A Consumer-Centric Architecture for Energy Data Analytics

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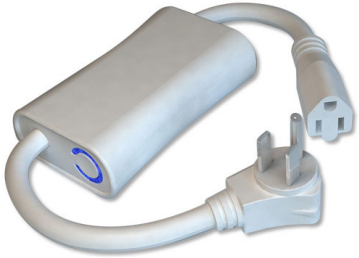
Home Energy Data



Smart Meter Deployments

Electricity

Gas

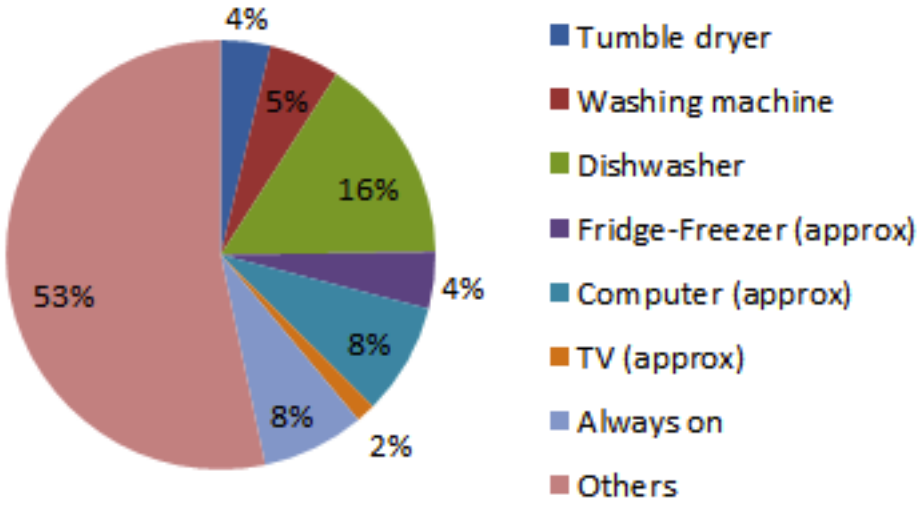
Water

Trials

Projects

Energy Retail Association

Energy Data Use



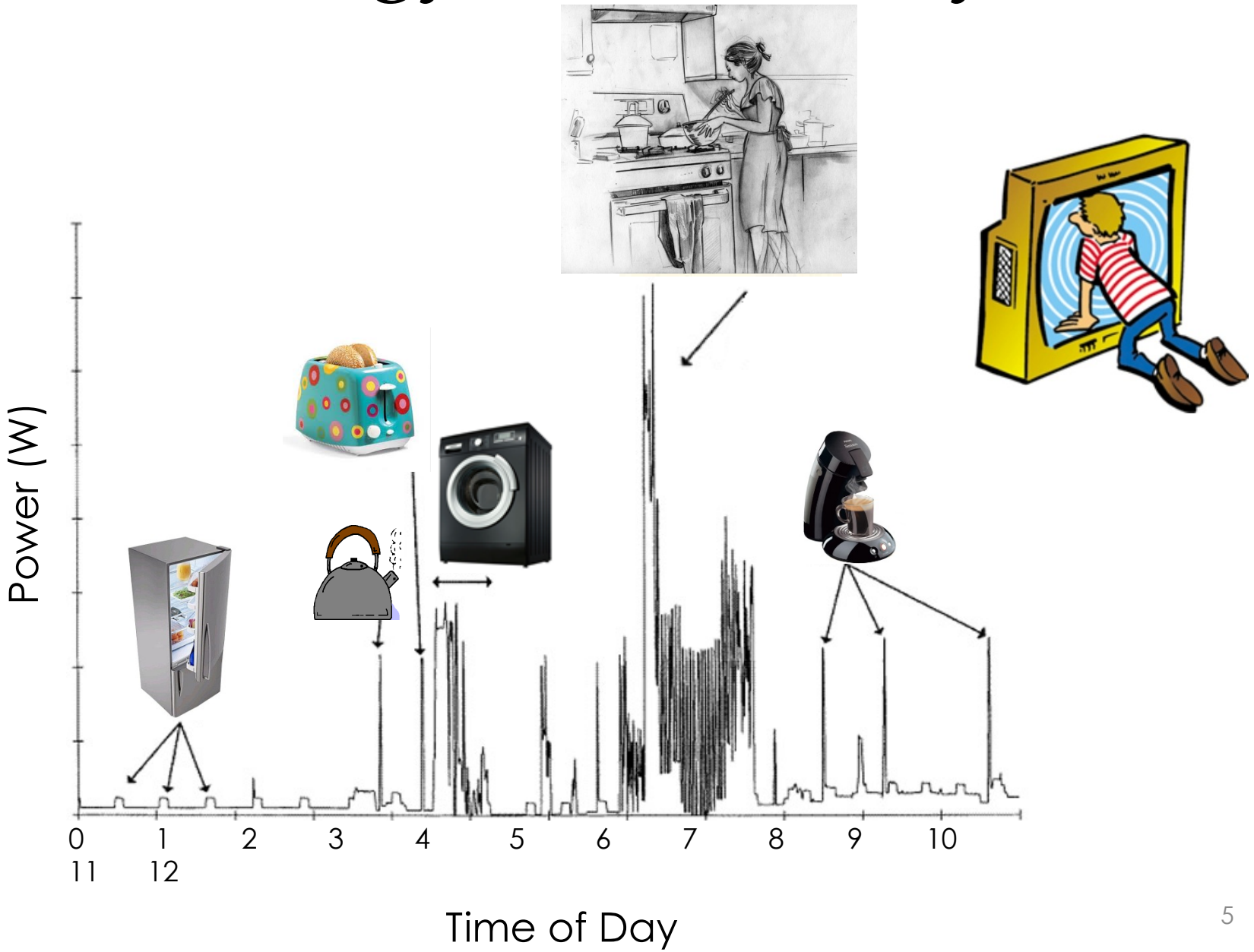
E-mail

"Your decade-old furnace is in-efficient and is costing you an additional $400 a year. Click here to see replacement options."

Text Message

"It is unusual for your oven to be on at this time of day. Would you like to turn it off ? Click Yes/No"

Energy Data Privacy



Current Situation

News

Power struggle: Texas woman uses gun to stop utility worker

- Utility websites
- Google Powermeter
- Microsoft Hohm
- Green Button

"Our constitution allows us not to have that kind of intrusion on our personal privacy"

"They'll be able to tell if you are running your computer, air conditioner, whatever it is"

Problems

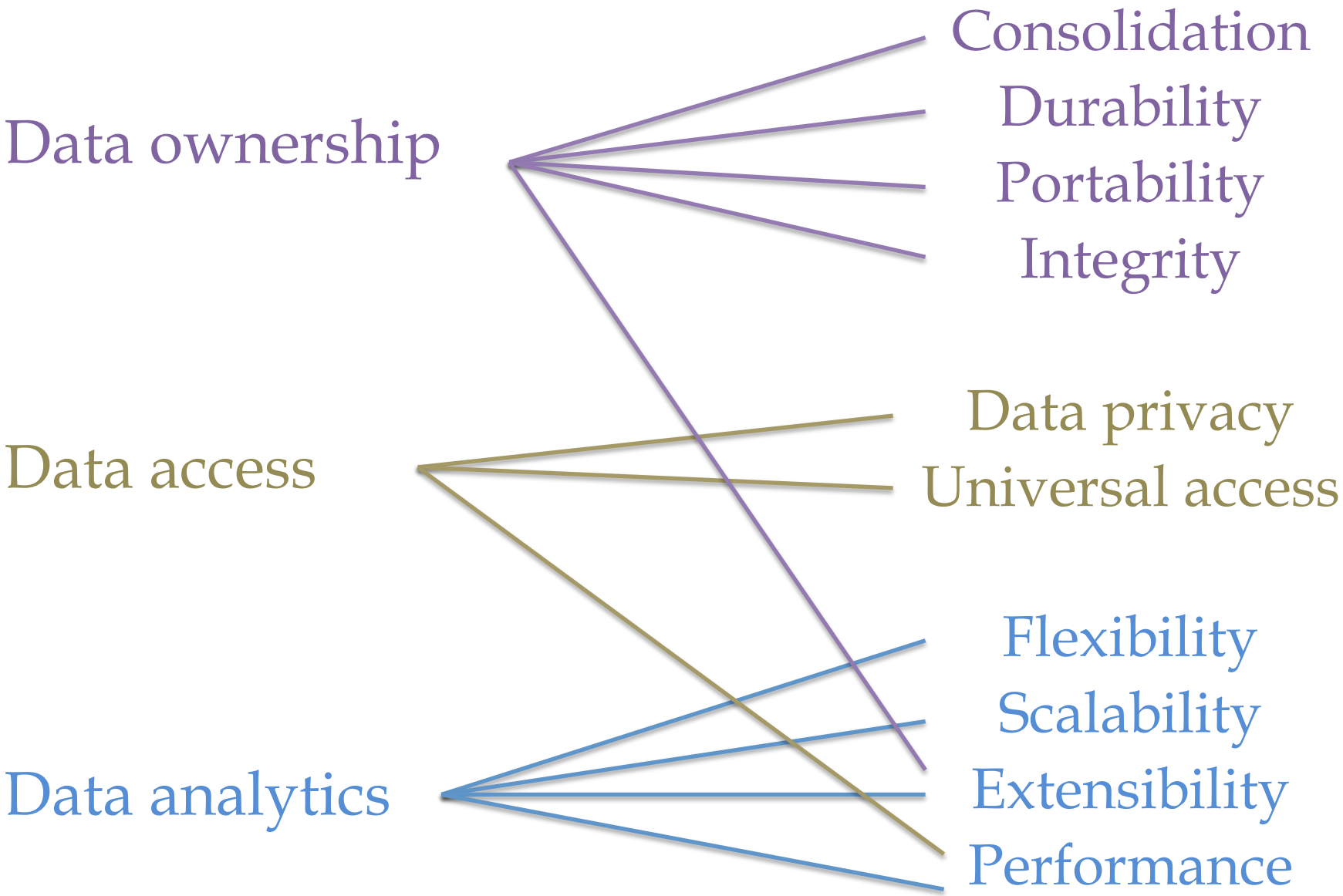
Data privacy loss

Frozen innovation in analytics

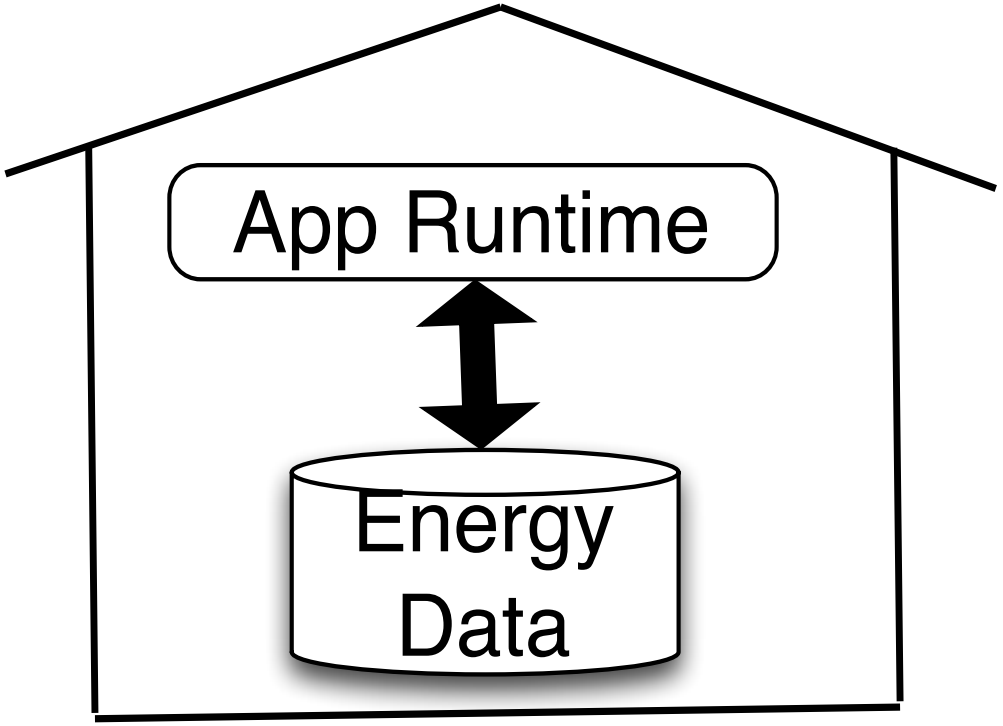
Microsoft® hohm™ beta POWERMETER

No *data ownership* or *control*

Goals


Data ownership
Data access
Data analytics
Consolidation
Durability
Portability
Integrity
Data privacy
Universal access
Flexibility
Scalability
Extensibility
Performance

Approach 1



Privacy, portability, ...

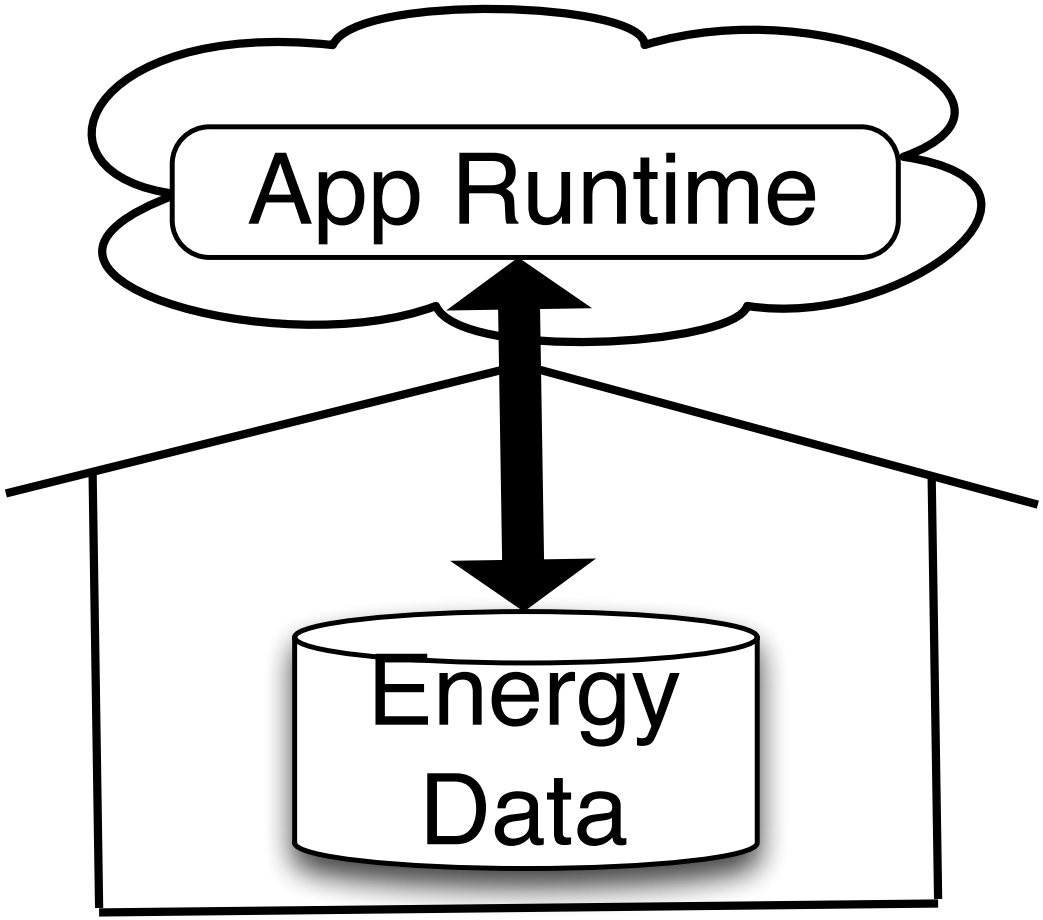
Scalability*

Extensibility*

Consolidation

Durability

Approach 2



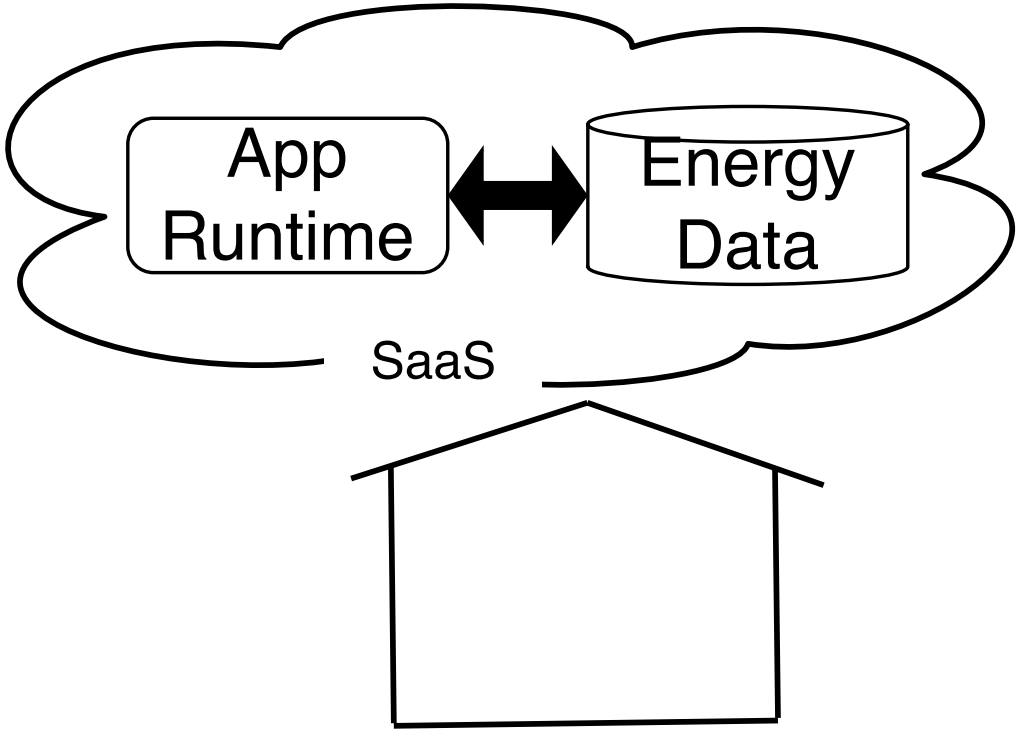
Scalability, ...

Privacy*

Consolidation

Durability

Approach 3



Universal Access, …

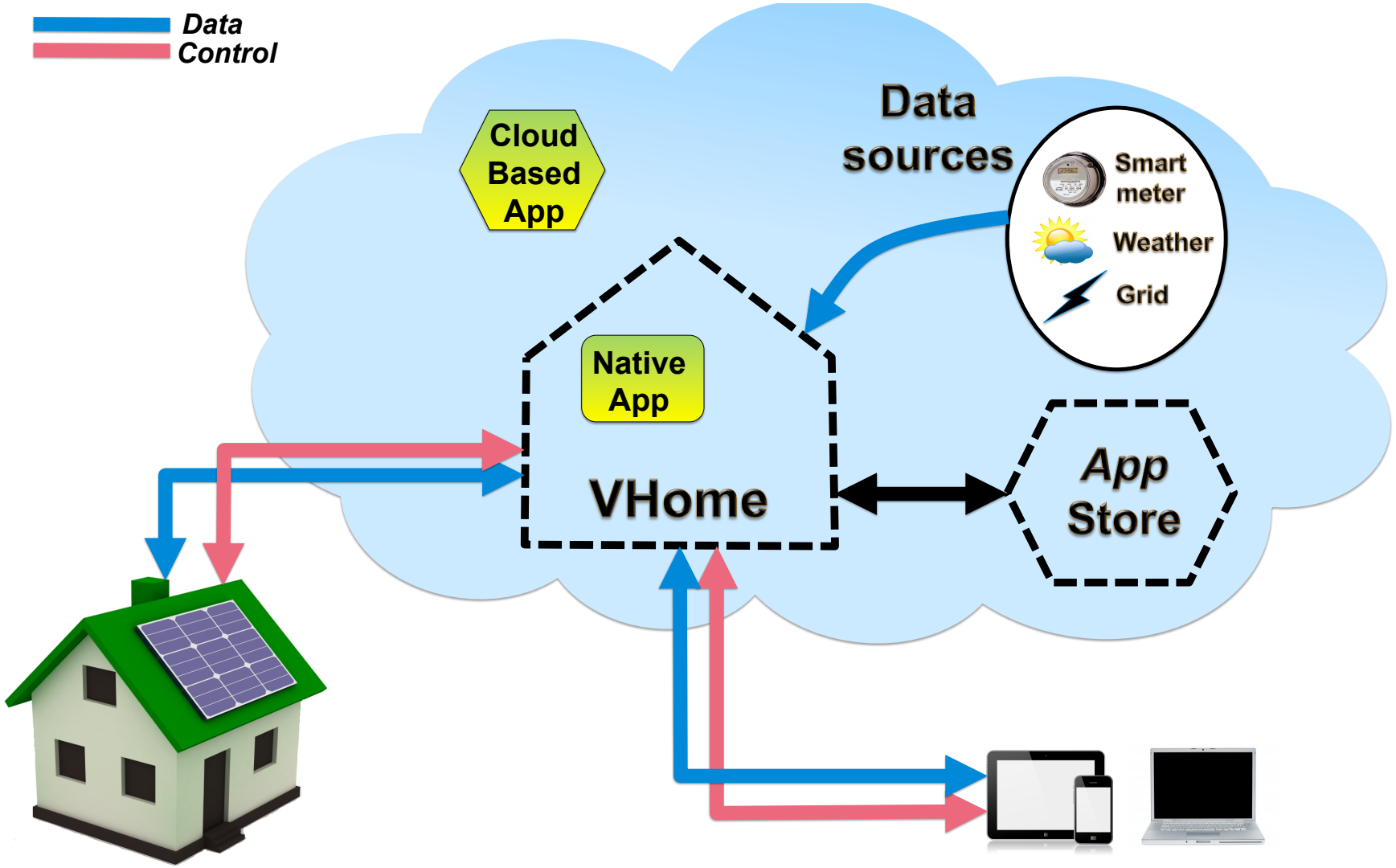
Privacy

Extensibility

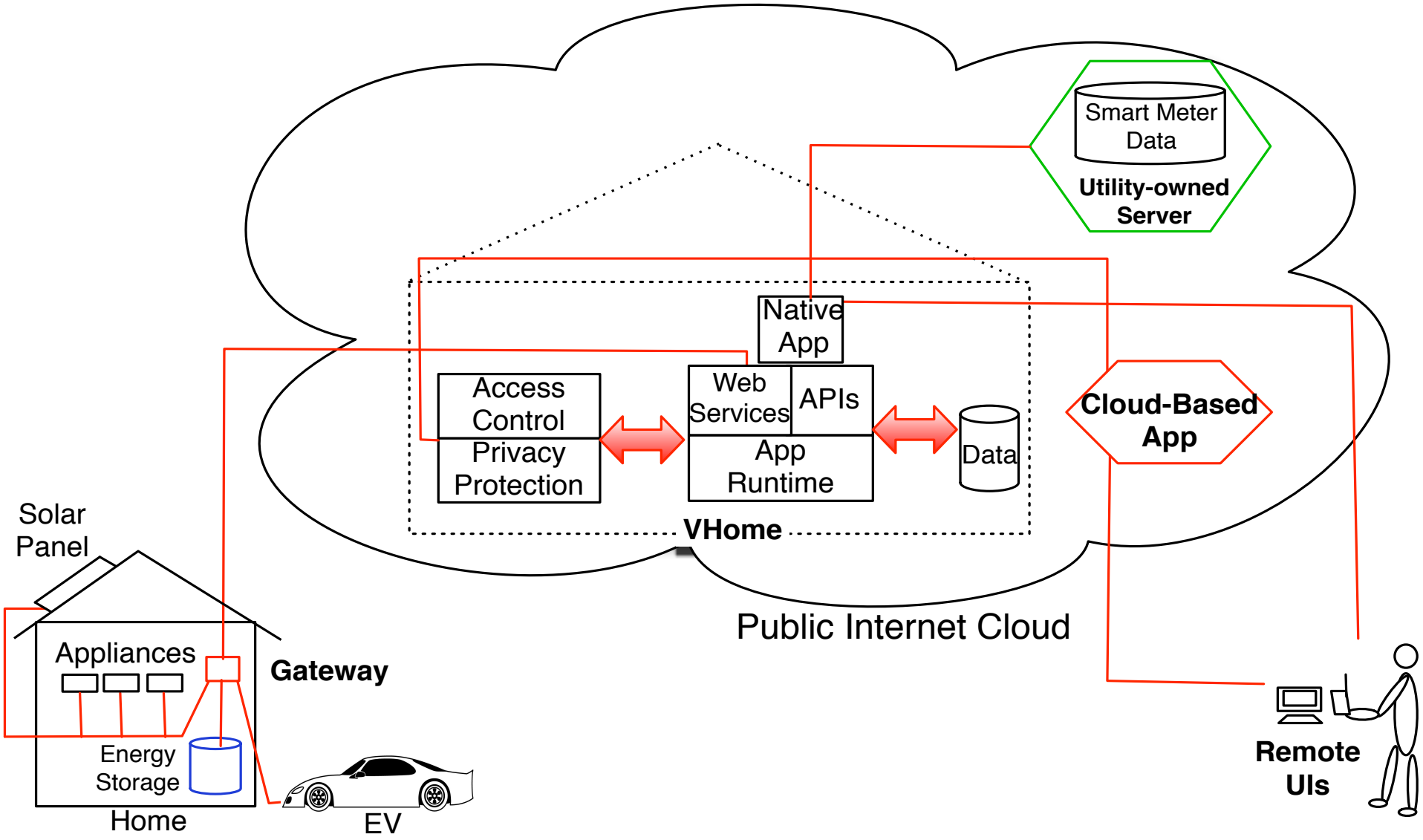
Flexibility

Microsoft hohm beta POWERMETER

Proposed Architecture

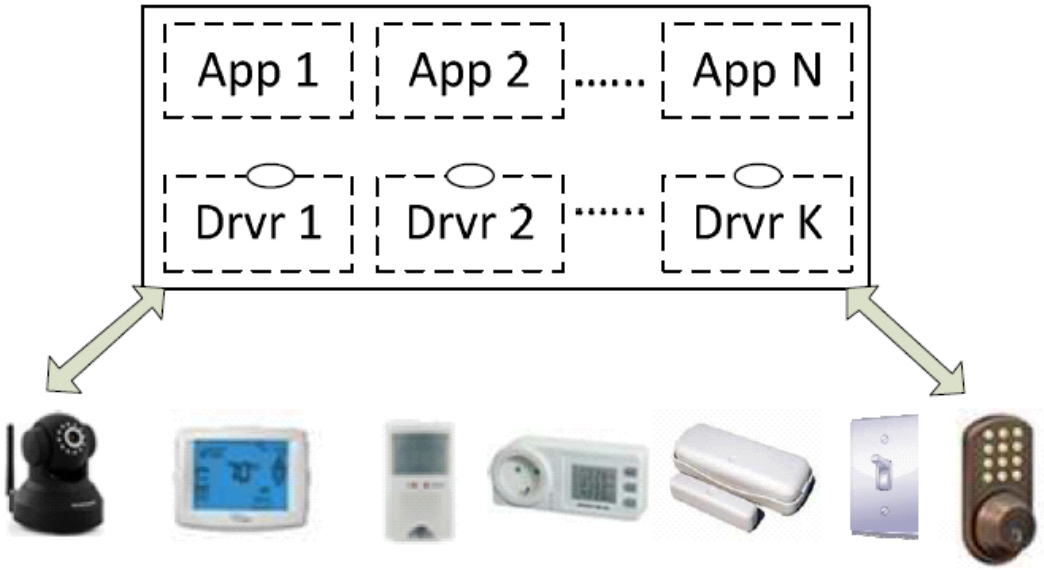


Proposed Architecture



Implementation

Gateway: Microsoft HomeOS



Dixon, C., Mahajan, R., Agarwal, S., Brush, A., Lee, B., Saroiu, S., & Bahl, V. (2012). An operating system for the home. Proc. NSDI 2012.

Implementation

Gateway: Microsoft HomeOS

- Driver modules

- Communication module

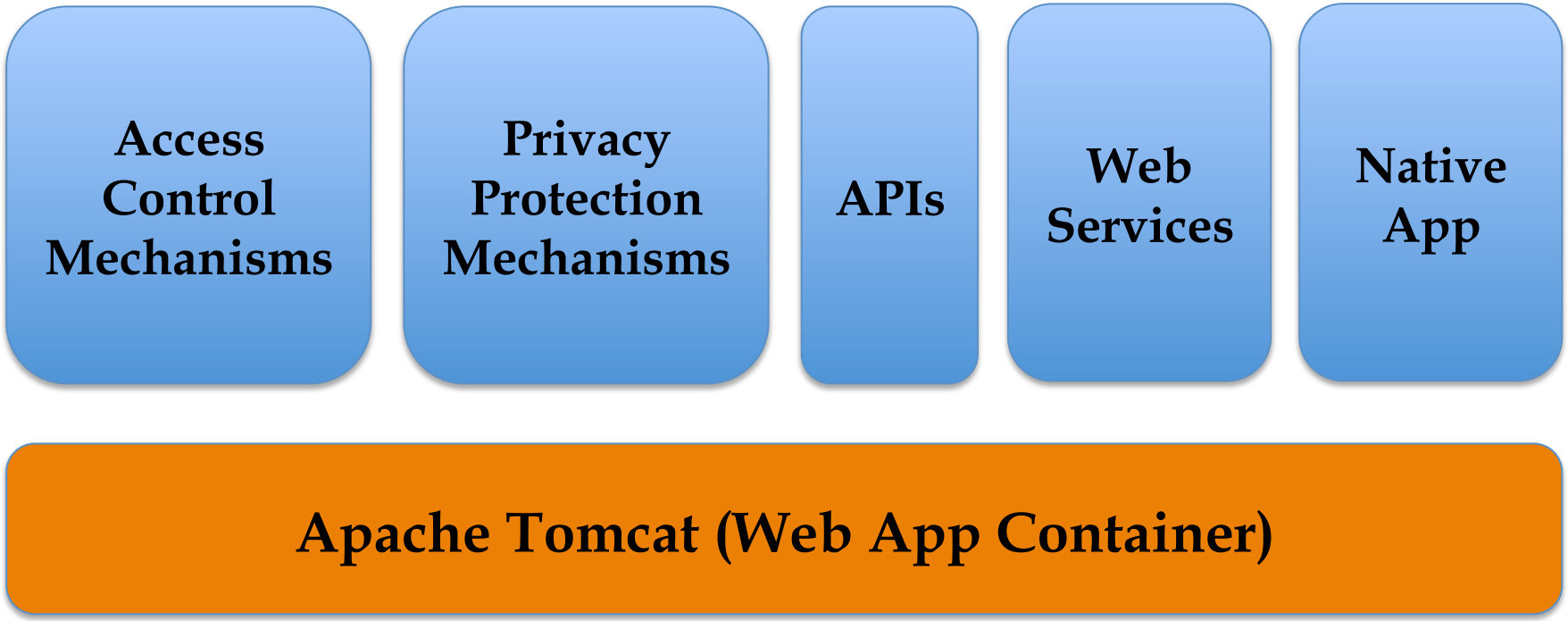
XMPP

- Coordinator module

```
<setStatus classID=1 objectID=2>
  <power>0.0</power>
</setStatus>
```

VHome

Suite of web applications using JAX-RS



Java ➔ Portability across clouds (Amazon EC2, Root BSD, Windows Azure)

VHome Implementation Details

Vhome DB using cloud datastores

Datastream: (Class ID, Object ID) specific time series
e.g., class – heating, object – space heaters

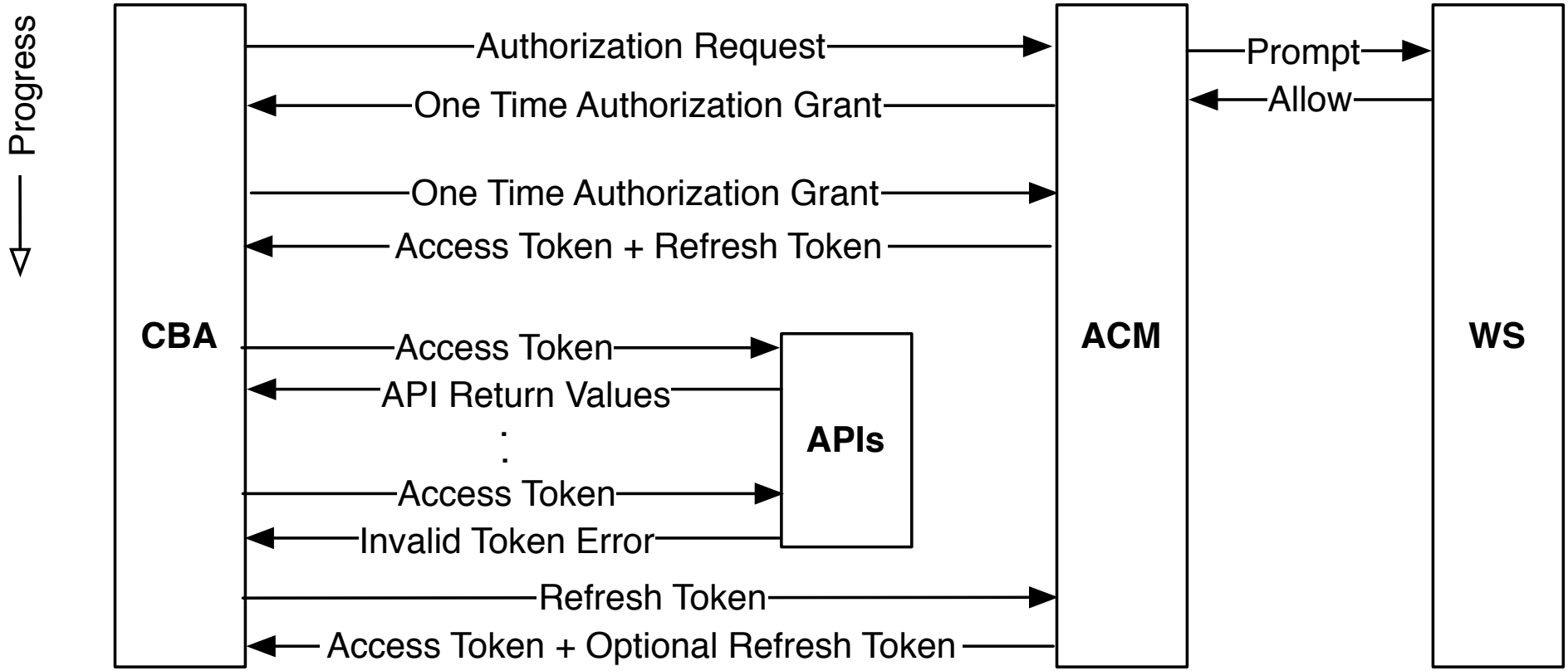
RESTful APIs to access datastreams

Token-based *fine-grained access control* mechanism
- OAuth 2.0

VHome Implementation Details

Access scope

r/w + datastream(s) + value-based and/or timestamp-based



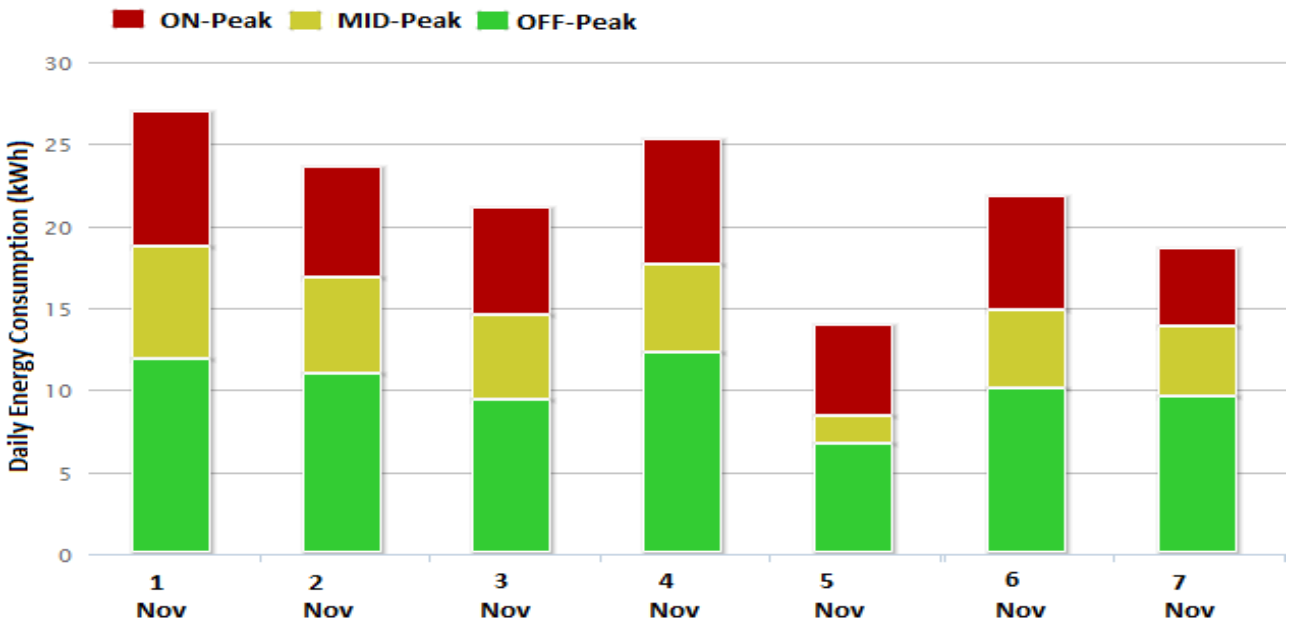
API access for a CBA

Example Applications

Data scraper

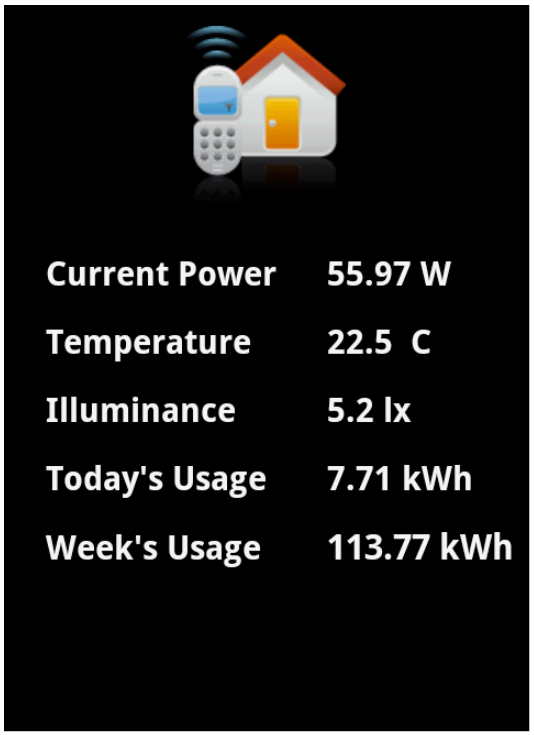
Waterloo North Hydro Inc.

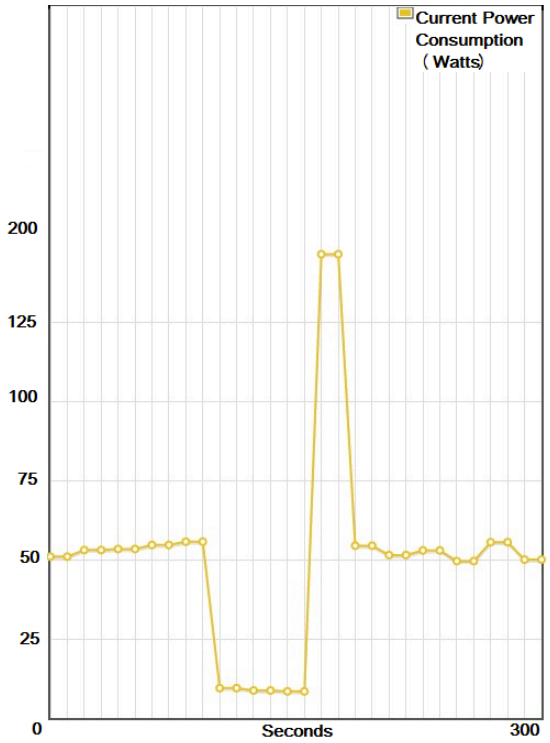
Energy data analytics



Example Applications

Interactive monitoring and control





Comparison with Existing Solutions

	Microsoft Hohm, Google Powermeter	Utility Web Portals	OPower	Green Button (Self)	Green Button (Third Party)	VHome
Consolidation				✓	✓	✓
Durability						✓
Portability				✓	✓	✓
Privacy				✓		✓
Flexibility				✓	✓	✓
Integrity		*		✓		*
Scalability	✓	✓	✓		✓	✓
Extensibility				✓	✓	✓
Performance	✓	✓			✓	✓
Universal access	✓	✓			✓	✓

Related Work

- ***Sandboxing*** native applications
  - *Language* based, e.g. *Transmute* (Griffins et al.)
  - *System* based, e.g. *xBook* (Singh et al.), OSN (Sariou et al.)

- *Dataware manifesto* (McAuley et al.)

- *Privacy Analytics* (Haddadi et al.)

Conclusions

- *Data privacy* v/s *data analytics*
  - Existing solutions provide just one

- Application *ecosystem* for home energy
  - Apple App Store, Google Play

- Leveraging modern clouds preserves *privacy*, fosters *application development*