Ontological requirements of the Service Oriented Grid

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Abstract

Process oriented integration of the power grid will be unable to scale out to support future diversity of systems and interactions. The approaches of service oriented architecture (SOA), applied to the processes in buildings and in the power grid, as well as to consumer interactions in intermittently connected devices and storage, provide a way around this barrier to smart integration.

Service oriented coordination of building services will open up new avenues for energy re-allocation and conservation. Service orientation deals with the diversity of building systems while providing the building owner/operator with new understanding of the costs and benefits of controlling power use.

The service oriented grid (SOG) must apply the same approaches to its own interfaces. Building-grid interactions must move past mere availability and consumption to include cost, quality, and projected reliability. On-site and microgrid energy sources will use the same surfaces as do grid-based sources.

Many hope that electric cars and their batteries will be a means to peak shaving and demand smoothing. Cars could instead increase demand volatility. Drivers, automobile producers, and the grid need a common vocabulary for the acquisition, storage, and use of power for use.

Ontologies naming building-based and grid-based services will enable applications for enterprise and consumer. The SOG will use them to enable technical and business innovation.

1. SEMANTIC MISMATCH BETWEEN BUILDINGS AND ENERGY

Process oriented integration of the power grid will be unable to scale out to support future diversity of systems and interactions. The approaches of service oriented architecture (SOA) enable orchestration of diverse technologies managed by different organizations. SOA can be applied to the processes in buildings and in the power grid, as well as to consumer interactions in intermittently connected devices and in energy storage.

1.1. The Information Gap

We do not make effective decisions about things we do not understand. Deep process information only makes sense experts within the domain of that process. Facilities owners and operators are unable to make decisions based upon the details of building control systems.

Control system integration has traditionally been detail oriented and process specific. Control system performance is usually described in terms of process results or code compliance. Code compliance leads only to minimum results, ones that the decision maker cannot opt-out of. Process outcomes are typically expressed in technical results that do not map easily to business goals. For example, HVAC CFM is not easily mapped to business goals such as Tenant Satisfaction and Lease Retention

Because of the information mismatch, building decision makers are not able to make decisions to produce maximum response to economic signals such as Demand / Response. This leaves engineers to design minimal responses with the goal that the tenant does not notice.

1.2. The Engineers Perspective

Building operations are described in procedural or algorithmic terms. Information is siloed so there may be no direct way to measure performance; systems traditionally report only their internal metrics. These metrics are likely to be reports of measurable physical qualities, free of business context.

Examples are reporting air conditioning performance in terms of CFM of air or battery status in terms of crystal degradation.

1.3. The Building Owners Perspective

To the facility manager or leasing agent, service curtailment can only have bad results. Customer Complaints will increase. A tenant may not renew a lease. A single month of vacancy coupled with between-tenant renovations could easily swamp the benefit of demand-response during the year. It is better not to take a risk.

1.4. The Building Tenant's Perspective

Sustainable operations have value only as tie-breaker between equivalent properties. There is no way to see or to understand building system operations on a daily basis. Without a way to audit performance of buildings, *my comfort, right now* is the only effective measure of competent operations.

1.5. Barriers to Innovation

Process-to-process interactions require that the integrator be aware of the operations of each system or domain. Changes in one system require re-integration with the next. Traditional integration leads utilities to specify a single brand of a single component, often a twenty year decision. Complexity is managed by eliminating diversity.

The largest source of diversity on the grid is the end nodes. Different purposes and individual tastes are served by different vintages of equipment. Traditional grid integration has simplified this interaction to the single point of the dumb meter and perhaps a signal to the water heater or air conditioner. As the future grid becomes the intelligent grid, this one way non-interaction will not be enough.

Future build technologies are likely to be more diverse than now. Each building may have a different mixes of systems for energy storage, energy conversion, energy recycling, and energy generation. Site-based decisions will support different technologies to support each of these functions. It is in all our interest to encourage innovation and competition between developing technologies to support these functions. This requires that we minimize integration costs between different technologies. We cannot afford for difficulty of integration to be the single largest source of market friction blocking innovation.

Integration patterns must support greater agility while requiring less deep domain knowledge of emerging energy technologies.

2. DEVELOPING BEST PRACTICES IN ADJACENT DOMAINS

Service definition and service alignment are the key concepts in IT systems integration and in facilities design. In either case, best practices are to define the service deliverables expected from each system and not the techniques and technologies to deliver the service.

Once the service is agreed upon, then one can define useful metrics as to how well that service is delivered. Measurements that are incidental to that service delivery are not interesting to those procuring the service. Alternative technologies and approaches that deliver those new metrics become acceptable alternative, spurring innovation.

The entity with the domain expertise to create, maintain, and evolve a given capability may not have the expertise or the desire to create, maintain, and evolve its service access. Visibility, interaction, and effect define the service.

2.1.1. Service Orientation: the IT Perspective

Service Oriented Architecture (SOA) is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. Capabilities to solve or support a solution for the problems they face in the course of their business. SOA provides a powerful framework for matching needs and capabilities and for combining capabilities to address those needs.

Visibility, interaction, and effect are key concepts in SOA. Visibility refers to the capacity for those with needs and those with capabilities to be able to see each other. This is typically done by providing descriptions for such aspects as functions and technical requirements, related constraints and policies, and mechanisms for access or response. The descriptions must be in a form (or must be transformable to a form) in which their syntax and semantics are widely accessible and understandable. Whereas visibility introduces the possibilities for matching needs to capabilities (and vice versa), interaction is the activity of using a capability.

SOA practitioners distinguish between public actions and private actions. Private actions are inherently unknowable by other parties. Public actions result in changes to the states that are shared between at least those involved in the current execution context. Real world effects are couched in terms of changes to this shared state. A cornerstone of SOA is that capabilities can be used without needing to know all the details.

SOA is not itself a solution to domain problems but rather an organizing and delivery paradigm that enables one to get more value from use both of capabilities which are locally "owned" and those under the control of others. Although SOA is commonly implemented using Web services, services can be made visible, support interaction, and generate effects through other implementation strategies

2.1.2. BIM: Enabling Owner Participation

Building Design approaches and business models are being re-written using the standards-based Building Information Model (BIM). BIM can include all information related to the design, procurement, and operation of a building, including the three dimensional Building Model. In the U.S., BIM as been codified in the National BIM standard (NBIMS). Internationally there is an effort to adopt NBIMS operating as buildingSmart. BuildingSmart is a transformative peer organization whose goals, scope, and reach can be compared to GridWise.

A core value of buildingSmart is granting authority to the Owner of a building to make design decisions by expressing them in terms of business deliverable early in the design process. For example, when reviewing the three dimensional rendering of alternate building design options, the owner can directly compare projected costs per square foot and net leasable space for each. This changes design selection into esthetics, capitalization, and revenue, and puts the business decision maker in charge.

BIM has many other benefits, especially in the areas of construction planning and process, but those are outside the scope of this article.

Today's BIM lacks any language to unambiguously discuss the desired system performance of a building. Building system performance relies on knowledge sets that are not possessed by most architectural firms. This has negative effects on commissioning and operations. This also precludes the owner from specifying and obtaining the same level of control over building operations as over the other design criteria.

3. ONTOLOGIES AND SEMANTIC DEVELOPMENT

If we cannot agree what to call it, we cannot compare services to provide it; semantics are an essential part of SOA. For the grid, semantic alignment will open up interoperability without locking in technology. When people can name it, then they can buy it on an open market.

But the intelligent grid will require intelligent partners. We must develop business and tenant oriented semantics for building services in parallel with the grid efforts to enable full interoperable responsiveness on both sides of the meter.

3.1. Grid Semantics

Availability, price, and consumption are essential components for any service. For any but the least interesting markets to develop, the semantic interface needs to allow for more meaning:

Capability & Reliability: Capacity / Capability / Availability (including time windows) / Anticipated Reliability / Marginal Price

Market Operations: Power Use curves, Negotiation & Contracts, Offer and Acceptance, Scheduling options, Periodic price curves. Settlement. Contracted Curtailment DR

Multi-party & Mobile transactions: PHEV, Non-Utility vendors, identity, transactional charge override

Tariffs: Distance charges, transmission, carbon taxes…

Attributes & Amenities: Carbon, Wildlife, Location… Optional attributes for later definition and market building.

3.2. Building Semantics

Buildings are occupied by different enterprises each with its own values. There will not be common ontology for all of them.

Efforts are underway in the building areas, particularly in the buildingSmart process, to define value semantics for owners and tenants. These standards are defining the services provided by building-based systems and creating a semantic of service performance.

To a business, an ontology is a business value proposition; each business has its own. The common semantics defined as above create a common way to discuss that proposition, and to elevate the quality of those services into core business concerns...and that which a business can name and measure, it will control.

Building-based ontologies, though, will not be brought to the grid. They are domain specific. Building-side semantics are used to bring internal energy use under management and control.

Buildings will use the demand side of the grid semantic interface. Capacity / Capability / Availability become market demand. Market Operations become symmetrical negotiations. Multi-party & Mobile transaction become federated identity management. Attributes & Amenities support the businesses internal ontology. These semantics will enable the Service Oriented Building (SOB).

3.3. Cross-over semantics

Zero net energy buildings are buildings that manage internal generation, storage, conversion, and recycling of energy. Zero net energy buildings will use diverse site-appropriate technologies to accomplish these ends. Zero net energy buildings will require internal interoperability standards and support internal energy negotiations.

The principle of parsimony suggests that at least some of these negotiations can best be performed using the semantics or energy scarcity and value, of supply and distribution for these internal negotiations.

3.4. Plug-In Cars, Hybrid and Otherwise

Many hope that electric cars and their batteries will be a means to peak shaving and demand smoothing. Cars without management are more likely to increase demands on the home, office, and local distribution.

Drivers, automobile producers, and the grid require a common vocabulary for the acquisition, storage, and use of power. There is no need for this vocabulary to be different than that outlined above as the cross-over semantics for buildings.

3.5. Semantics enable Security

Traditional power grid security has been based on isolation. New two-way interaction patterns require that energy systems no longer be isolated. This requires that security be reconsidered

Security without context is meaningless. Security without context can only say no. Key opportunities in energy management are lost because current business models do not share even such basic information as consumption data in real time. At the same time, non-granular security puts all operations at risk from any intrusion.

Where possible, systems should not share deep process information, but present only the information required for interoperation and safety. This informational interface presents a smaller attack surface to the outside world. Each such system defends its own mission first, and responds to the outside world only in defined ways.

As we standardize these simplified modes of interoperability, interactions move from the low level process to the higher level business function. Different technologies, such as small point-generation systems may present the same business function. A storage system may present two business functions, one as a consumer of power, and one as a sporadic producer of power. The deep process of each technology would be hidden from the operational interface. This in itself provides one layer of a defense in depth security.

The vocabulary that names these business functions maps more easily to business rules of who may do what. These rules are more understandable to the observer or security auditor, another source of security. The business semantics become one layer of a multi-layer security model.

4. CONCLUSION

Future energy technology will place more technical diversity than today in closer interaction. Process oriented integration of the power grid will be unable to scale out to support such diversity of systems and interactions. Service level integration will be applied to both the processes in buildings and in the power grid and to consumer interactions and intermittently connected devices.

Service oriented coordination of building services will open up new avenues for energy re-allocation and conservation. Service orientation deals with the diversity of building systems while providing the building owner/operator with new approaches to controlling power use.

The SOG will apply the same approaches to its own interfaces, those between Generation, Transmission, Distribution, and Consumption. Building-grid communications will move past mere availability and consumption to include cost, quality, and projected reliability. On-site and microgrid energy sources will use the same surfaces as do grid-based sources.

Service based integration is the way to expand intelligence and interaction of the grid and its end-nodes. Service definitions will prevent integrations from becoming enmired in atomic interactions. Ontologies naming building-based and grid-based services will enable applications for enterprise and consumer. The SOG and the SOB will hide complexity to enable technical and business innovation.

References

[1] "Better Behavioral Description for Dynamic Semantic Web Services Collaboration" Zhangbing Zhou; Bhiri, S.; Ke Ning; Vasiliu, L.; Foxvog, D.; Gaaloul, W. Semantics, Knowledge and Grid, Third International Conference on, Volume , Issue , 29-31 Oct. 2007 Page(s):338 – 341, IEEE Digital Object Identifier 10.1109/SKG.2007.57

[2] "Reference Model for Service Oriented Architecture 1.0" OASIS Standard, 12 October 2006 Editors: C. Matthew MacKenzie, Ken Laskey, Francis McCabe, Peter F Brown, Rebekah Metz, Location: http://docs.oasis-open.org/soa-rm/v1.0/

Biography

Toby Considine has been integrating building systems and business processes for longer than he cares to confess. Since the Y2K push ended with the post-midnight phone call from the University of North Carolina Cogeneration Plant, Toby's focus shifted to standards-based enterprise interaction with the engineered systems in buildings.

Toby has been chair of the OASIS oBIX Technical Committee. oBIX is an unencumbered web service designed to interface between building systems and e-business. In the summer of 2008, he became co-chair of the OASIS Technical Advisory Board. He is active on the NIST Smart Grid Domain Experts Group and works to promote applying information technology to with groups such as buildingSmart and FIATECH.

Before coming to the university, Mr. Considine developed enterprise systems for technology companies, apparel companies, manufacturing plants, architectural firms, and media companies old and new. Before that, Toby worked as a biochemist following undergraduate work in developmental neuropharmacology at UNC.

Mr. Considine is a recognized thought leader in applying IT to energy, physical security, and emergency response. He is a frequent conference speaker and provides advice to companies and consortia on new business models and integration strategies.