

Private Memoirs of a Smart Meter and Privacy for Smart Meters: Towards Undetectable Appliance Load Signatures

Outlines

Part 1: “Private memoirs of a Smart Meter”

Part 2: “Privacy for Smart Meters: Towards
Undetectable Appliance Load Signatures”

Part I

Private Memoirs of a Smart Meter

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Power reading rate:

- Dumb meters once a month
- early smart meters between 5 - 60 min
- 2010 every 1 minute
- Today less than every second

Approach:

- 2 month of data
- 3 households
- Simple clustering and pattern recognition techniques
- Power Activity logs

Table 1. Private questions and answers that fine-grained power consumption data reveals.

| Question | Pattern | Granularity |
|---------------------------------------|--|--------------------|
| Were you home during your sick leave? | Yes: Power activities during the day No: Low power usage during the day | Hour/Minute |
| Did you get a good night's sleep? | Yes: No power events overnight for at least 6 hours No: Random power events overnight | Hour/Minute |
| Did you watch the game last night? | Yes: Appliance activity matching TV program No: No power event in accordance with game showtime | Minute/Second |
| Did you leave late for work? | Yes: Last power event time later than Google maps estimated travel time No: Last power event time leaves enough time for commute | Minute |
| Did you leave your child home alone? | Yes: Single person activity pattern No: Simultaneous power events in distinct areas of the house | Minute/Second |
| Do you eat hot or cold breakfast? | Hot: Burst of power events in the morning (microwave/coffee machine/toaster) Cold: No power event matching hot breakfast appliances | Second |

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“with fine-grained reading comes
great responsibility”

Setup:

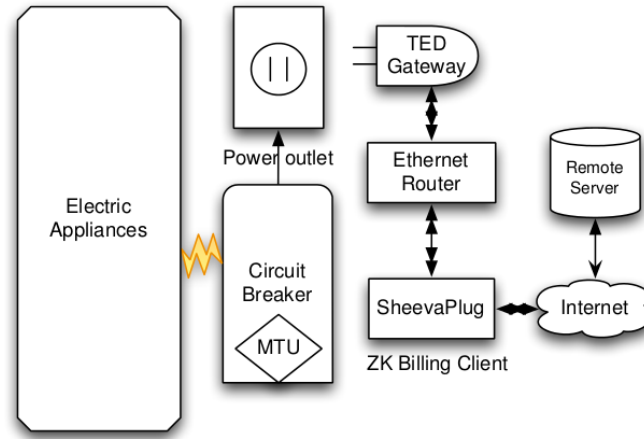


Figure 1. Our architecture using TED monitors/gateways and SheevaPlug computers.

Analysis done in four steps

- Label Power Events
- Tag Power Events
- Filter Automated Appliances
- Map Events to Real Life Events

Label Power Events

- Density based clustering algorithm
- power tuples (t,p) \rightarrow power segments

Tag power Events

```
- power_segment(label, start_time,  
                average_power,  
                duration,  
                power_step,  
                shape_label)
```

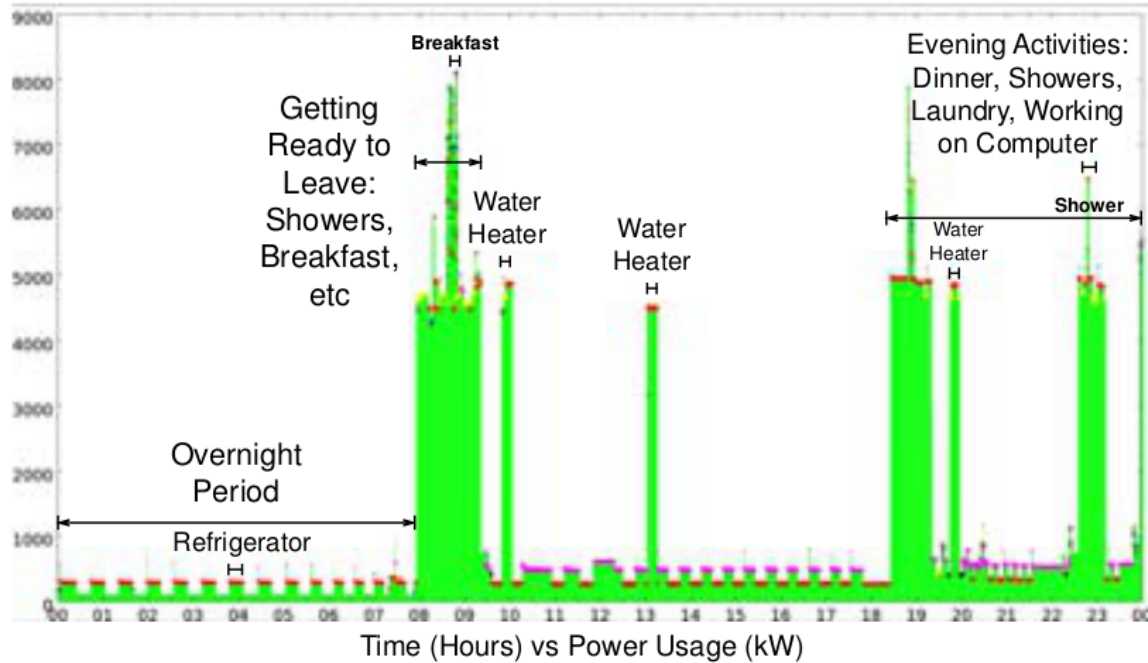


Figure 2. Example day-long second-level power trace with labels from the day's activity log.

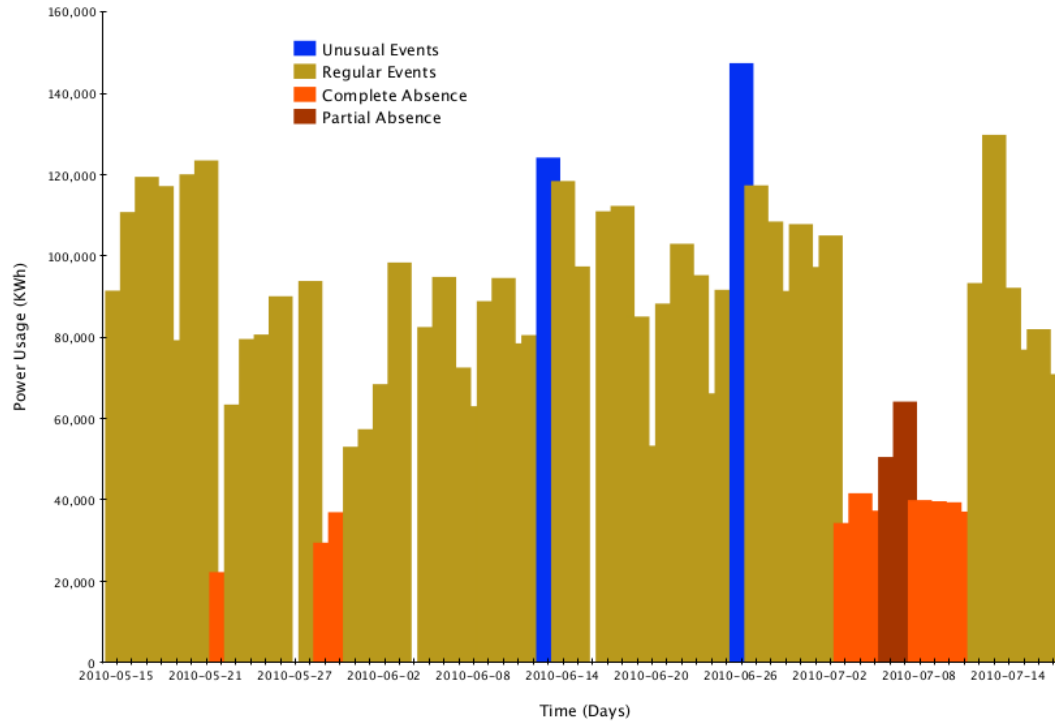


Figure 4. Low power periods correspond to little human activity over our two-month trace for one home.

Filter Automated Appliances

- Find low human activity periods
- Isolate the power signatures

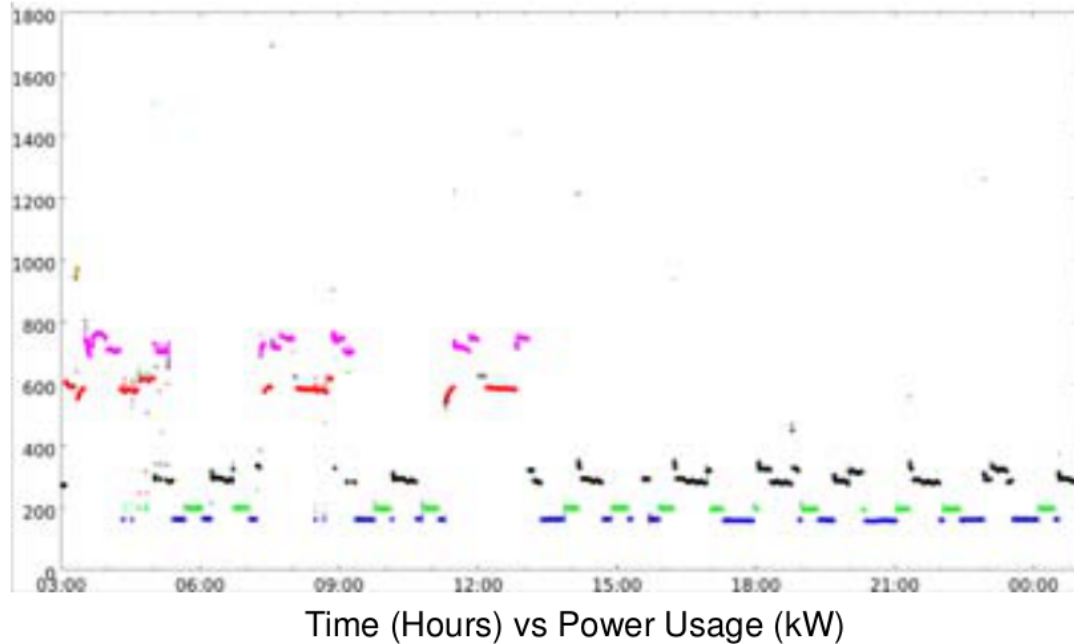


Figure 5. Power signatures for a dehumidifier and an air re-circulator. Note that the dehumidifier shuts off after it fills up.

Map Events to Real Life

- Possible to identify patterns of recurring clusters
- Filter out groups of power segments

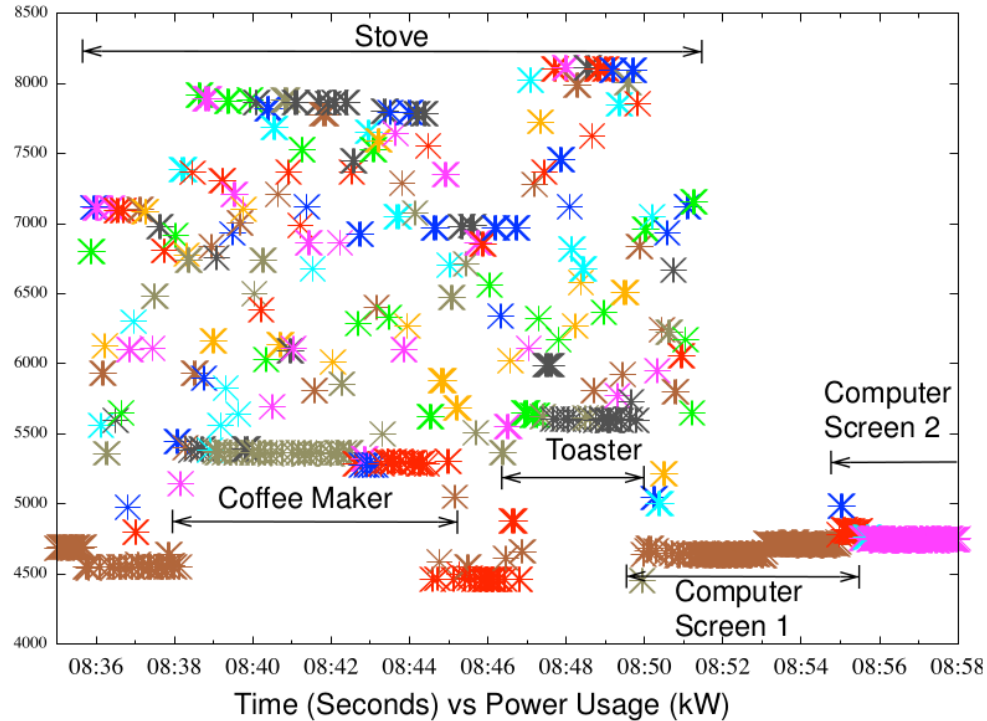


Figure 6. Power segments from eating breakfast. The clustering algorithm automatically generates the color scheme. The labels are from our activity logs.

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Part II

Privacy for Smart Meters: Towards Undetectable Appliance Load Signature

By: Georgios Kalogridis, Costas Efthymiou, Stojan Z. Denic, Tim A. Lewis and Rafael Cepeda

Toshiba Research Europe Limited

System overview assumes that future homes has

- variety of energy storage
- power generating devices
- that electrical power routing is feasible

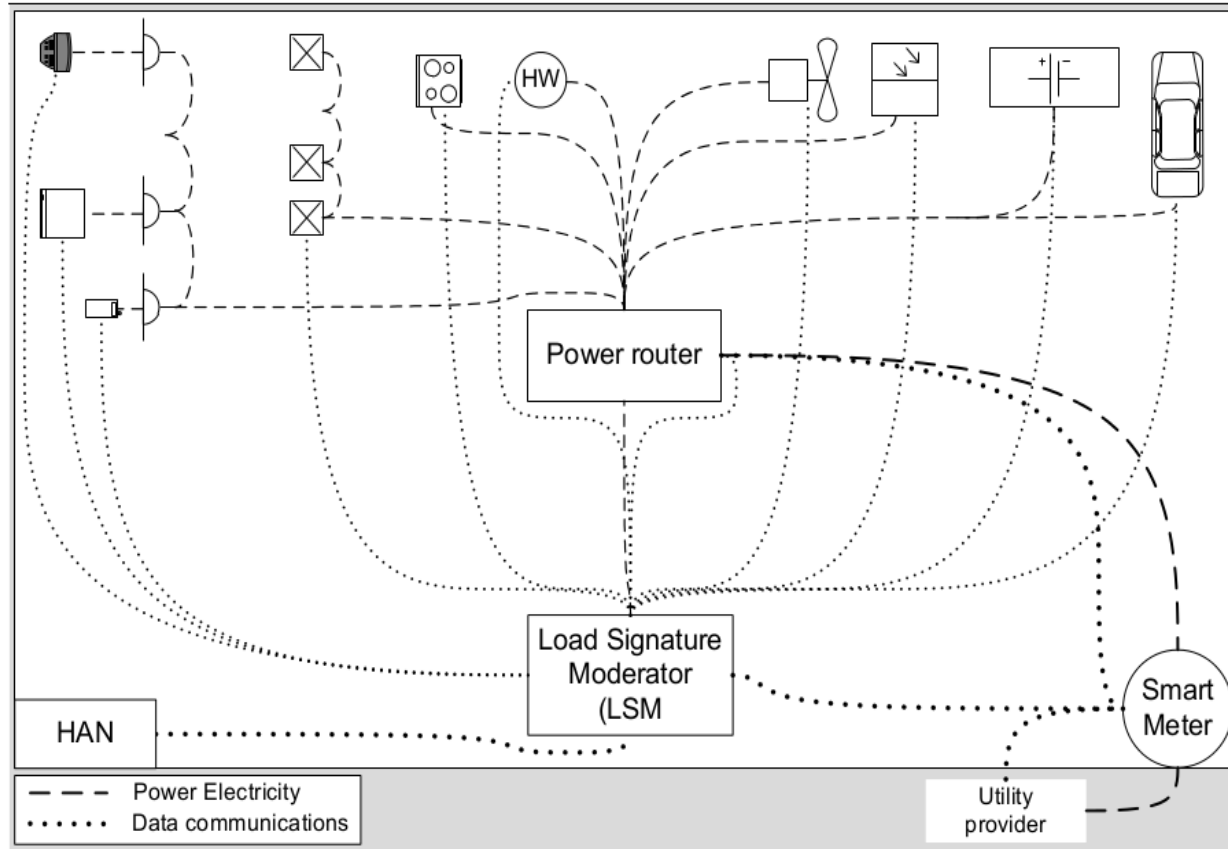


Fig. 1. System overview

Home Area Network (HAN)

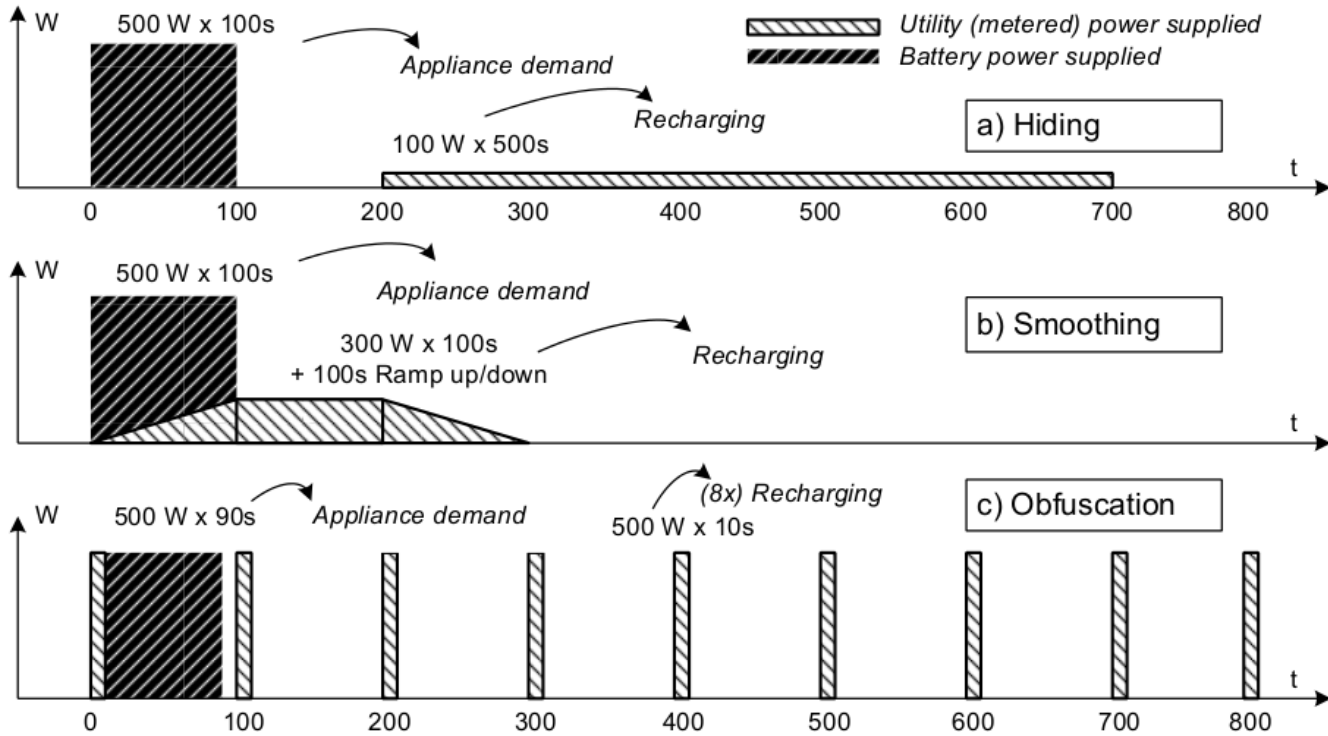
- could help to communicate between smart devices
- smart devices could negotiate time for scheduling from the Load Signature Moderator Unit

Routing of power

- A kettle drawing 2 kW
 - 1 kW from solar panel
 - 0.5 kW from a battery
 - 0.5 kW from the electrical grid

Power mixing using battery

- the power to the devices is taken from a rechargeable battery



Thank you for listening

Question?