Automating and Optimizing Demand Response in Buildings

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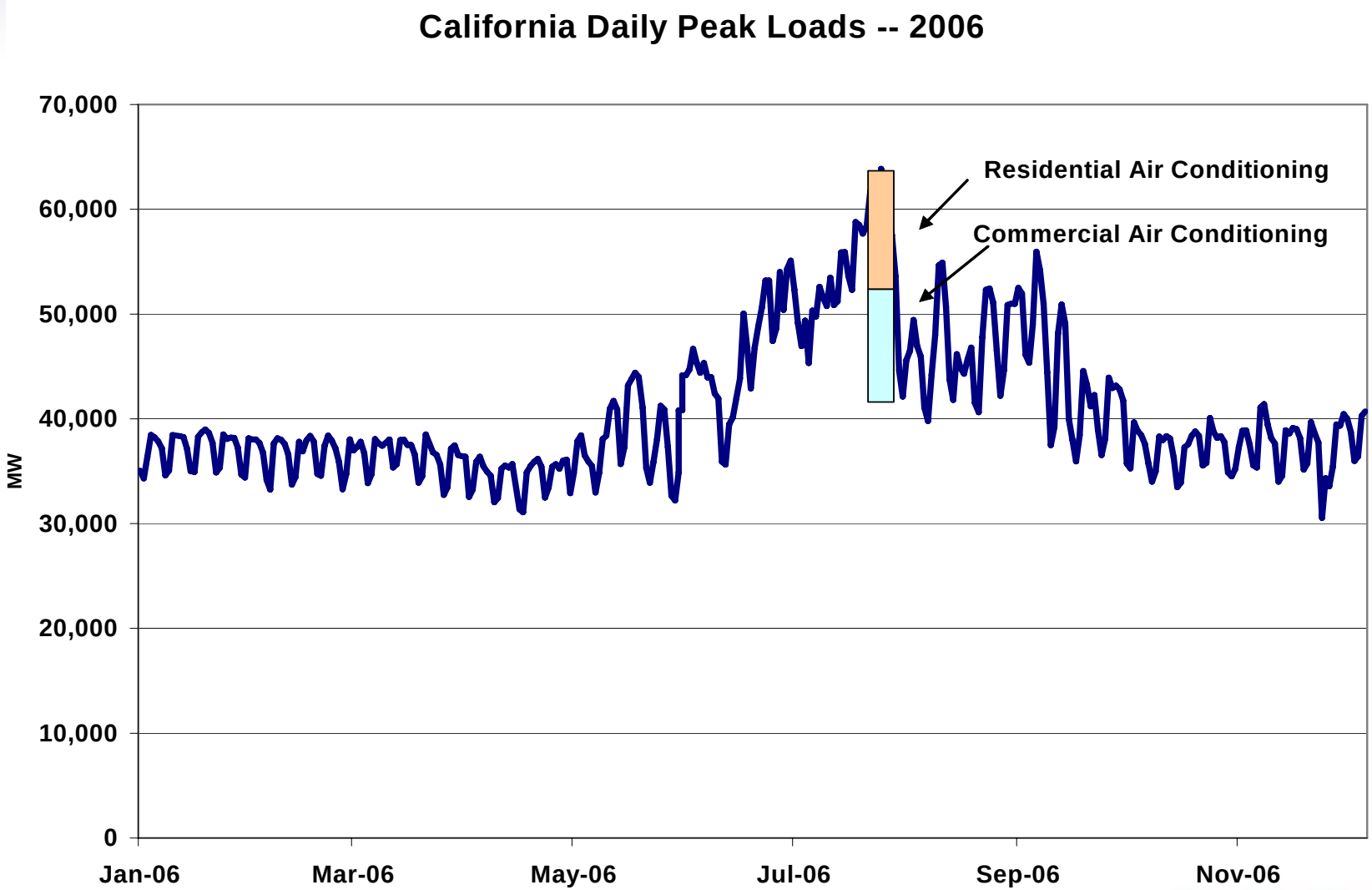
Mary Ann Piette – mapiette@lbl.gov
Environmental Energy Technologies Division
Research Director, Demand Response Research Center
drrc.lbl.gov

California is Summer Peaking



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Automated DR Project

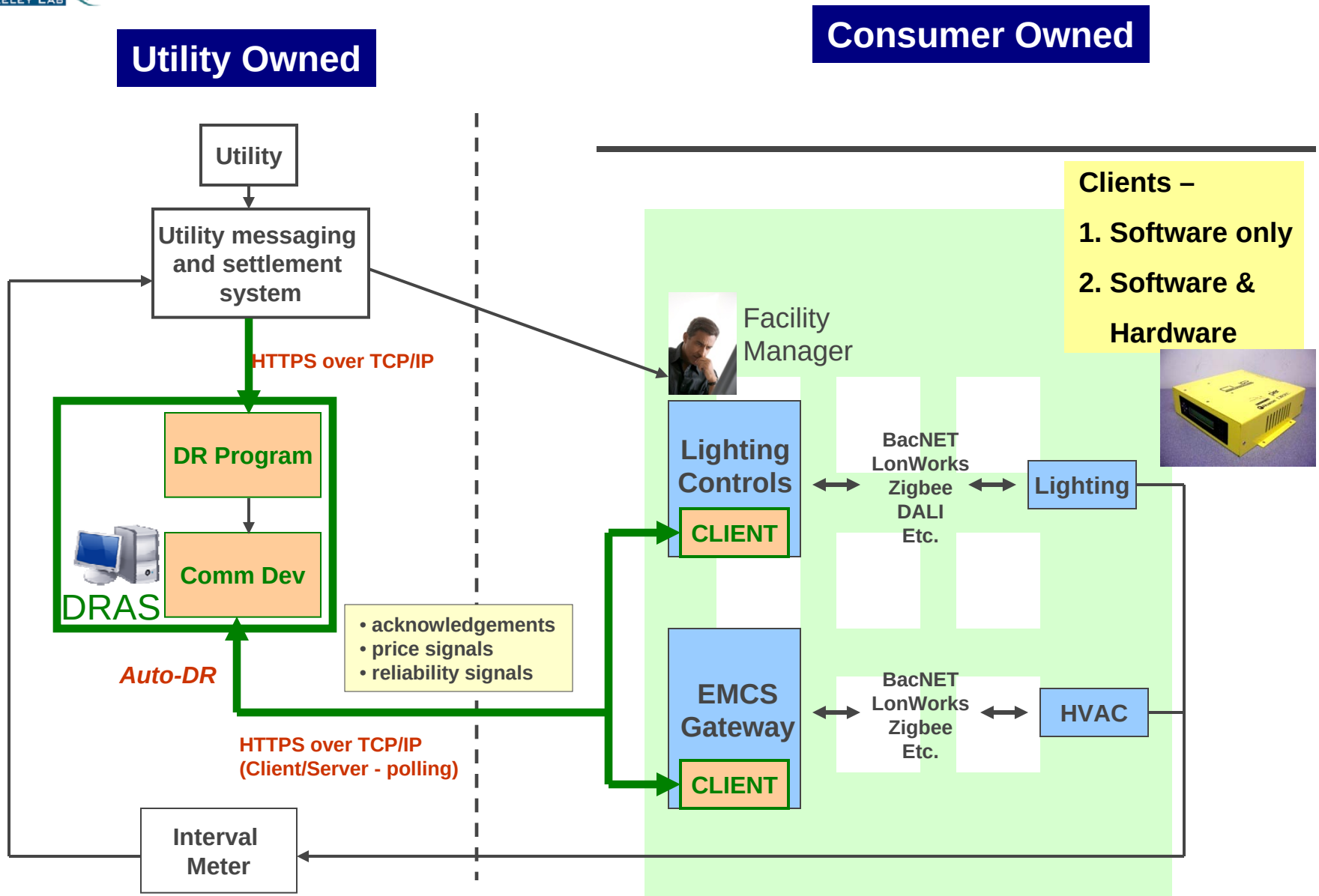
AutoDR Goals

- **Cost** - Develop low-cost, fully automated infrastructure to improve DR capability in California
- **Technology** - Evaluate "readiness" facilities to receive common signals
- **Capability** - Evaluate capability of control shed strategies and measurement of sheds to improve future buildings

AutoDR Definition - Fully automated signal for end-use control

- **Signaling** – Continuous, secure, reliable, 2-way communication with listen and acknowledge signals
- **Industry Standards** - Open, interoperable standard control and communications to integrate with both common EMCS and other end-use devices that can receive a relay or similar signals (such XML)
- **Timing of Notification** - Day ahead and day of signals are provided to facilitate a diverse set of end-use strategies

DR Automation Server and Clients



Improving DR capability in Buildings – from present to future

- Improved levels of granularity/modular control
- Improved intelligence of building modes – lighting, HVAC, other
- Improved end-use metering, service level performance metrics
- Multivariate optimization trade off with other criteria

		HVAC											Lighting					Other
	Building use	Global temp. adjustment	Duct static pres. Increase	SAT Increase	Fan VFD limit	CHW temp. Increase	Fan qty. reduction	Pre-cooling	Cooling valve limit	Boiler lockout	Slow recovery	Extended shed period	Common area light dim	Office area light dim	Turn off light	Dimmable ballast	Bi-level switching	Non-critical process shed
ACWD	Office, lab	X	X	X		X			X	X		X						
B of A	Office, data center		X	X	X	X			X									
Chabot	Museum	X						X										
2530 Arnold	Office	X									X							
50 Douglas	Office	X									X							
MDF	Detention facility	X																
Echelon	Hi-tech office	X	X	X			X						X	X	X	X		
Centerville	Junior Highschool	X						X										
Irvington	Highschool	X						X										
Gilead 300	Office			X														
Gilead 342	Office, Lab	X		X														
Gilead 357	Office, Lab	X		X														
IKEA EPaloAlto	Furniture retail	X																
IKEA Emeryville	Furniture retail	X																
IKEA WSacto	Furniture retail																	
Oracle Rocklin	Office	X	X															
Safeway Stockton	Supermarket																X	
Solectron	Office, Manufacture	X													X			
Svenhard's	Bakery																	X
Sybase	Hi-tech office														X			
Target Antioch	Retail	X					X											
Target Bakersfield	Retail	X					X											
Target Hayward	Retail	X					X						X				X	
Walmart Fresno	Retail	X															X	

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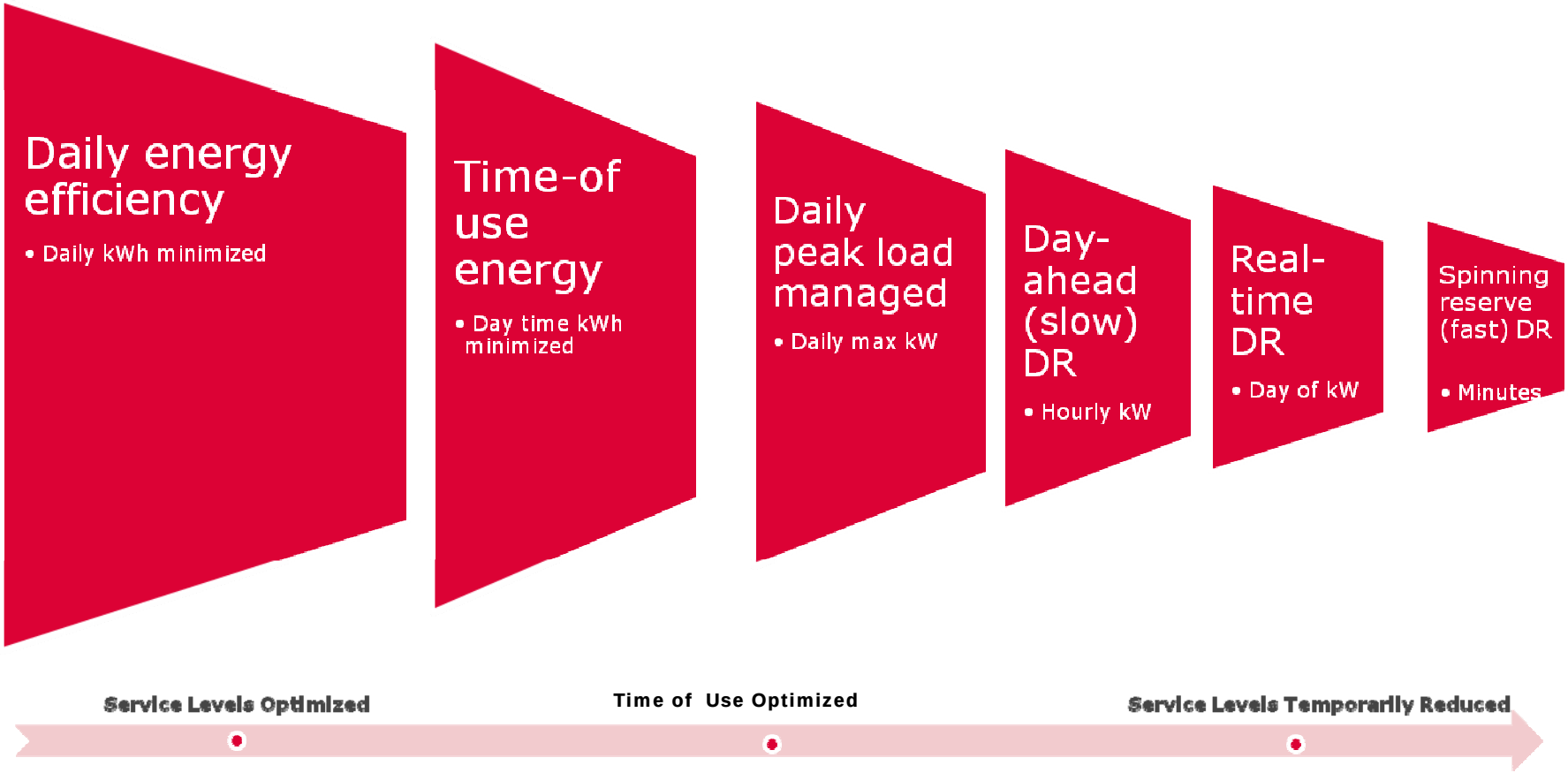
Time Scales of Building/Grid Optimization – Automated DR Future



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Multivariate Optimization and Criteria

Energy

-On/off mode/control
-Weather/solar/wind
-Occupancy/comfort/schedule
-Equipment loads
- Continuous diagnostics

Operating Costs

- Rate $/kWh, TOU, demand charges
- Dynamic – critical, variable peak, RTP
- DR program – shed frequency, duration
- Maintenance and operations

Emissions

-Real-time CO_2/kWh (time of day)
-Grid or on-site power
-Energy source

Demand Response / Grid

- Loads to limit, shift, shed
- Service level control capability
- Service level requirements
  Duration, frequency of DR participation
- Spinning reserve participation

	Energy (kWh)	Operating Costs ($)	Emissions (CO_2)	DR ($/kW)
Conventional Variable Air Volume				
Ice/Chilled Water Storage				
VAV with Pre-Cooling				

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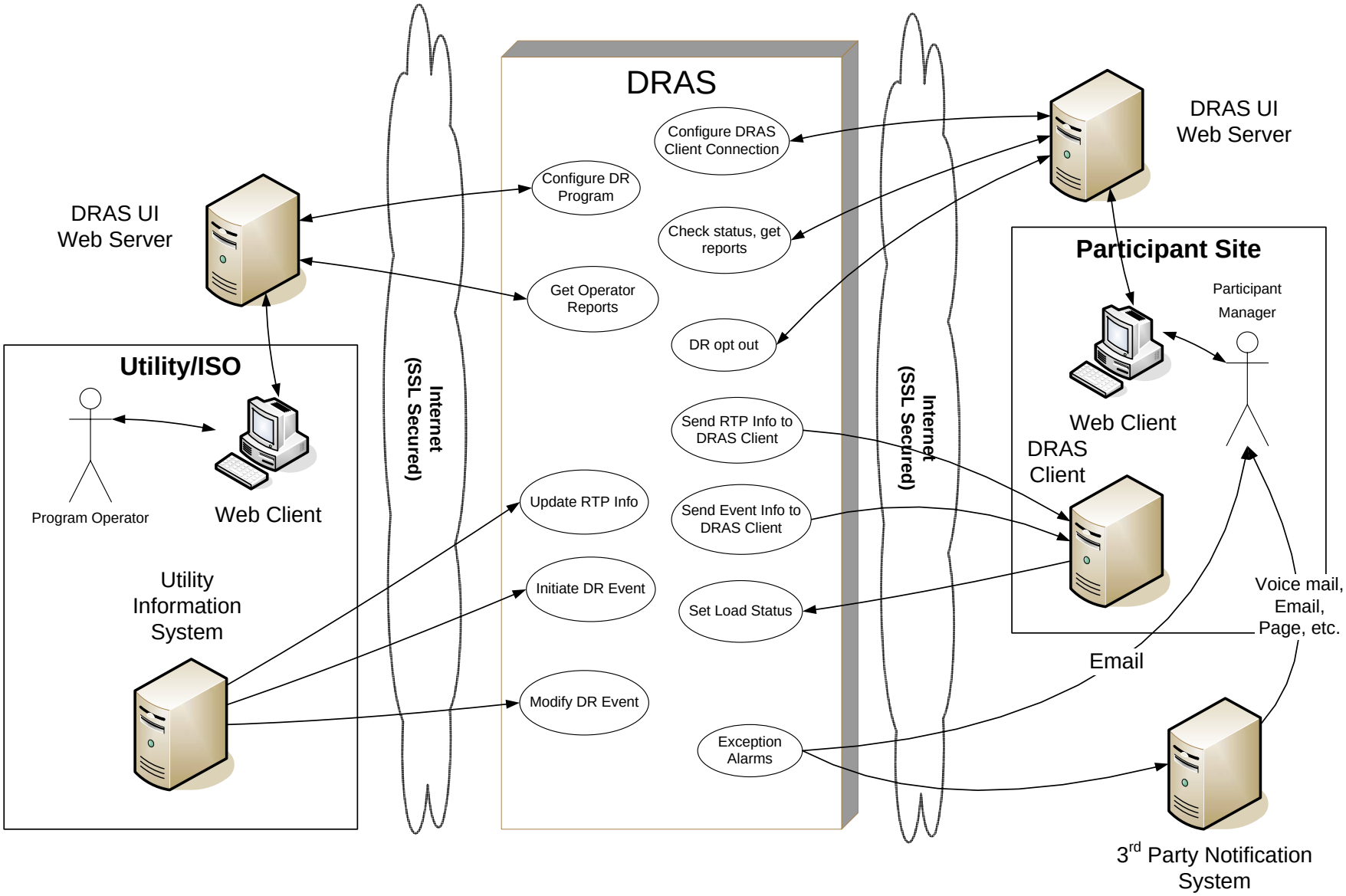
Research Needs

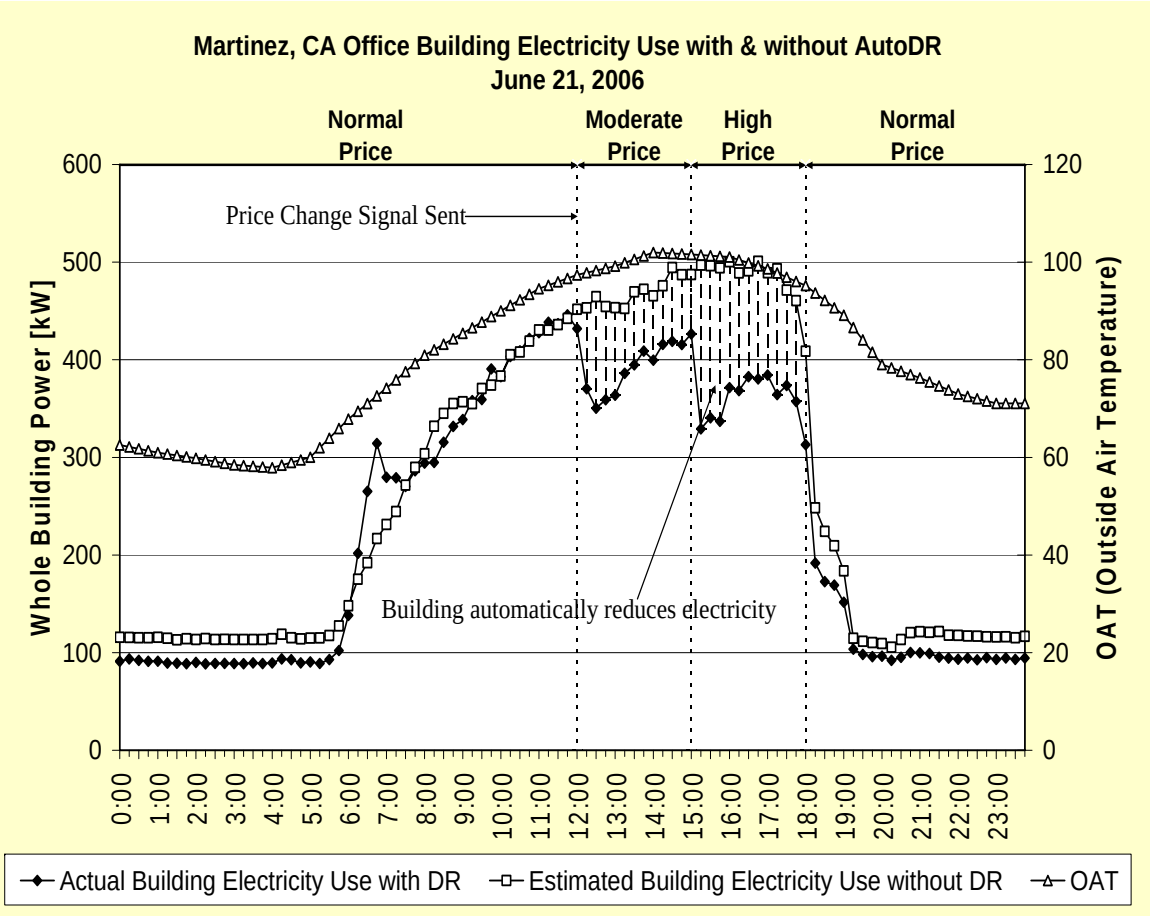
- Model-based optimization tools and techniques
- Improved sensing and forecasting of occupancy, lighting, HVAC, misc. loads
- Economic feedback – common tariff models
- Common communications infrastructure
- Real-time and forecasted emissions data
- Continuous diagnostics and feedback
- Dashboard objects and performance metrics
- Test bed demonstrations
- Engineering guides and training

APPENDICES

DRAS Event Architecture



Example of Auto-DR in 130,000 ft² County Office



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