Challenges in Building a Scalable and Cost Effective Energy Disaggregation

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ABSTRACT

In this session, we present the technology and market challenges in commercializing the Non-Intrusive Load Monitoring technology beyond finding the algorithms for energy disaggregation.

Keywords

Non-Intrusive Load Monitoring, Smart Meters, Energy Efficiency, Energy Big Data.

1. INTRODUCTION

Non-Intrusive Load Monitoring (NILM) techniques have been under research for over last 20 years. With Smart Grid industry momentum and deployment of hundreds of millions of Smart Meters, NILM finally has a chance to be deployed into millions of premises. Numerous large and small companies are working on energy disaggregation algorithms to solve this problem. An aspect usually ignored is the challenges beyond disaggregation algorithms that companies can expect to face in creating scalable and cost effective solution to serve millions of users.

This session divides the challenges into two primary categories – technology challenges and market challenges.

2. TECHNOLOGY CHALLENGES

After one has solved the algorithms optimal for energy disaggregation for the data set available for the application, there are several technology challenges in creating a platform that can be used to commercialize the technology for use by millions of users. The technology challenges are classified into several categories as described in the sub sections below.

2.1 Data Storage

Millions of Smart Meters may send data every few seconds or even faster with each packet containing varying amount of data based on sampling frequency and compression techniques. The data storage requirements of such a system can easily grow into petabytes of data generated per year for tens of millions of premises.

2.2 System Availability

Since meters or in-premise gateways send data in real time to the servers, the system availability is a critical requirement. Any downtime of servers means the data sent during the down time is missed and can never be accessed again.

2.3 Data Redundancy

Users trust that the data collected by a reputable cloud service will be stored and accessible by consumers anytime in future. Data redundancy is very important to ensure that consumer energy consumption data is never lost because of system failures caused by (including but not limited to) hard disk failures, viruses or system scalability issues. Hence, it is a common practice to maintain several copies of data such that any failure in software, hardware or the entire physical data center will not jeopardize the loss of energy consumption data permanently.

2.4 Real Time Data Access

Real Time energy consumption display is considered one of the first steps in making consumers aware of when they turn on large loads. Till date, in-home displays have been used to show real time power consumption on a screen inside the premise. If cloud based platforms need to accomplish the same functionality, the data should be accessible by consumer in almost real time via the cloud service. This translates into very low latency for the data to be accessible after it is sent to the server.

2.5 User Interfaces

It is well known that the way information is presented to consumers can make a huge impact in influencing consumer behavior. Hence, user experience based on user interface, design, presentation of information and means of presentation can make a large impact on the success of the platform.

2.6 Computing Resources

The computation requirements depend on two major factors – how complicated are the algorithms and how well is the system designed to optimize the computations. The selection of real time disaggregation versus time lagging can also add to the computational requirements being higher.

2.7 Security

Data privacy has been one of the largest protests against Smart Meter deployment. NILM technology makes the issue more concerning since the results of NILM can demonstrate several aspects of users' lifestyle, example, for a home, when they take shower, when do laundry, when they are on vacation etc. Hence, keeping the data secure is very important from a consumer perspective. Appropriate encryption and authentication techniques must be used when data is transferred from premise to the server and when being accessed by applications.

2.8 Low Cost per user

Deploying the technology at a mass scale at a very reasonable set up and operational fee is not only very important but also a challenging task. Computations by authors showed that the cost per user per year can range widely from $0.05 to $5.00 depending on the design and implementation of the system.

3. MARKET CHALLENGES

NILM solution brings a promise to save energy for residential and small commercial consumers that can be substantial when aggregated at national level. A 5% reduction in US residential will avoid greater than $6B in generation costs. It is however frequently challenged that the savings for individual users can be small which leads to two major market challenges – how to get consumers excited about energy savings and how to make money from the technology.

3.1 Consumer Participation

In an analogy to the medical world, consumers are known to be willing to pay lot more for pain killers & drugs than for the vitamins. Positioned as a tool for energy savings, NILM falls under the vitamins category where consumers are not always interested in energy savings.

Several techniques are being researched and applied to influence consumer behavior and make them more interested in energy savings. A list of (not exhaustive) such techniques are:

- Comparison with Peers
- Social Games at Individual Level
- Social Games at Community level
- Social Status
- Need to have more Information

3.2 Business Case

With low financial motivation for an individual consumer to work on energy reduction, how does one justify building a business on commercializing this technology? One obvious way is the use of public funds (example Energy Efficiency dollars available to Utilities) to pay for the service and not require consumers themselves to pay for the service. It is debatable whether a free service will increase consumer interest in the energy savings and make the use of public funds justified for this service. However, applied with the techniques described in the previous section to enhance consumer interest and not require consumers to pay (by using public funds) can together be a powerful means to take NILM technology mainstream.

4. Conclusion

Several challenges lie ahead of the organizations working on NILM energy disaggregation algorithms that will be discussed in this session. With careful product design and business decisions, these issues can be overcome and NILM can be made a technology adopted by the masses to accomplish the energy reduction at a massive scale.

About the authors:

Vivek Garud leads the technology team at Bidgely. His charter is to build the biggest and best energy analytics technology yet. He brings in several years of experience building large scale complex software systems in telecommunications and web industry. Prior to Bidgely, Vivek contributed to building voice recognition technology at Microsoft. He has a B.Tech degree in Computer Science from Indian Institute of Technology, Bombay. Once done solving the world's energy problems, he fantasizes of becoming a full time musician.

Abhay Gupta is the founding CEO of Bidgely, a technologist and entrepreneur at heart. He spent his initial years at Sun Microsystems where he worked on various aspects of hardware chip design. He then moved on to taking on product management and business development roles, spending time at Echelon and Grid Net in the field of Sensor & Control Networks, Smart Meters/Smart Grid, Home Area Network, Commercial Buildings, and LED lighting. After leaving Grid Net, he started Bidgely (known as MyEnerSave formerly) with a mission to accomplish energy efficiency at a massive scale by performing deep analytics on energy data generated by Smart Meters. Abhay holds a B.Tech from Indian Institute of Technology Delhi, M.S. from University of Southern California and MBA from Santa Clara University.