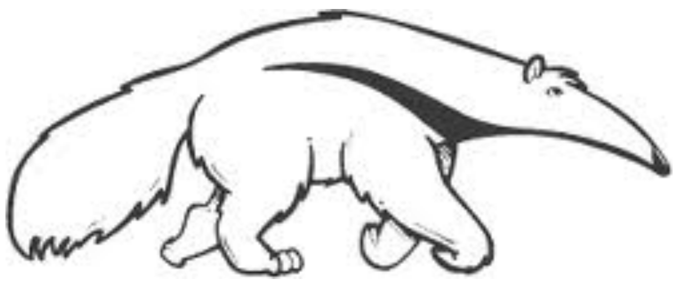
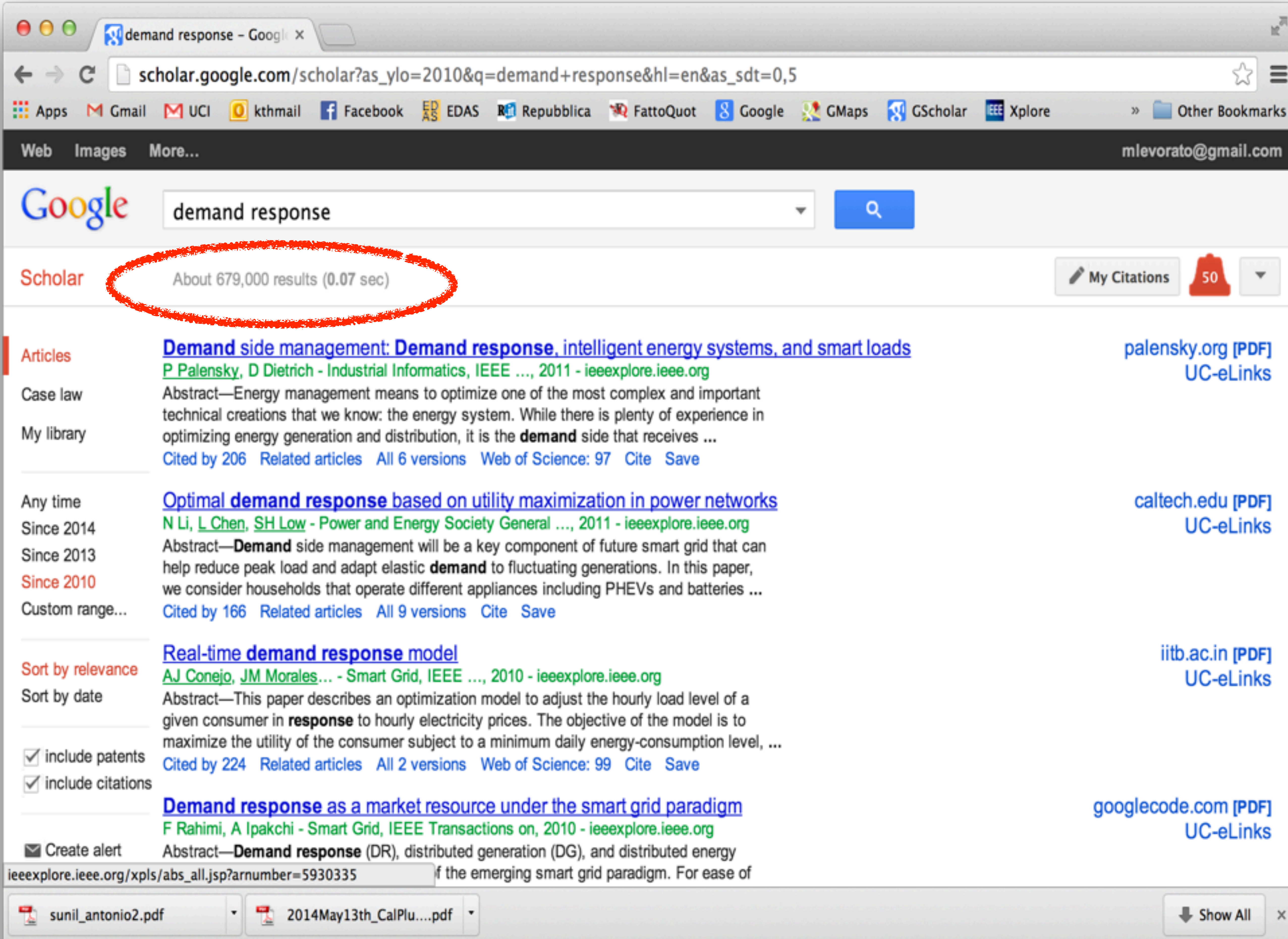


Consumer Touch Points:
System dynamics

Marco Levorato
ICS/CS - University of California, Irvine


demand response - Googl
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Demand side management: Demand response, intelligent energy systems, and smart loads
P Palensky, D Dietrich - Industrial Informatics, IEEE ..., 2011 - ieeexplore.ieee.org
Abstract—Energy management means to optimize one of the most complex and important technical creations that we know: the energy system. While there is plenty of experience in optimizing energy generation and distribution, it is the demand side that receives ...
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Optimal demand response based on utility maximization in power networks
N Li, L Chen, SH Low - Power and Energy Society General ..., 2011 - ieeexplore.ieee.org
Abstract—Demand side management will be a key component of future smart grid that can help reduce peak load and adapt elastic demand to fluctuating generations. In this paper, we consider households that operate different appliances including PHEVs and batteries ...
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Real-time demand response model
AJ Conejo, JM Morales... - Smart Grid, IEEE ..., 2010 - ieeexplore.ieee.org
Abstract—This paper describes an optimization model to adjust the hourly load level of a given consumer in response to hourly electricity prices. The objective of the model is to maximize the utility of the consumer subject to a minimum daily energy-consumption level, ...
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Abstract—Demand response (DR), distributed generation (DG), and distributed energy
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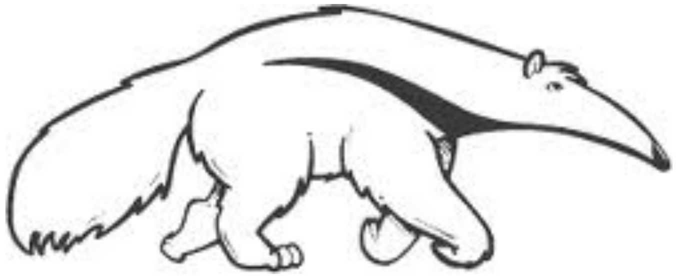

Consumer Touch Points:
System dynamics

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Top-Down Approach

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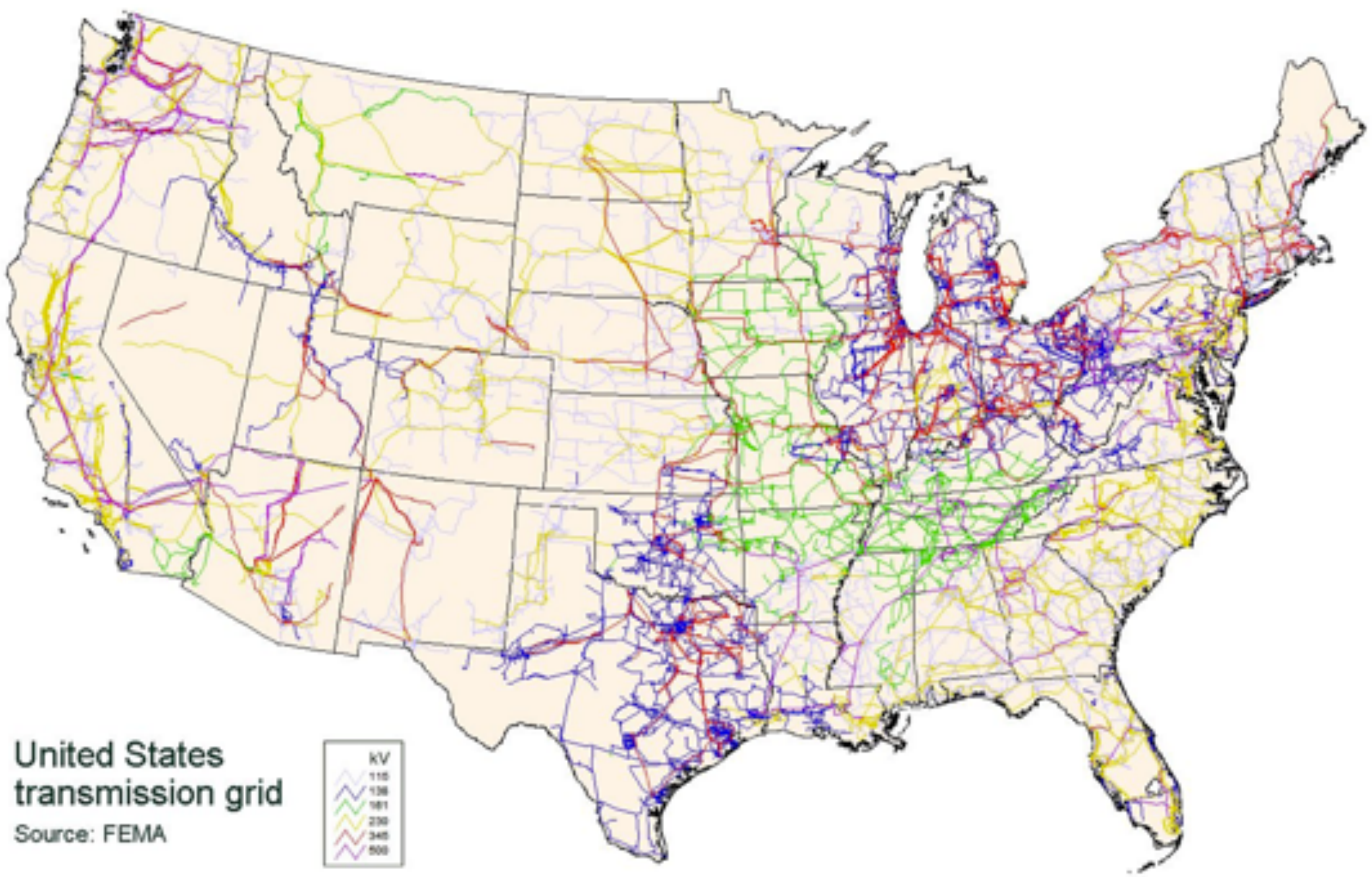


GENI: Global Energy Network Institute

- Energy grid as a distribution network
- Focus on the topological complexity

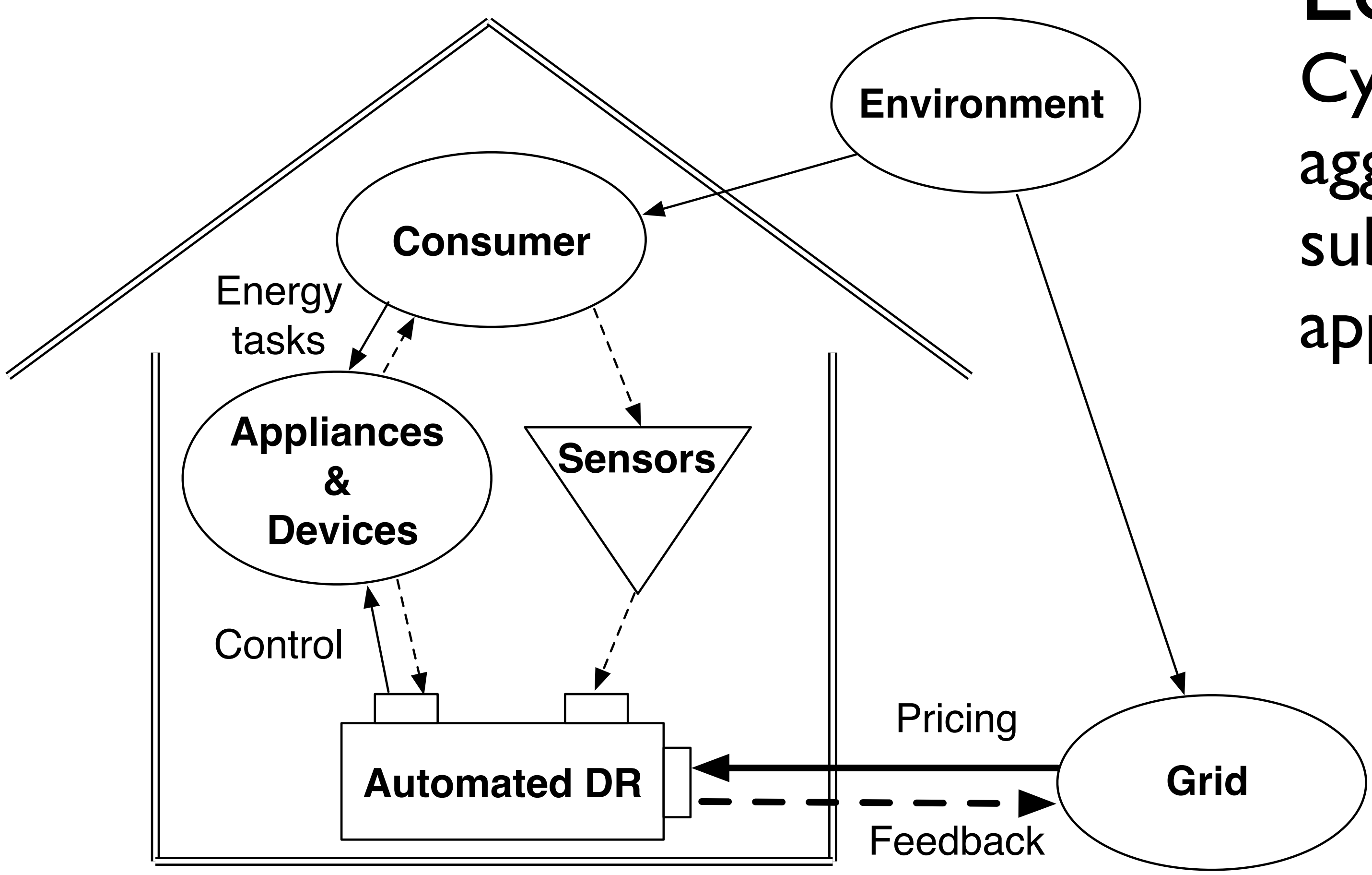
Graph:

- Vertices are physical nodes
- Edges are physical connections

Future Energy Grid

Intelligence pushed to the edge of the system

- Improve efficiency, reliability, QoE
- + control, - uncertainty (load control vs renewable energy production)



Local system:

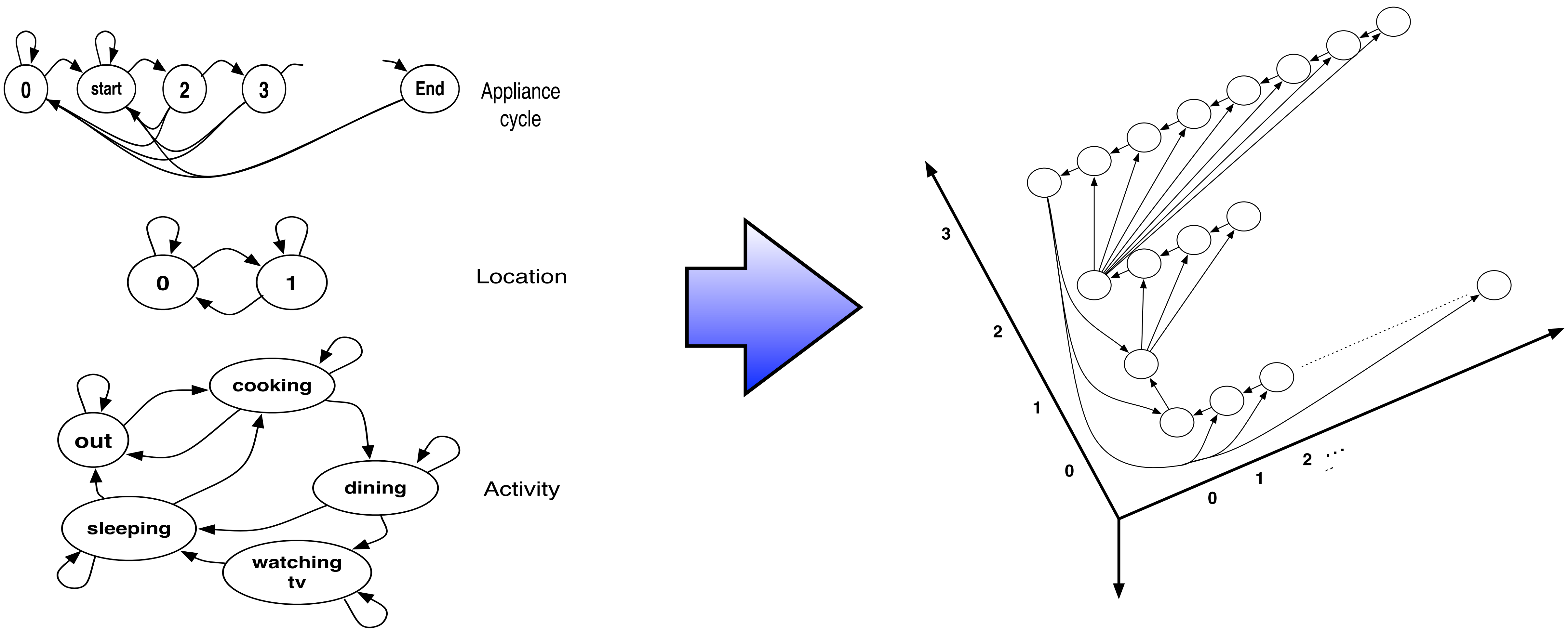
Cyber-physical system defined as the aggregation of many heterogeneous sub-systems: consumer, algorithms, appliances,...

Consumer is a driving component for the dynamics of the system

Graph: Local system

Operational complexity vs Topological Complexity

Modeling and control the dynamics of local systems



Logical Graph:

- Vertices are logical states
- Edges are state transitions

Local System: consumer

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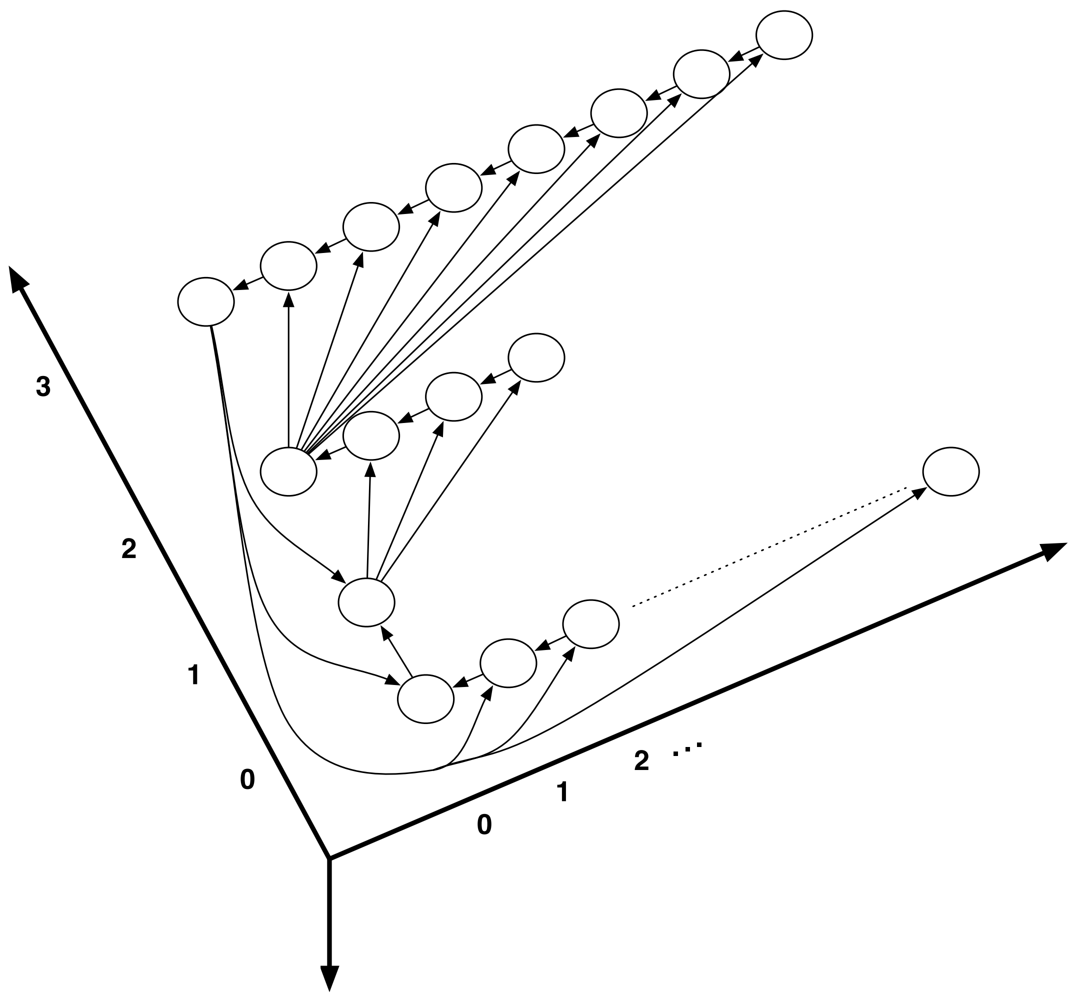
Joint consumer-system control



Graph analysis:
- Consumer classification
- Identification of critical "points"

Graph control:
- Traditional EMS functionalities (sensing, control)
- Feedback as a control signal to steer the "trajectory" of the consumer
- Compliance

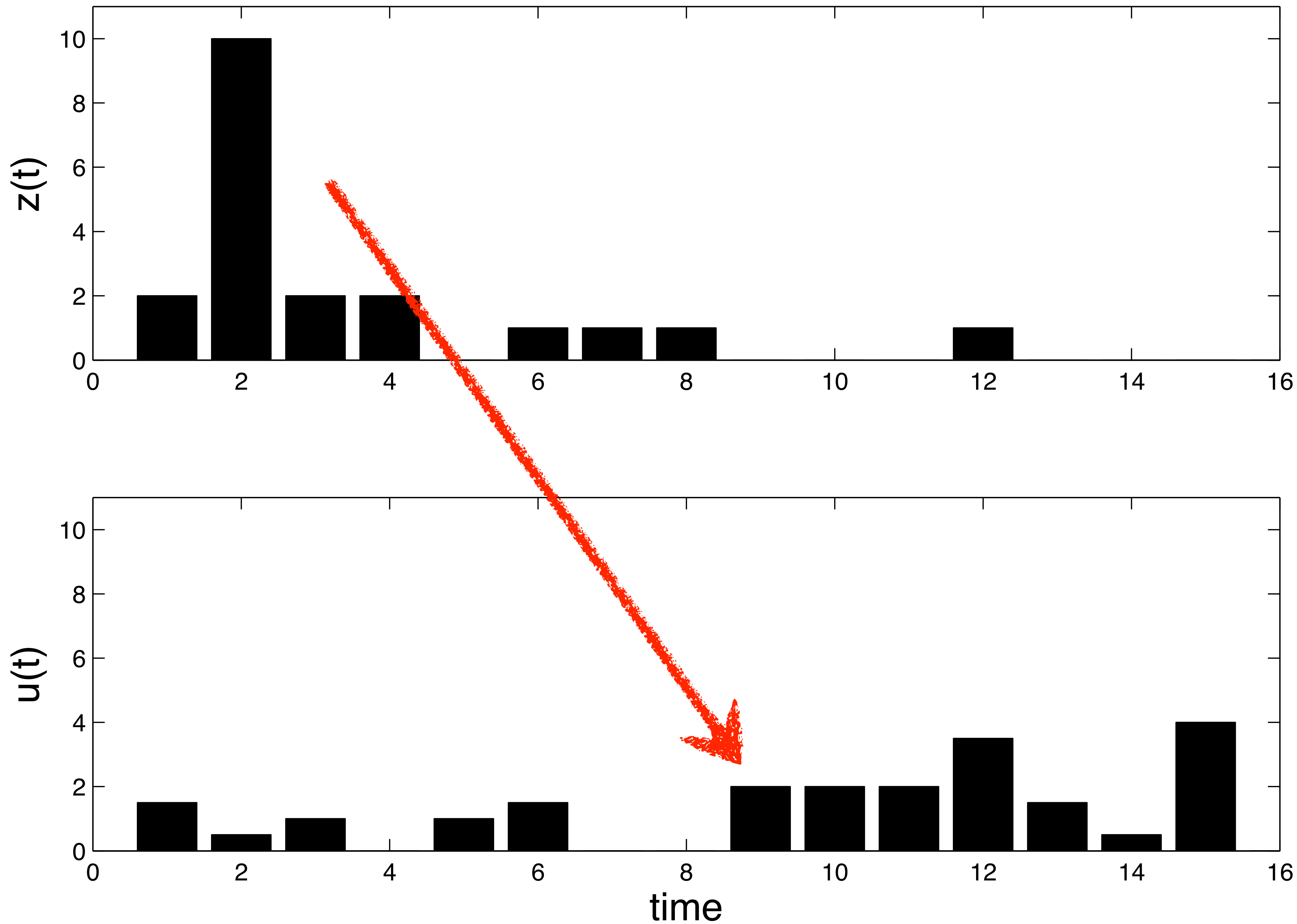
- Build reference models
- Classification from available information
- State identification - trajectory analysis
- Control (feedback)

Residential Demand Response

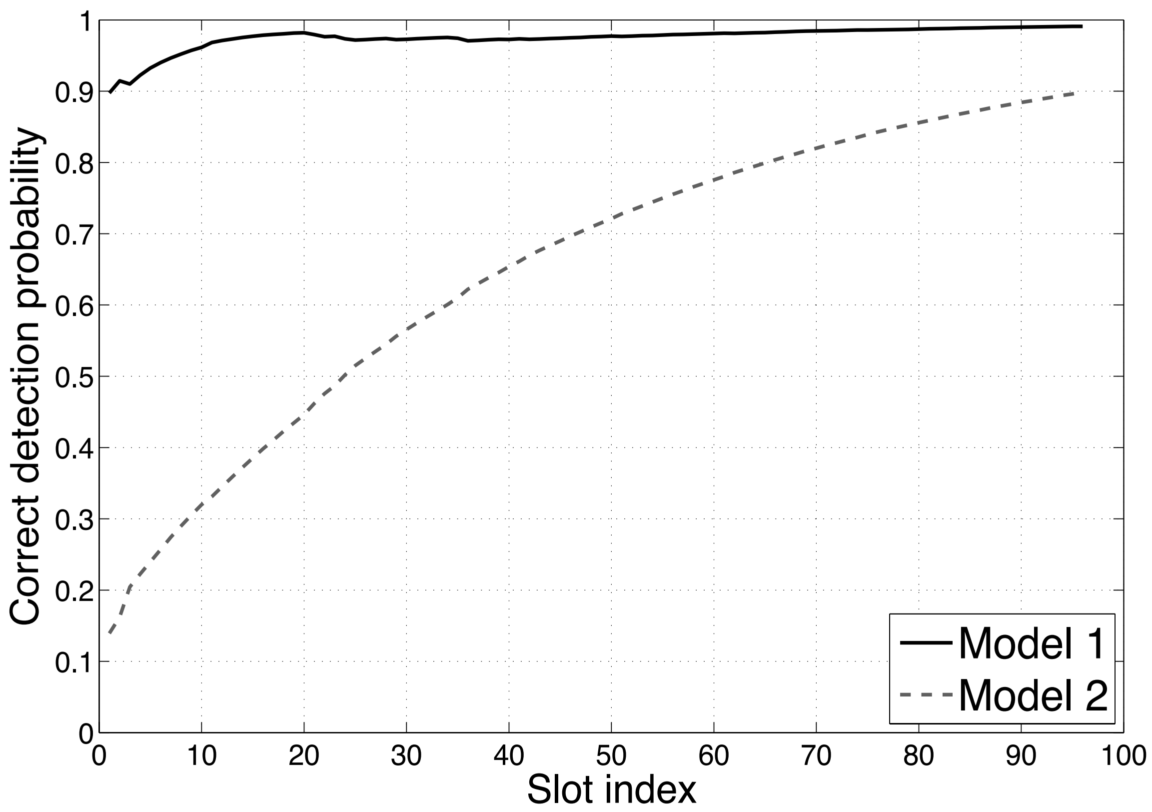
Tradeoff: consumer dissatisfaction - financial cost

Instantaneous request

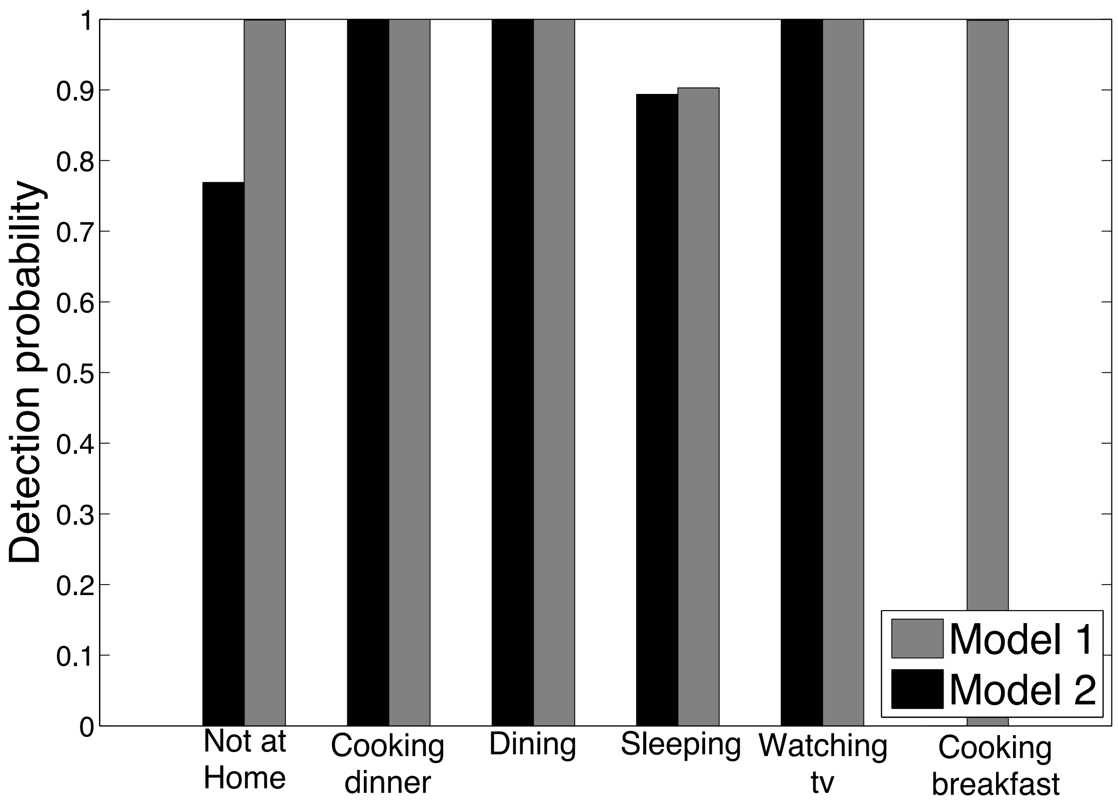
scheduled



Some results



Classification:
Detection probability as a function of time



State classification:
Detection probability as a function of the consumer state

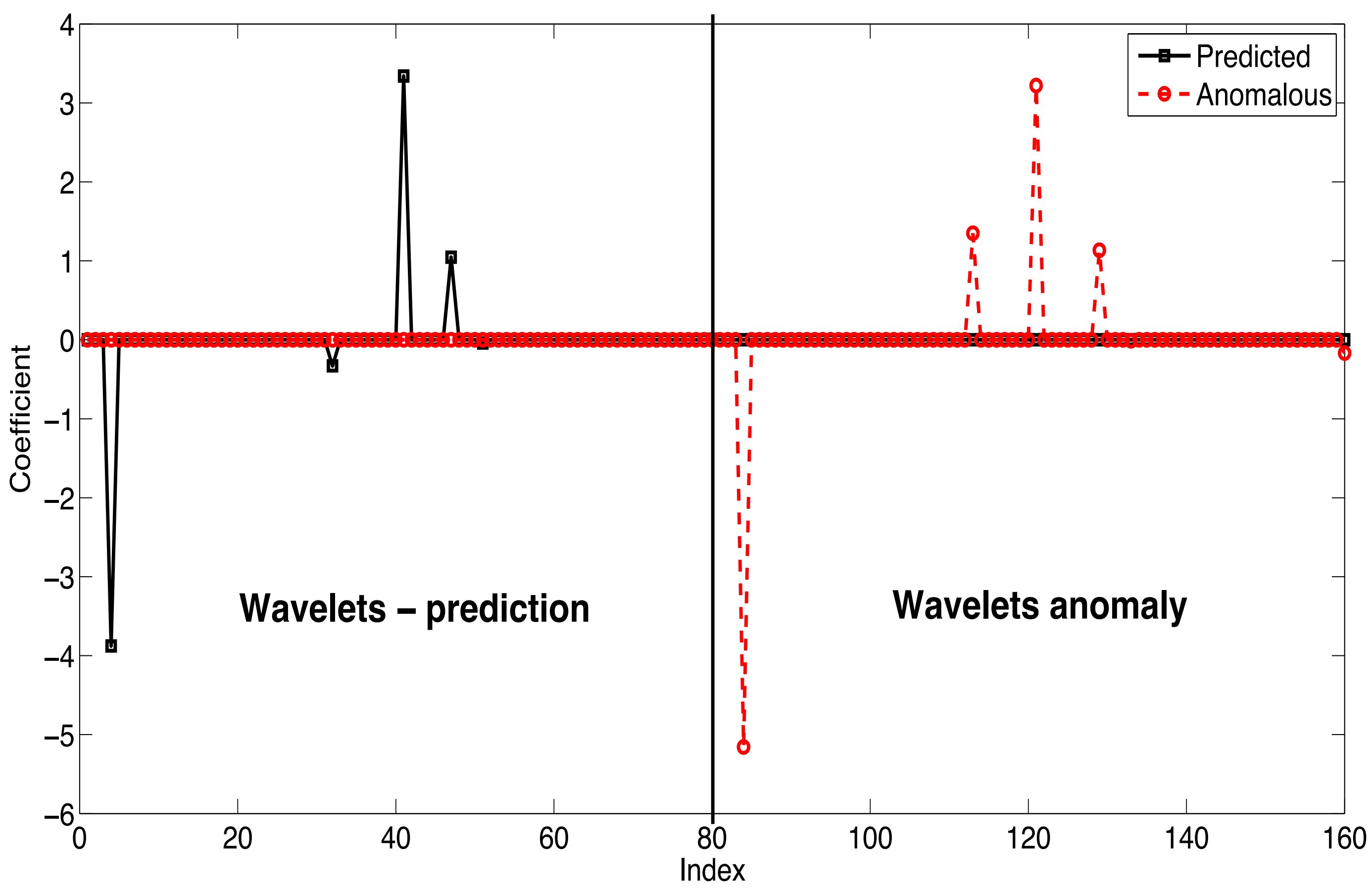
Grid-Wide

Aggregation of local *logical graphs*

- Large(r)-scale prediction
- Analysis (identification of critical design criteria for components)

Complexity

- Intrinsic regularity of logical graphs
- Complexity reduction by graph sampling/projection



Compact representation based on graph wavelets

LoCal

local.cs.berkeley.edu/wiki2/index.php/Main_Page

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Main Page

LoCal (A Network Architecture for Localized Electrical Energy Reduction, Generation and Sharing)

investigates Information Age approaches for managing society's most limited resource: energy. The world's electric grids are an engineering wonder of last century's physical age, each with a vast geographic reach, epitomized by a highly centralized, synchronized, and reliable distribution tree that allows electric power to be consumed without concern for its source. But rapidly changing energy demands, incorporation of non-dispatchable renewable sources, and the need to proactively manage load, have pushed this aging marvel to its limit. As the rise in greenhouse gases threatens civilization, it is time to examine how pervasive information can fundamentally change the nature of energy production, distribution and use. Taking guidance from the design principles of the dominant triumph of the cyber age, the Internet, we investigate how to design an essentially more scalable, flexible and resilient electric power infrastructure-one that encourages efficient use, integrates local generation, and manages demand through omnipresent awareness of energy availability and use over time. The crucial insight is to integrate information exchange everywhere that power is transferred.

The LoCal Energy Network is a cyber overlay on the energy distribution system in its various physical manifestations, e.g., machine rooms, buildings, neighborhoods, isolated generation islands and regional grids. Pervasive information exchange will enable a more efficient scalable energy system with improved resilience and quality of delivered power. Our key contribution is to bring together

- (1) pervasive information about energy availability and use,
- (2) interactive load/supply negotiation protocols,
- (3) controllable loads and sources, and
- (4) logically packetized energy, buffered and forwarded over a physical energy network.

Together these yield a system for agile, distributed, and integrated management of energy that can buffer energy on the path to reduce peak-to-average energy consumption, moderate infrastructure provisioning, and encourage power-limited design and operation. Our building block is the intelligent power switch, logically connecting sources to loads by bundling information (bits) with energy (electrons) flows.

Contents [hide]

LoCal

navigation

- Main page
- Community portal
- Current events
- Recent changes
- Random page
- Help

search

Go Search

toolbox

- What links here
- Related changes
- Special pages
- Printable version
- Permanent link

Conclusions

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- Smart grid introduces complexity at the local scale behavior: system dynamics
- Analysis of dynamics/interactions based on graph representation (local/larger scale)
- Compression/complexity reduction is possible