOASTER_algo	WATER_
1	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1400630400	0	0	0	0	0	0	
2	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1400716800	0	0	2261.83375	2261.83375	0	0	
3	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1400803200	0	0	0	0	0	0	
4	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1400889600	0	0	517.12	517.12	0	0	
5	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1400976000	0	0	1963.35388889	1963.35388889	0	0	
6	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401062400	0	0	0	0	0	0	
7	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401148800	0	0	0	0	0	0	
8	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401235200	0	0	0	0	0	0	
9	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401321600	0	0	0	0	0	0	
10	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401408000	0	0	900.778888889	900.778888889	0	0	
11	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401494400	0	0	7877.92786782	7877.92786782	0	0	
12	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401580800	0	0	0	0	0	0	
13	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401667200	0	0	164.35805863	164.35805863	0	0	
14	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401753600	0	0	0	0	0	0	
15	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401840000	0	0	0	0	0	0	
16	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1401926400	0	0	0	0	0	0	
17	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402012800	0	0	0	0	0	0	
18	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402099200	0	0	0	0	0	0	
19	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402185600	0	0	0	0	0	0	
20	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402272000	0	0	290.543611111	290.543611111	0	0	
21	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402358400	0	0	11486.3319584	11486.3319584	0	0	
22	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402444800	0	0	0	0	0	0	
23	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402531200	0	0	0	0	0	0	
24	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402617600	0	0	0	0	0	0	
25	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402704000	0	0	521.719305556	521.719305556	0	0	
26	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402790400	0	0	0	0	0	0	
27	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402876800	0	0	0	0	0	0	
28	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1402963200	0	0	0	0	0	0	
29	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403049600	0	0	0	0	0	0	
30	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403136000	0	0	0	0	0	0	
31	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403222400	0	0	0	0	0	0	
32	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403308800	0	0	0	0	0	0	
33	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403395200	0	0	0	0	0	0	
34	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403481600	0	0	0	0	0	0	
35	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403568000	0	0	0	0	0	0	
36	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403654400	0	0	0	0	0	0	
37	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403740800	0	0	0	0	0	0	
38	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403827200	0	0	0	0	0	0	
39	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1403913600	0	0	0	0	0	0	
40	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1404000000	0	0	0	0	0	0	
41	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1404086400	0	0	0	0	0	0	
42	5714	2dd7eceb-8eed-4c15-83b7-82297a4a23d2	1404172800	0	0	0	0	0	0	

Binary comparison aggregate for a user

	A
1	SPACE_HEATER TP:11 TN:76 FP:3 FN:0 MissingGT:0 MissingAgg:0
2	CENTRAL_FURNACE TP:19 TN:65 FP:0 FN:6 MissingGT:0 MissingAgg:0
3	REFRIGIRATION TP:5 TN:85 FP:0 FN:0 MissingGT:0 MissingAgg:0
4	ALWAYS_ON TP:5 TN:85 FP:0 FN:0 MissingGT:0 MissingAgg:0
5	AC TP:26 TN:62 FP:0 FN:2 MissingGT:0 MissingAgg:0
6	COOCKING TP:12 TN:72 FP:1 FN:5 MissingGT:0 MissingAgg:0
7	CLOTHES_DRIER TP:17 TN:71 FP:0 FN:2 MissingGT:0 MissingAgg:0
8	
9	
10	

Daily stats for a user

	appliance_name	timestamp	binary	percentage	reference_consumption	source_consumption
2	SPACE_HEATER	1400630400	TN	nan	0	0
3	SPACE_HEATER	1400716800	TN	nan	0	0
4	SPACE_HEATER	1400803200	TN	nan	0	0
5	SPACE_HEATER	1400889600	TN	nan	0	0
6	SPACE_HEATER	1400976000	TN	nan	0	0
7	SPACE_HEATER	1401062400	TN	nan	0	0
8	SPACE_HEATER	1401148800	TN	nan	0	0
9	SPACE_HEATER	1401235200	TN	nan	0	0
10	SPACE_HEATER	1401321600	TN	nan	0	0
11	SPACE_HEATER	1401408000	TN	nan	0	0
12	SPACE_HEATER	1401494400	TN	nan	0	0
13	SPACE_HEATER	1401580800	TN	nan	0	0
14	SPACE_HEATER	1401667200	TN	nan	0	0
15	SPACE_HEATER	1401753600	TN	nan	0	0
16	SPACE_HEATER	1401840000	TN	nan	0	0
17	SPACE_HEATER	1401926400	TN	nan	0	0
18	SPACE_HEATER	1402012800	TN	nan	0	0
19	SPACE_HEATER	1402099200	TN	nan	0	0
20	SPACE_HEATER	1402185600	TN	nan	0	0
21	SPACE_HEATER	1402272000	TN	nan	0	0
22	SPACE_HEATER	1402358400	TN	nan	0	0
23	SPACE_HEATER	1402444800	TN	nan	0	0
24	SPACE_HEATER	1402531200	TN	nan	0	0
25	SPACE_HEATER	1402617600	TN	nan	0	0
26	SPACE_HEATER	1402704000	TN	nan	0	0
27	SPACE_HEATER	1402790400	TN	nan	0	0
28	SPACE_HEATER	1402876800	TN	nan	0	0
29	SPACE_HEATER	1402963200	TN	nan	0	0
30	SPACE_HEATER	1403049600	TN	nan	0	0
31	SPACE_HEATER	1403136000	TN	nan	0	0

Current status and post midsem plans

- Bug fixes for the end to end tester.
- A testing Suite for gateway devices.
- A Simulation Suite for creating mock data , to be used with end to end tester

Test Suite for Gateway Device

- Create mock data and feed it to a smart meter simulator.
- Connect to the meter over serial interface and check whether the data matches or not.
- Poll the cloud api's to make sure that the data is sent to cloud,
- Create a comandline interface for doing all of this.

Simulation Suite

- Bidgely doesn't have too many houses with plug level sensors.
- The data from the available plug level sensors are often contaminated.
- Can the data be simulated?

The Plan

- Model different appliances from the available data.
- The model should be designed to be tweakable to simulate different variations of appliances.
- The simulated appliances could be added up to simulate a house's load signal.

Summary

- Build a tool for comparing ground truth to the disaggregation results.
- Built tools for automating data fetching for testing and benchmarking.
- Automate more things in the future.

Questions