

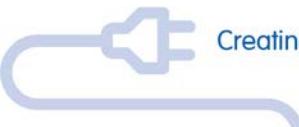
Modeling Entertainment Devices - Research on progress -



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www.calplug.org



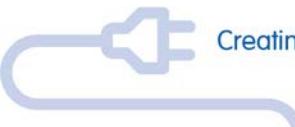
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The well-known Problem of PLDs

Plug Load Devices (PLDs) vs Lighting / HVAC

- Growing # PLDs will reach 50% usage electricity by 2020.
- PLDs are diverse and complex. Over 3 billions in The U.S.
- PLDs are dynamically introduced in a household over time.
- PLDs are not localized and do not have fixed running times
- PLDs consumption strongly depends on users' behavior

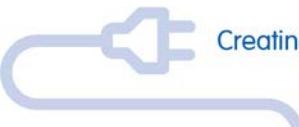


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Case Study: Entertainment Systems (ES)

Current ES are multidevice-networked system

- TV, Blu-ray player, Set-top box, game console, and sound system.
- Occupy Americans for an average of five hours every day.
- They consume 800 kWhr / household annually, (9 TWhr in California)

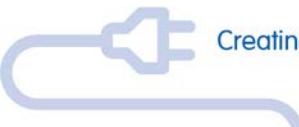


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Research Goals

Create automated and non-intrusive systems able to

- Track and understand the use of PLDs to identify behaviors that waste energy.
- Perform fault-detection.
- Classify PLDs that are not efficient and propose replacement.



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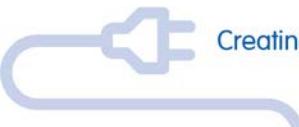
Previous Work: The Wall of Power

What is Wall of Power

- Interface to help users to improve Energy Efficiency at home.

Main Features

- Monitor/control individual consumption directly on the wall or a mobile device.
- Build an open product database to assist finding top energy efficient devices.



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Current Work

- ***Understanding usage and providing personal advice***
 - based on user's preference to purchase new products.
 - Identify user's preference on price, performance and energy efficiency.
 - List top energy products according user's preferences.
 - based on installed PLDs.
 - Classify current devices and its operational energy modes.
 - Compare installed devices with top efficient products.
 - based on user's behavior.
 - Register operation for each device time/energy consumption.
 - Provide advise/management to avoid wasting habits and propose more suitable products.

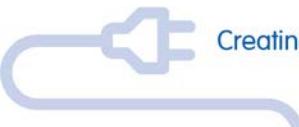


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Research Challenges

- ***Understanding usage and providing personal advice***
 - based on user's preference to purchase new products
 - Identify user's preference on price, performance and energy efficiency.
 - List top products according user's preferences
 - based on current PLDs
 - Classify current devices and its operational energy modes.
 - Compare installed devices with top efficient products
 - based on user's behavior
 - Register operation for each device time/energy consumption
 - Provide tips to avoid wasting habits or more suitable products.



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Possible Solutions

Solution	Engineer	Consumer
Install plug meters and sensors everywhere		
Ask consumers to register their devices models and usage		
Design non-intrusive, deployable and automated solutions		



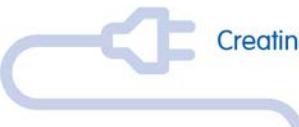
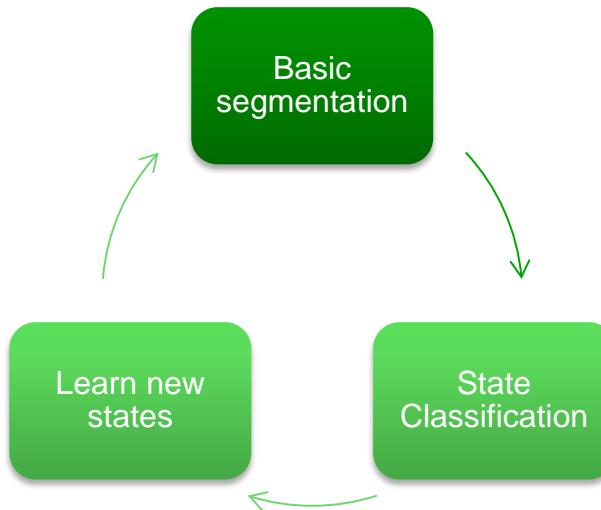
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Proposed Solution

Statistical approach for PLDs Classification via Machine Learning

- Modeling PLDs energy signature for each power state.
- Building algorithms to disaggregate superposed data.

Methodology of PLD identification



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Proposed Solution

Modeling & Classifying energy states of PLDs

Noisy
energy
signal

- Coming from a Power Strip

Constant
regime
interval

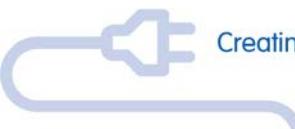
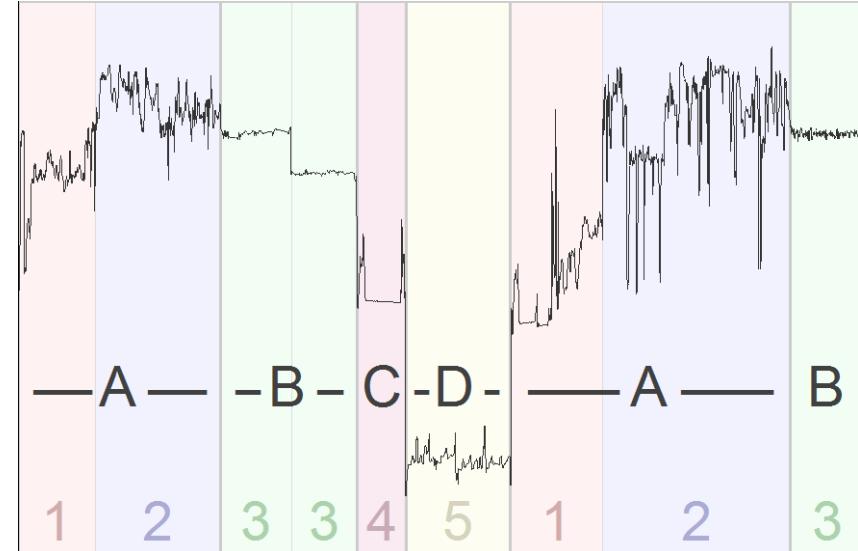
- Identify patterns

Energy
states

- Group of patterns

Logical
states

- Analyzing sequence of energy states



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Preliminary Results

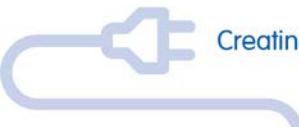
Modeling & Classifying energy states of a Game Console: Xbox



88-95% Success

Xbox Logical States

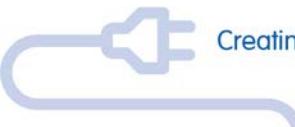
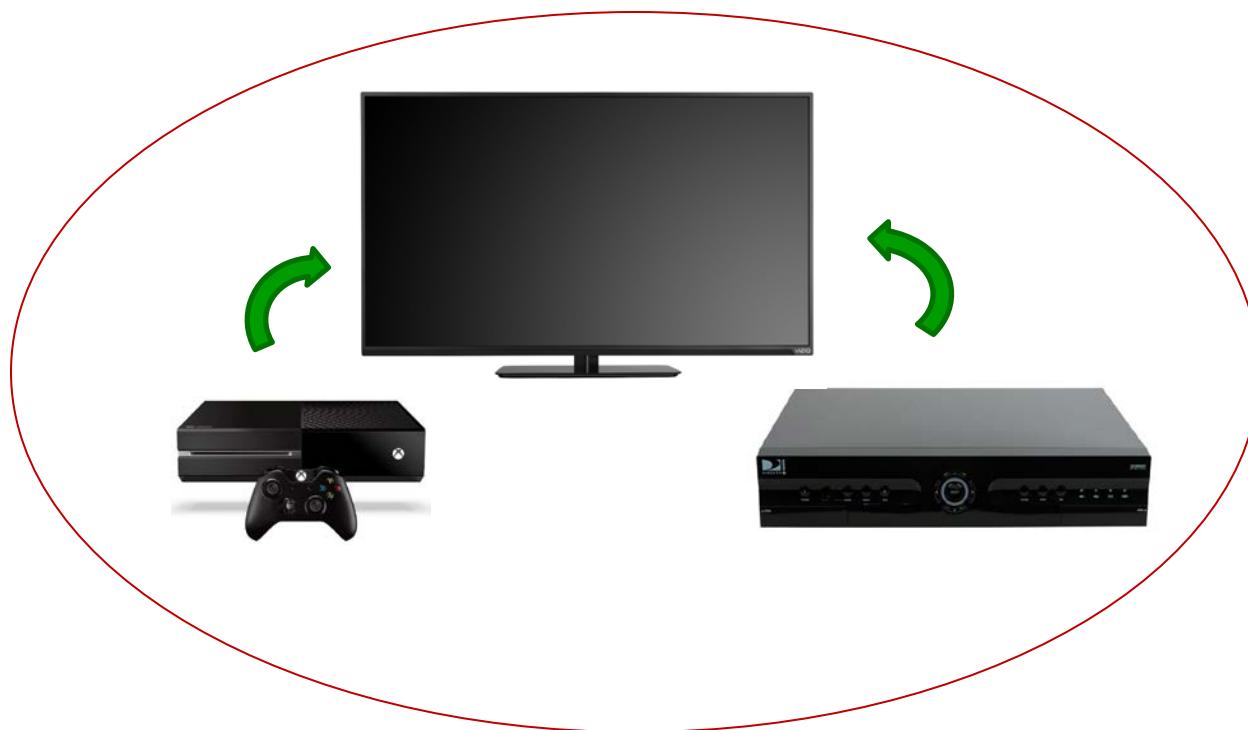
1. Playing games
2. Inactive while game paused
3. Instant-on mode
4. Playing Movies
5. Playing Music
6. Main menu
7. Energy-saving mode
8. Playing games with Kinect



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Future Work

- Improving the training algorithm to achieve a higher rate of success.
- Modeling Set-top box and integrate it in the current system.
- Use external data for presence detection (GPS, Wi-fi)



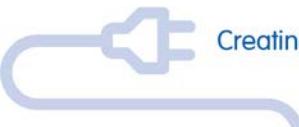
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Previous Work: The Wall of Power

Thank you!

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