

# Architectural Elements Categorization

Smart Grid Architecture Committee (SGAC)

Architecture Development Team

Release 0.9



Smart Electric  
Power Alliance

## Proceed With Caution



- The following material is offered as **guidance** for practitioners involved in Enterprise Architecture.
- This is not a tutorial and the assumption is made that the reader has at least a basic understanding of enterprise architecture frameworks and semantic information concepts.
- Background information on enterprise architecture and semantic frameworks, including TOGAF, Zachman, SOA, and OWL, is widely available and as near as a Google query.

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# Agenda



- Background
- Key Contributors
- Problem Statements
- Objective/Goal
- Contributions
- Data Reduction/Normalization Process
- Architectural Element Categorization Guidance
- Neutral Concepts Model Approach
- Potential Future Phase

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## Background



This effort advances smart grid / grid modernization architecture development efforts

- Built upon earlier smart grid architecture efforts: NIST Framework and Roadmap for SG Interoperability Standards, SGAC smart grid architectural conceptualization and gathering of architectural elements, GWAC Interoperability Layers, and SGAM development and release
- Using a methodology from common Architecture Frameworks: TOGAF, Zachman, and SOA

NIST- National Institute of Standards and Technology

SGIP- Smart Grid Interoperability Panel

GWAC - Gridwise Architecture Council

SGAM – Smart Grid Architecture Model (European Union)

SOA- Service Oriented Architecture

TOGAF- The Open Group Architecture Framework

## Key Contributors



- Chair (2014-present): Dr. Elizabeth Sisley (Calm Sunrise Consulting)
- Dr. Steven Ray (Carnegie Mellon University)
- Ron Cunningham (AEP)
- Dr. Gerald Gray (EPRI)
- Stephan Amsbary (Emeritus Member)
- John Ruiz (Emeritus Member/Chair)

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AEP – American Electric Power  
EPRI- Electric Power Research Institute

## Problem Statements



### IT/OT Projects:

- If fortunate, have access to prior/related projects' artifacts to work from, but many times start from scratch when updating existing system or application architecture/designs
- Deal with business, system, application, terms and definitions differently:
  - Assume that named terms/vocabularies used in industry or found in standards are interpreted the same across all users, groups, organizations, nations, or
  - Define their own Terms/Definitions without reuse of existing company or industry terms/definitions that are commonly accepted, or
  - Discover after the fact, what are in reality the same thing, are named differently across users, groups, organizations, nations, or
  - Project-defined context and abstraction levels of architectural terms and elements are not the same from one system-application project to the next, or
  - Struggle to gain understanding when integrating a project's application(s), data, and messaging with another set of applications, data, and messaging.
- End up identifying/naming/defining their own set of Actors, ServiceCompositions (~roles), Services used to document business scenarios, use cases, and stories

IT - Information Technology

OT – Operations Technology

## Objectives/Goals



- Provide Guidance/Examples on how to align from one project's set of architectural/business elements to another. Alternately encourage reuse of a reduced number of sets of architectural/business terms via understanding how a setA-element relates to a setB-element
- Build up a common set of architectural/business elements and the relationships between them, that can be used, interpreted, understood, and modeled the same way across projects and organizations
- Reduce the time/effort of each project's re-identifying/re-naming/re-defining Actors, ServiceCompositions (~roles), Services, relationships, and associated missteps from one integration to the next
- Help create a common vocabulary of terms and elements that is expected to make it easier to create new business use cases/stories that in turn are used to help identify the business requirements and services/capabilities that are used in project business scenarios and use case development, and advancing interoperability standards work

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## Contributions



### Produced SGAC Architecture Element Metadata Model

- Clarified architectural abstraction term definitions, categorized gathered use case architectural elements, developed a Decision Tree to classify:
  - Abstraction levels: Conceptual, Logical, Physical, Implementation
  - Architectural element types: Service, ServiceComposition, Actor
- Leveraged architectural standards and business use cases for architectural elements from 18 organizations including, e.g., NIST, SGIP, NAESB, IEEE, IEC, and European Union (EU)
- Used Web Ontology Language (OWL) and various architectural tools
- Introduced “Neutral Concepts” multi-level model including the above metadata

NAESB- North American Energy Standards Board

IEEE- Institute of Electrical and Electronics Engineers

IEC- International Electrotechnical Commission



## DATA REDUCTION/NORMALIZATION PROCESS

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# Data Summary



SGAC gathered a set of Use Case elements from 18 organizations and performed initial categorization of elements to Conceptual, Logical, Physical architecture abstraction levels. Combined set was also categorized as:

- ~ 180 Actors
- ~ 230 ServiceCompositions (~role)
- ~ 800 Services

## Submitting Organizations

- |   |   |
|---|---|
| ■ NIST (AMI Systems, Electric Transportation, Distribution Grid Mgmt, WASA, Demand Response, Electric Storage, Conceptual Model, and Reference Diagram) | ■ SGAC Conceptual Arch                          |
| ■ NAESB   | ■ IEC TC57-WG19 & TC8 (SyC) WG6 DER Actor/Roles |
| ■ CSWG NISTIR 7628  | ■ EU SC-CG WP1                                  |
| ■ IEEE P2030 Draft 3  | ■ ENTSO-E role model                            |
| ■ EIS   | ■ AhG Charging                                  |
| ■ EU Commission   | ■ IEC61968 IRM                                  |
| ■ EU WGSP Vers 0.5  | ■ IEC SG3                                       |
|   | ■ GUC   |
|   | ■ DKE Repository                                |
|   | ■ SMCG  |
|   | ■ EG3   |

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## Data Reduction & Normalization Process



For each named Element, in TopBraid Composer's (TBC) OWL model:

- Where there were multiple submissions, definitions were reviewed to normalize entries
  - When definitions were either identical or very similar, or one had a missing definition – source data was consolidated, and all references kept for traceability
  - A few elements remain ambiguous, and will need to be reviewed by the submitting organizations for determination
    - These are flagged via a SeeAlso relation in TBC: listing one or more likely related elements
    - A few have no similar entries but are missing definitions, these remain uncategorized
- Elements that are redundant or out of scope (such as 'ActorA' and 'ActorB') were marked as deprecated, but kept within the model

Elements were then categorized as described in the following slides



## ARCHITECTURAL ELEMENT CATEGORIZATION GUIDANCE

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## Architectural Abstraction Level and Element Categorization Guidance

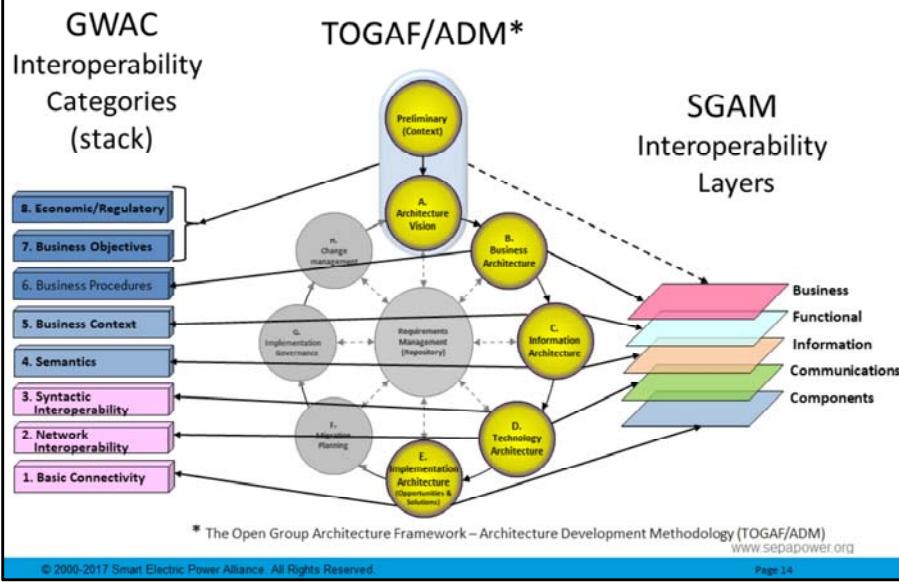


- Architecture Abstraction Levels
  - Conceptual, Logical, Physical, Implementation
- Service Oriented Architecture (SOA) Elements
  - Categorization of Elements into Actors, Services, and ServiceCompositions (~roles)
- Categorization Guidance Decision Tree

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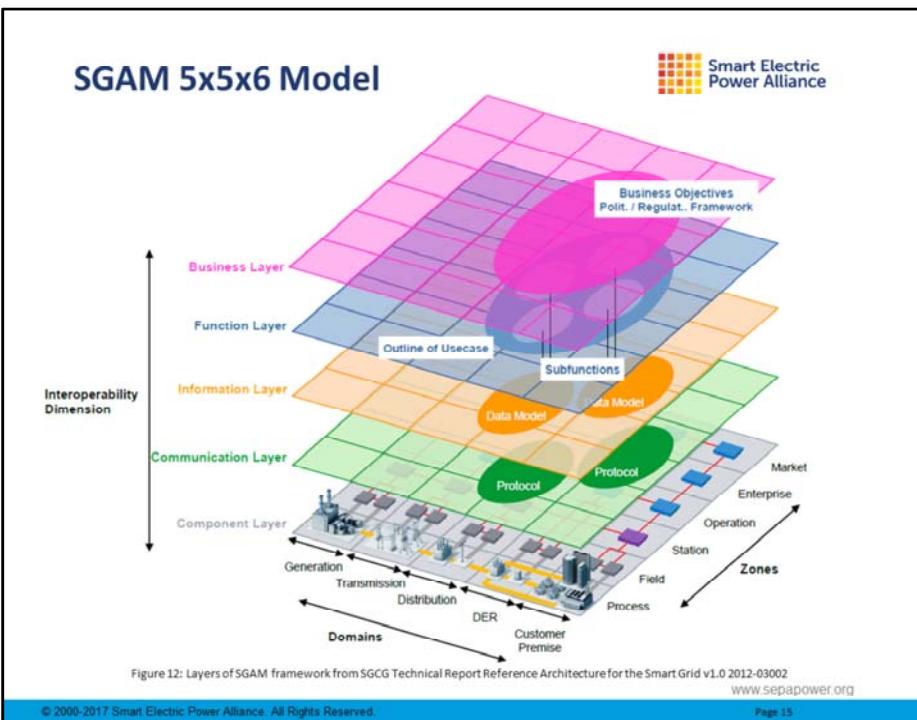
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## Framework Mapping GWAC & SGAM Alignment with TOGAF

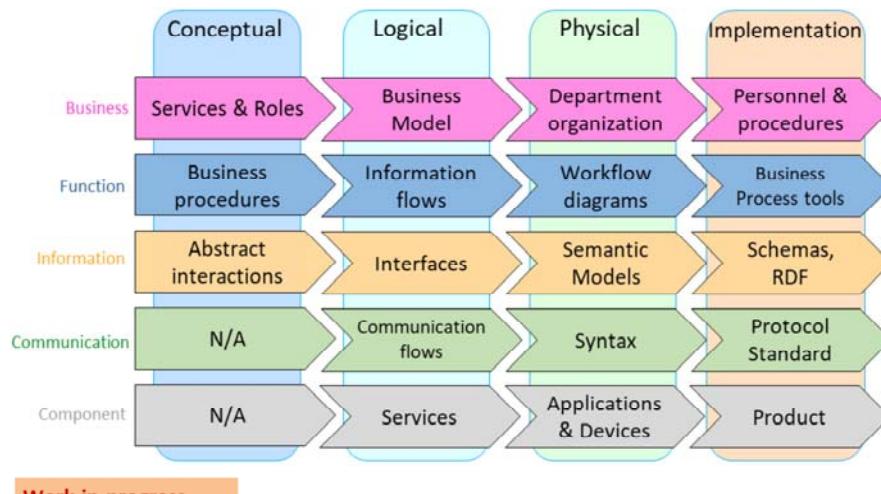


GWAC – GridWise Architecture Council

SGAM – Smart Grid Architecture Model



## Architectural Abstraction Level mapping onto SGAM Interoperability Layers, with examples



Work-in-progress

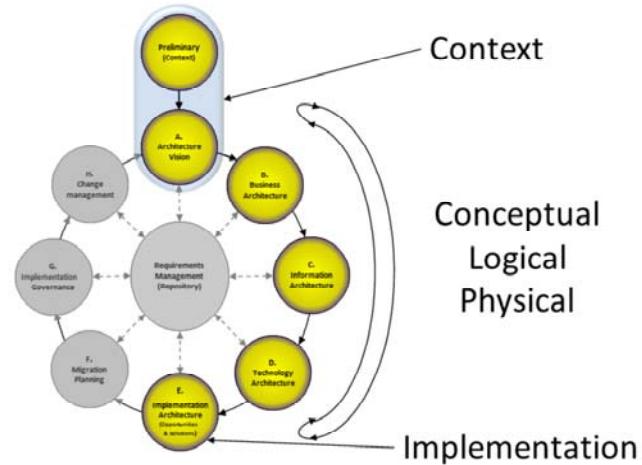
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## Architectural Abstraction Iterations within TOGAF



TOGAF/ADM

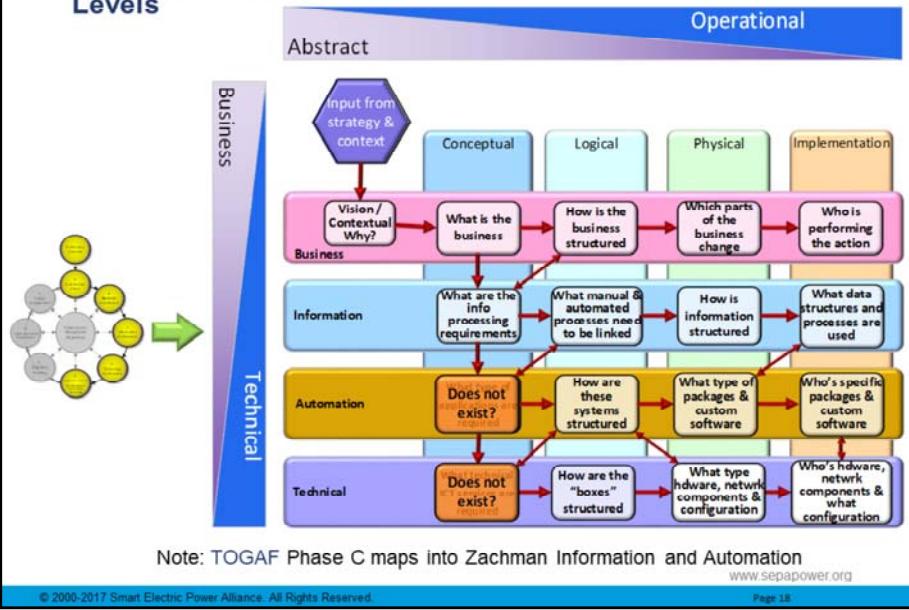


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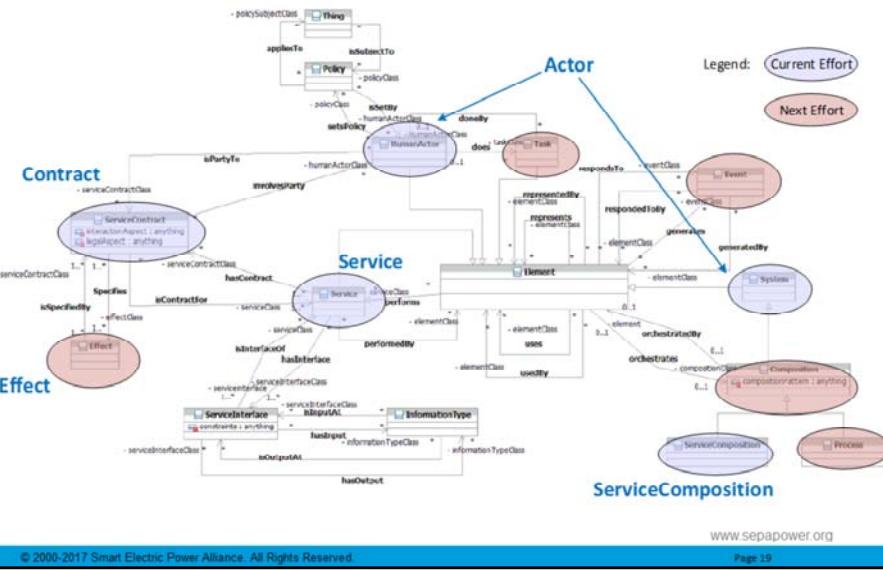
## Conceptual, Logical, Physical, Implementation applied to Zachman Levels



The 2 lower left orange shaded cells under Conceptual Level are to indicate that the Automation and Technical aspects are not applicable at this high level of Architecture Abstraction (the ? Mark indicates still need to conform this with the Zachman International e.g.

- Automation ask – What type of applications are required
- Technical ask – What technology ICT (Information Computing Telecommunications) services are required.

# Full Open Group SOA Ontology Mappings to SGAC Arch.Dev. Effort



Source of SOA metamodel – The Open Group “Service-Oriented Architecture Ontology Version 2.0” Figure 1: SOA Ontology – Graphic Overview

We choose Actor, Service, ServiceComposition, and Contract (not yet populated) for our modeling. Contracts is where the business contracts (Conceptual level) and non-functional (Logical and Physical levels) information will be represented.

Note:

- 1) Effect is not currently in the ADWP OWL model.
- 2) SOA element and thing are used in different context than SOA. SGAC uses element as in the phrase “architectural element” that includes e.g. Actors, Service, ServiceComposition, Contract. Thing is used in the SGAC Architecture Element Metadata Model as a general class, but not otherwise called out.

## Conceptual Architecture Definition\*



**Conceptual Architecture** models the business as the organization owner conceptually thinks the business is or wants the business to be. (e.g. black box view)

### What are the services that are required to satisfy the business needs?

- Business Services at the Conceptual abstraction level represent the goals of the owner
  - **WHAT** the organization *wants* to do, which is driven by its mission
  - **WHAT** it *needs* to do, which is often driven by regulations
- Conceptual Services have a lot of attributes
  - Service levels and other non-functionals
  - Specifications of functionality
- Simplest questions to identify Conceptual Elements:
  - **WHAT** are the essential elements within scope?
  - Which services are needed to provide to the outside world to fulfil its mission?
  - Which services from the outside world are needed to do that?

\* Based upon Zachman Framework

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## Zachman Example of Conceptual, Logical, Physical Abstractions

• The '*Owner*': '**CONCEPTUALLY**... I would like a pot of flowers in the center of my patio about 10 feet off the ground. They would be purely for ascetic reasons, but I want the pot to be BIG and the flowers to be real.'

• The '*Designer*': 'Hmmmm. Let me see now... the physics of this situation would suggest that there are two **LOGICAL** alternatives... either 1) you would have to have a pedestal about 10 feet high, the weight it would have to sustain is max of 100 pounds so if it was 10 square inches in area (cross-section) the material would have to hold 10 lbs per sq. inch. You're second alternative 2) would be to hang it from something above the pot... do you have a roof over the patio?? If not, that would mean we would have to construct a tripod to suspend the pot from the apex. Do you care if you see the tripod? Hmmnnn. I recommend you go with the pedestal.'

• The '*Builder*': 'Hmmmm... the Architect is suggesting a pedestal that would be 10 feet high and sustain 10 pounds per square inch. That Architect wouldn't recognize a lathe if he fell on one... but here's what we could do... we could **PHYSICALLY** build the thing in three pieces and then glue it together with superglue... just in case, we could make flanges on the pieces so we could bolt the pieces together to make sure they don't come apart. Your

other alternative is to have it made in Japan and ship it in one piece and then we could install it by drilling a hole in the patio, sinking the base down 2 feet and filling in the hole with cement.

Reference: <http://www.zachman.com/ea-articles-reference/58-conceptual-logical-physical-it-is-simple-by-john-a-zachman>

## Logical Architecture Definition



**Logical Architecture** models the technology-agnostic “systems” and representations of the business that are used to realize the services defined at the conceptual level. This includes business functions and actors. (e.g. white box view)

### How are the business functions and actors ideally structured?

- **HOW** are basic elements related, according to the specific objectives and constraints of the architecture? (Logical Structure)
- What are the building blocks needed to run the business as defined in the Conceptual Architecture?
- Building blocks are technology independent services
- This is more about the interfaces than the technologies

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Technology specific details are included in the Physical abstraction level.

## Physical Architecture Definition



**Physical Architecture** further constrains the Logical architecture. This is the abstraction level where application and system architecture/design/technology choices are made that address and may constrain the business, application, and data model. This level represents HOW the Architecture ideally is being designed, excluding further implementation level restrictions.

### Addresses what actors, software and processes are necessary

- **HOW** elements of structure will be realized, according to architecture and design strategies and implications, and with **WHAT** will this be achieved?
- Describes physical implementation components. This set of components is a representation of components or building blocks an architect will use:
  - A person
  - A process
  - A piece of software
  - A piece of infrastructure
- Provides technical implementation specifications; the details needed for white box development processes (eg: ITIL, Rational Unified Process, Software Development Life Cycle, Agile), vendor solutions, and manual processes (TOGAF Phase E).

## Categorizing the Data

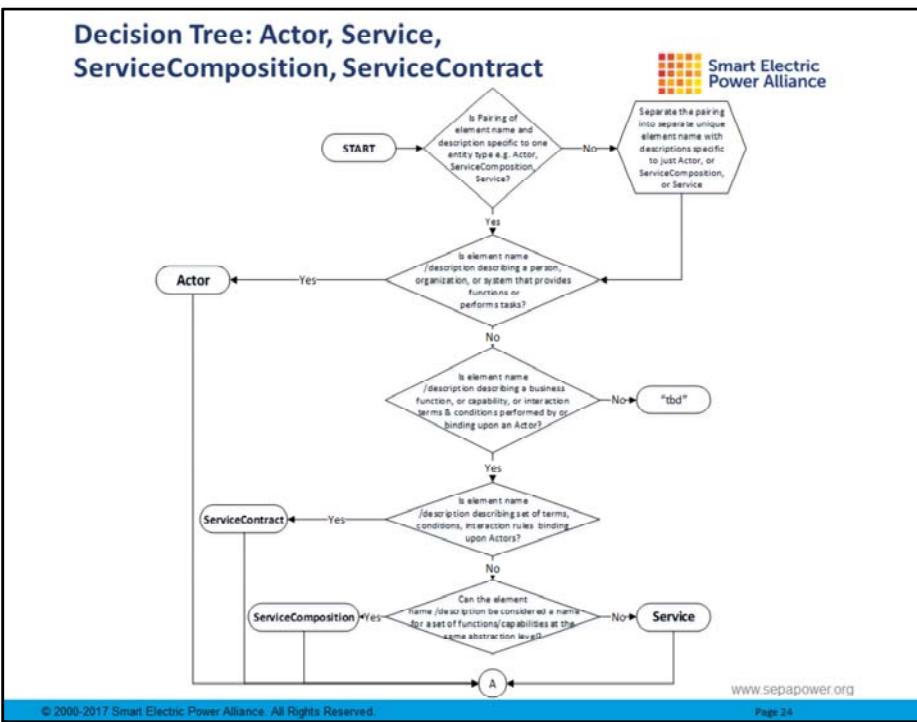


SGAC modelers categorized the data in two ways:

- Type of Element
  - Actor
  - Service
  - ServiceComposition
- Architecture Abstraction Levels
  - Conceptual
  - Logical
  - Physical

Using the Decision Tree on the following slides

The data did not contain Contracts or Implementation category items



The typing to “tbd” is to account for the gathered set of terms, not being able to mapped to SOA terms or elements of immediate architectural interest e.g. measured terms like voltage, current, rate-of-change

Also more detail can be added to especially the Actor and Service to a call out sets of elements at the same abstraction level that all at the same set of inherited attributes but are different sub-classifications of that named inherited set e.g. think parents/offspring where the offspring are the set of common siblings.

[https://members.sgid.org/kws/groups/sgip-sgac-awp/documents/working309/document?document\\_id=9837](https://members.sgid.org/kws/groups/sgip-sgac-awp/documents/working309/document?document_id=9837)

## Decision Tree: Conceptual, Logical, Physical, Implementation



At a context level, treat the business as "black box" noting the major functions & capabilities that business has with 3<sup>rd</sup> parties

Within the business context, treat the business as "white box" to further detail and describe the functions & capabilities performed within the business and with 3<sup>rd</sup> parties

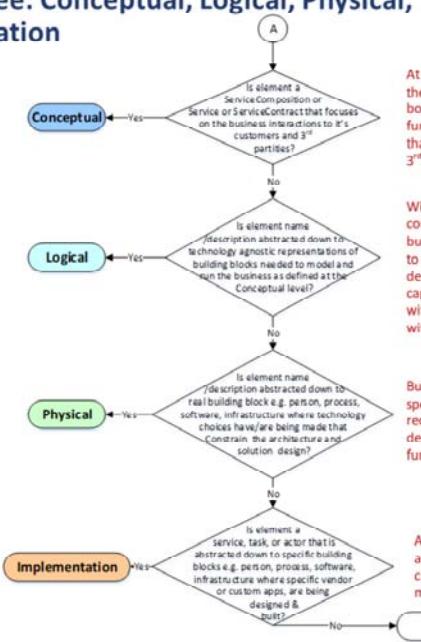
Building block specifications, requirements, descriptions, non-functionals are created

Actual technology and implementation configurations are made

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## Semantic Architecture



### Modeled in OWL

- Similar to Unified Modeling Language (UML), but with added expressiveness to capture constraints, arbitrary relationships and a supporting query language (SPARQL)
- Supports automated reasoning with popular reasoning engines (e.g. SPIN, OWLIM, Apache Jena)
- TopQuadrant's TopBraid Composer™ was used as the modeling environment, under license to SGIP

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SPARQL – SPARQL Protocol And RDF Query Language

SPIN – SPARQL Inferencing Notation

OWLIM - family of semantic repositories and describes many of its features that make it a world-leading RDF storage, reasoning and query-answering platform.

## Meta Object Modeling Approach



- **Meta Classes** - Used to categorize classes

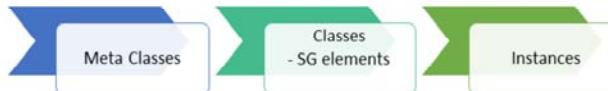
- Actor
  - Service
  - Service Composition (Role)
  - Service Contract
- ...with relations between them

- **Classes** - Used to represent terms

- e.g.
  - Smart Grid Elements
  - Premise Management
  - Communication Network
- ... categorized by the Meta Classes

**Instances** - Used to inventory specific Systems and Services e.g.

- Meter #4127
- Web service implemented at <http://fakesite.com/premise>
- Network A at 129.6.24.159

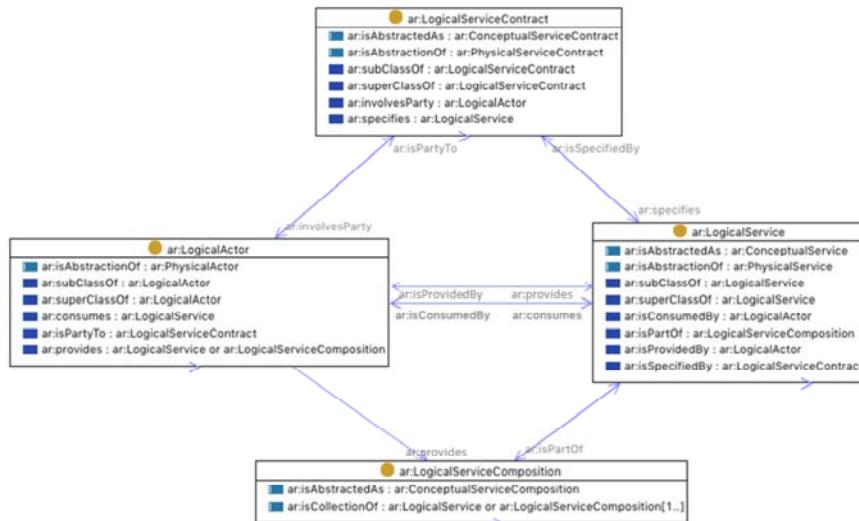


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The architectural model uses three levels. Another way of describing this process is that terms collected from smart grid standards are modeled as Classes. These classes are categorized into a small number of Meta Classes. Actual systems and services in operation are Instances of the Classes.

## Architectural “Meta Classes” Logical Level

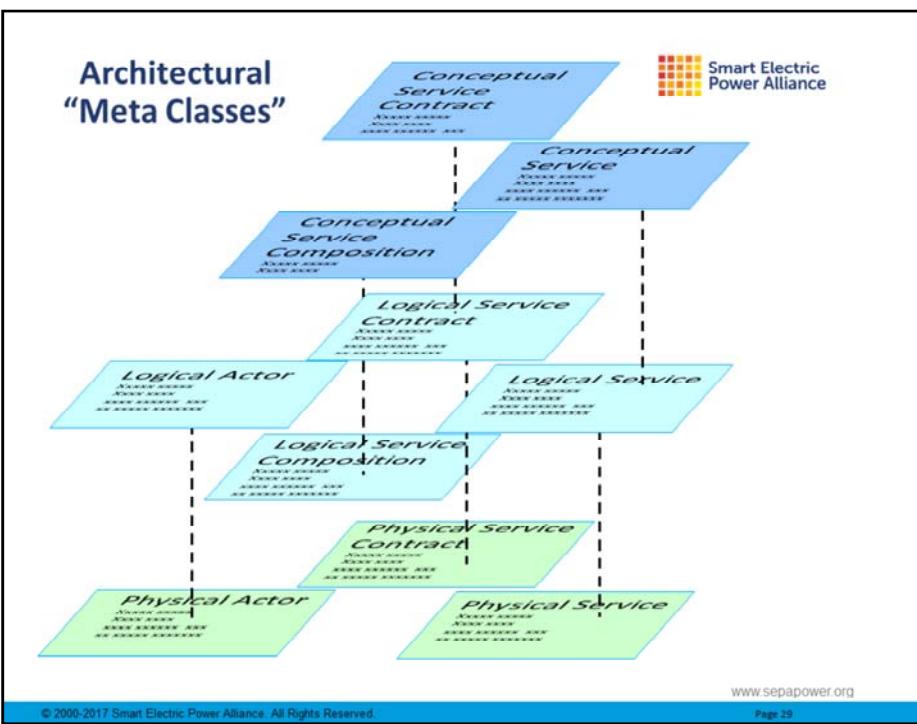


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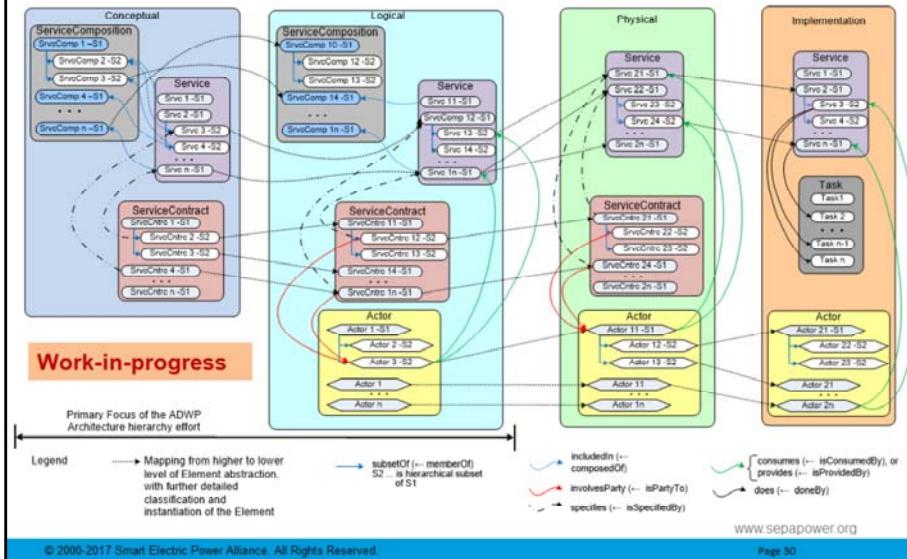
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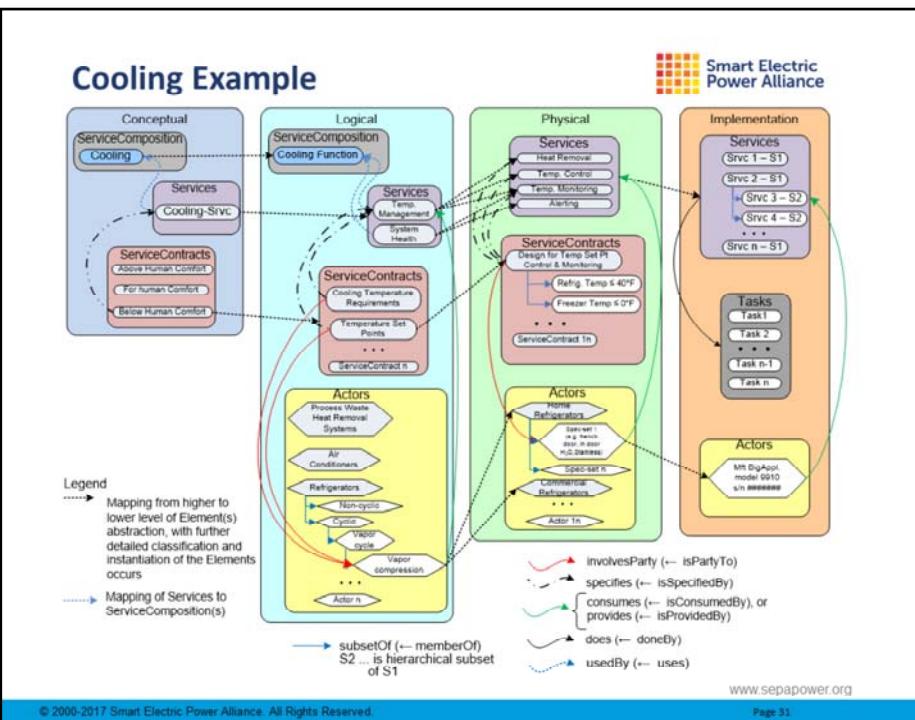
The Meta Classes have defined relationships.



The Meta Classes are organized into three levels of abstraction: Conceptual, Logical and Physical

## Abstraction Levels Applied to SOA





## Categorization Guidelines for Architectural Elements



### Categorize the original elements

- Identify elements as Actors, Services, ServiceCompositions, and ServiceContracts
- Identify the Architecture Abstraction Levels
  - **Conceptual** - these are the business-to-business (B2B) relationships, the B2C (consumer), and the B2R (regulatory & policy). Thus a black-box view of the business.
  - **Logical** – this is where Actors come in, but there are also Services. This is a white-box view of the business, showing the internal elements and their relationships.
  - **Physical** - the representation of a Specification, where the required features (functional and non-functional) are included. Technology approaches are chosen.
  - **Implementation** – actual technology product choices and implementation configuration decisions are made.

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## Categorization Guidelines for the Elements



- Semantics should be explicitly documented to reduce ambiguity
- An Actor is considered to be a person, organization, or system that has at least one role (ServiceComposition) that initiates or interacts with other Actors. Actors may be internal or external to an organization
- A ServiceComposition is the usual or expected function, or context, in which an actor consumes/provides a service. An Actor may play a number of roles
- At the highest level, a Conceptual ServiceComposition represents the goals of the stakeholder (e.g.: Energy Provider). A Conceptual ServiceComposition will have many defining characteristics
- A Logical ServiceComposition decomposes/partitions a conceptual role into functional components. At the Logical level is where the mapping from roles to Actors occurs
- There is no such thing as a Physical ServiceComposition. At this level an Actor simply offers services according to advertised interfaces. Similarly, there is no such thing as a Conceptual Actor
- A Conceptual ServiceComposition maps to one or more Logical Service Compositions, which get related to one or more Logical Services which are consumed or provided by Logical Actors
- A Physical Actor is an instantiation of a Logical Actor. A Physical Actor performs a set of actions which is a Physical instantiation of a Logical ServiceComposition

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## Summary



- Created an OWL model (SOA focused), that shows the relationships of the elements across the Conceptual, Logical, Physical abstraction levels
- Started work on:
  - using a specific real world use case set of Actors, Services, messages to vet out the OWL model;
  - relating the use case set of elements to the gathered set of elements using a “neutral concepts” OWL model of the business scenario that the use case came from;
- Intent is to create the appropriate relationships of one set of elements to another for the purposes of helping identify a common vocabulary of architectural/business terms and elements.

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## Mapping Use Case Terms

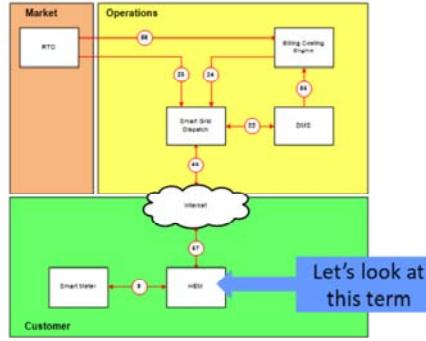
(example from EPRI IntelliGrid Use Case Repository)



### Performing Real Time Price Auction

\*Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-OE0000193.

Disclaimer: This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.\*



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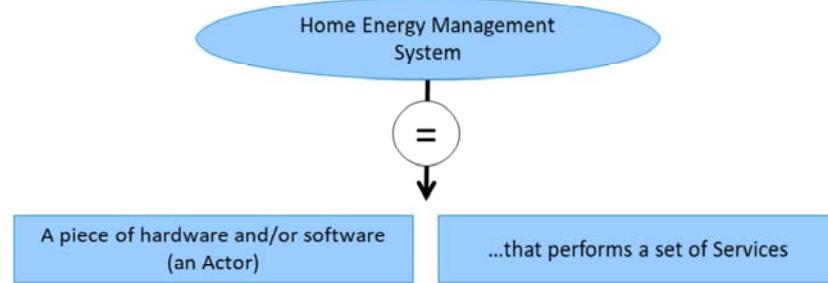
To illustrate how the categorization works in a use case, let's consider a use case example from AEP "AEP Performing Real Time Price Auction", located in EPRI's Use Case Repository <http://smartgrid.epri.com/Repository/Repository.aspx>. In particular, let's focus on the term called HEM, for Home Energy Manager.

## The HEM in the AEP/EPRI use case



HEM stands for “Home Energy Management” (System)”

What does that really mean?



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We can tease apart the words “Home Energy Management System” to suggest that it is an Actor that provides a set of Services

## The HEM in the AEP/EPRI use case



A piece of hardware and/or software  
(an Actor)

There are different kinds of hardware.  
What kind of hardware?

Sensor hardware

Actuator hardware

Control hardware

Industrial grade

Commercial grade

Residential grade



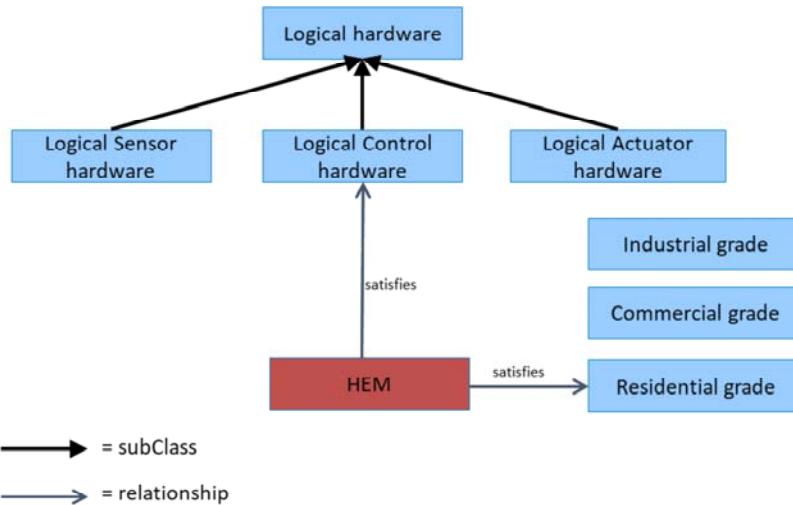
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Since the collected terms may not cover all possible kinds of Actors, a Neutral Model is helpful to cover all possibilities. For example, you could classify different subclasses of hardware, such as Sensor hardware, Actuator hardware, Control hardware, etc. Similarly, it might be useful to partition hardware by quality grade.

## The HEM in the AEP/EPRI use case



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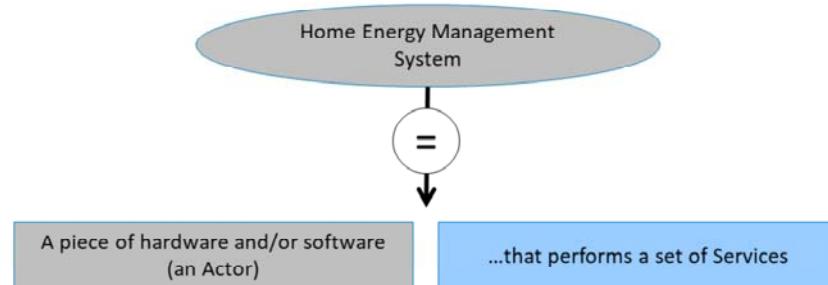
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The HEM can be classified under both of these (and other) schemes as shown here. The implication of the “satisfies” relation is that it meets all the specifications defined for the relevant classifications.

## The HEM in the AEP/EPRI use case



OK, we have characterized the hardware.  
What about the Services it performs?



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Next, we can examine the kinds of services provided.

## The HEM in the AEP/EPRI use case



### Services

We can define a hierarchy of Services

For this Demand Response (DR) use case, we know the HEM provides at least a DR service

HVACManagementService

DRVENService

DERManagementService

= subClass

= relationship

HEM

LogicalServiceComposition

FacilityService

DistributionService

EnergyManagementService

SecurityService

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Again, the Neutral Model can give the context for classifying services.

HVAC – Heating, Ventilation, Air Conditioning

DRVEN – Demand Response Virtual End Node

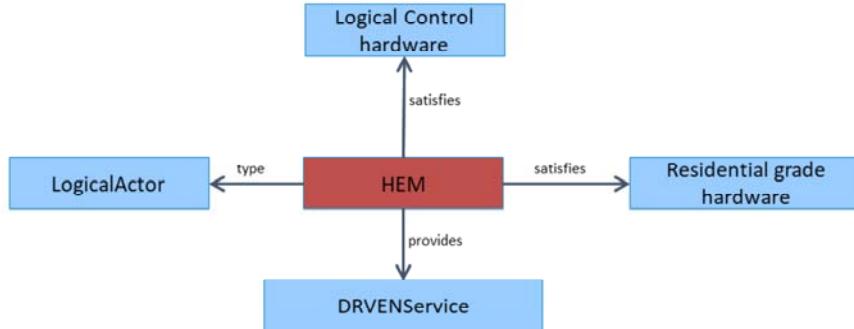
DER – Distributed Energy Resource

## The HEM in the AEP/EPRI use case



### Definition of HEM

So, a definition of the HEM in this use case might be captured as follows:



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We end up with this partial characterization for HEM, which is captured in a computer-sensible form that can be used for reasoning.

DR: demand response

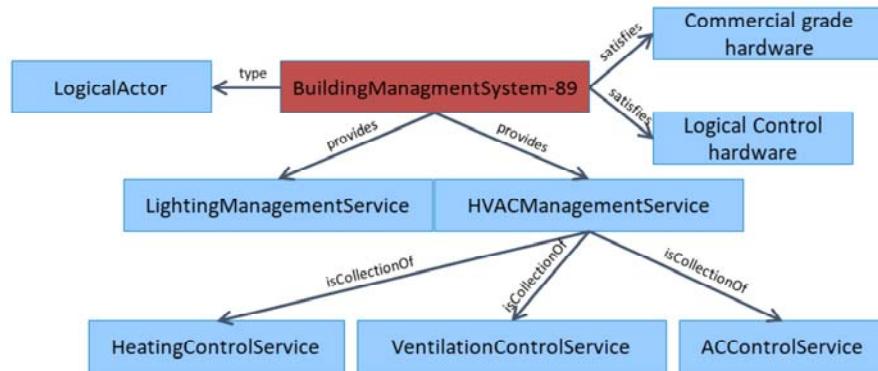
VEN: virtual end node, from OpenADR

## “BuildingManagementSystem”



### Definition from the EU

A system consisting of several decentralized controllers and a centralized management system to monitor and control the heating, ventilation, air conditioning, light and other facilities within a building.



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Let's look at some other terms in our collection. From the description of BuildingManagementSystem-89, we can establish the associations to a Neutral Model as shown.

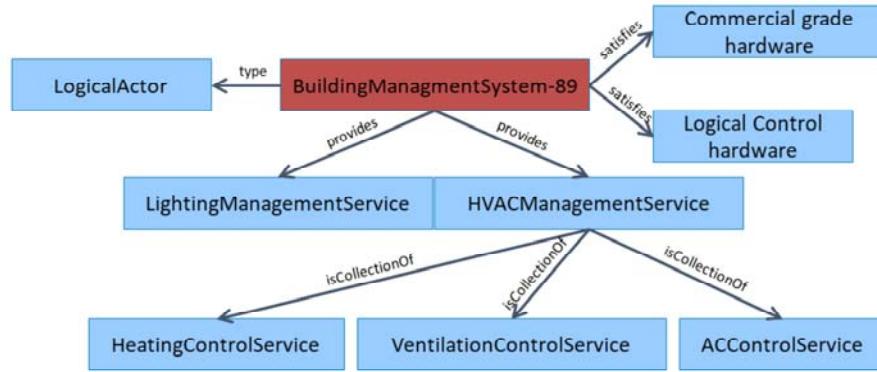
HVAC is heating, ventilating, and air conditioning

ACControlService is air conditioning control service

## “BuildingManagementSystem”



How does this help? Because if you want to interface with something that provides HVACManagementService, then you are guaranteed that it can perform HeatingControlService (for example).



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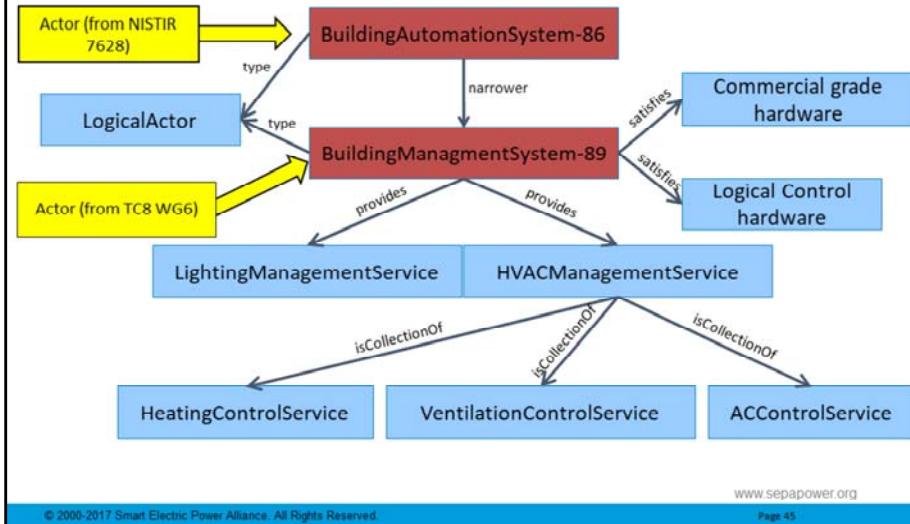
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How does this help? Because if you want to interface with something that provides HVACManagementService, then you are guaranteed that it can perform HeatingControlService (for example).

## “BuildingAutomationSystem”



...and we can infer that BuildingAutomationSystem-86 can do everything BuildingManagementSystem-89 can do because of the skos:narrower relation.

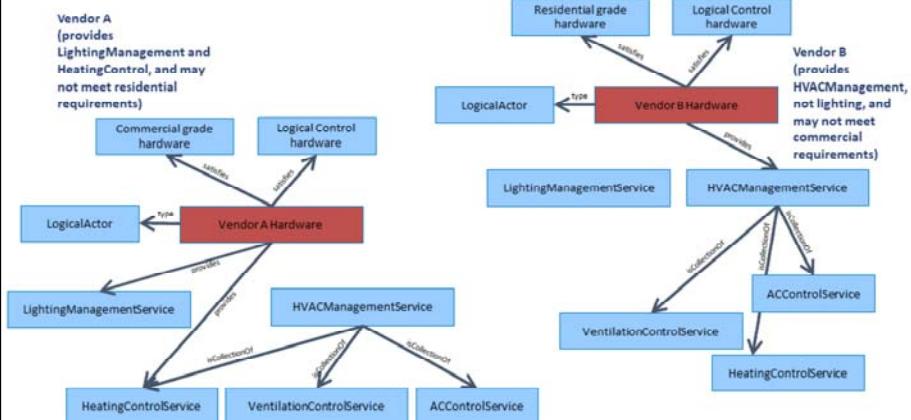


...and we can infer that BuildingAutomationSystem-86 can do everything BuildingManagementSystem-89 can do because of the skos:narrower relation. This is because BuildingAutomationSystem-86 is declared to be a special case of BuildingManagementSystem-89 .... a system that is also automated.

## Implications



Because all this information is represented formally in a semantic language (OWL), it is possible to perform logical reasoning on it. Therefore, if we correctly categorize systems and services, we can begin to automatically identify where interoperability is possible, and where there will be problems.





POTENTIAL  
FUTURE PHASE

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## Potential Future Phase



- Add relationships between concepts based on latest tool capabilities
- Populate and expand Neutral Concepts model
- Expand interoperability between modeling tools

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## Future Phase - Details



### Adding Relationships

- Serves to validate and clarify the initial categorizations
- Reveals ambiguities, missing concepts, distinctions between terms. **This is a key effort in the next phase.**
- Ties together concepts originating from different domains (as in the BuildingAutomationSystems example)
- Formalizes the terms in a computable manner

## Future Phase - Details



### Populating the Neutral Concepts Model

- Provides the concepts that didn't happen to show up in the contributed terms/vocabularies (as in the HEM example)
- Provides abstractions (superclasses) that tie together terms
- Provides context for contributed terms

## Future Phase - Details



Interoperability: TBC OWL to Sparx EA's including support for ArchiMate 3.0

- SGAC modelers have started on mapping Architectural Elements between SOA and ArchiMate 2.1 – DRAFT r0.6
- A plan for data sharing between tools

Mappings from [https://members.sgid.org/kws/groups/sgip-sgac-awp/documents/working309/document?document\\_id=9836](https://members.sgid.org/kws/groups/sgip-sgac-awp/documents/working309/document?document_id=9836)

**Mapping: Architectural Elements between SOA  
and ArchiMate 2.1 – DRAFT r0.6**



table row set 1

SOA (aka ADWP Interpretation)		ArchiMate 2.1 (aka ADWP Interpretation)		
Item	Definition (extracted from <a href="http://www.opengroup.org/soa/source-book/ontologyv2/index.htm">http://www.opengroup.org/soa/source-book/ontologyv2/index.htm</a> )	Abstraction Level	Item	Model Layer
Actor	SOA HumanActor and/or System (an organized collection of Services and Tasks)	Logical, Physical, Implementation	Business Actor	Business
			Application Component	Application
			Node	Technology
			Network	Technology
			Application Collaboration	Application
<a href="#">How to represent in ArchiMate?</a>				
ServiceComposition	aka Role. Result of assembling a collection of services in order to perform a new higher-level service.	Conceptual, Logical	Business Role	Business
ServiceComposition – level 1,2,3	A nested level of granularity of detail of Services that make up the Service Composition at a given abstraction level		Business Collaboration	Business

**Work-in-progress**

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This comparison was done between SOA r2 with ArchiMate 2.1. Need to vet this mapping with ArchiMate 3.0 for what has changed that might address some of the raised points.

**Mapping: Architectural Elements between SOA  
and ArchiMate 2.1 – DRAFT r0.6**  
table row set 2



Service	a logical representation of a repeatable activity that has a specified outcome. It is self-contained and is a 'black box' to its consumers.	Conceptual, Logical, Physical, Implemen- tation	• Business Service Application Service Infrastructure Service	Business	a unit of functionality that a system exposes to its environment, while hiding internal operations, which provides a certain value (monetary or otherwise) Fulfils a business need for a customer (internal or external to the organization). exposes automated behavior
				Application	an externally visible unit of functionality, provided by one or more nodes, exposed through well-defined interfaces, and meaningful to the environment
Service – lvl 1,2,3			How to represent in ArchiMate?		
Task	an atomic Activity within a Process flow	Implemen- tation	Application Function	Application	a behavior element that groups <b>of</b> automated behavior that can be performed by an application component
ServiceContract	defines the terms, conditions, and interaction rules that interacting participants must agree to (directly or indirectly). explicitly regulate both the interaction aspects and the legal agreement aspects of using a service.	Conceptual, Logical, Physical	Contract	Business	a formal or informal specification of an agreement that specifies the rights and obligations associated with a product
ServiceContract – levels 1,2,3			How to represent in ArchiMate?		

**Work-in-progress**

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**Mapping: Architectural Elements between SOA  
and ArchiMate 2.1 – DRAFT r0.6**  
table row set 3



Event	Something that happens		Business Event	Business	something that happens (internally or externally) and influences behavior.
			Business Function	Business	a behavior element that groups behavior based on a chosen set of criteria (typically required business resources and/or competences).
			Infrastructure Function	Technology	a behavior element that groups infrastructural behavior that can be performed by a node.
			Business Process	Business	a behavior element that groups behavior based on an ordering of activities. It is intended to produce a defined set of products or business services.

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**Mapping: Architectural Elements between SOA  
and ArchiMate 2.1 – DRAFT r0.6**  
table row set 4



<i>Conceptual</i>	models the actual business as the Owner conceptually thinks the business is or maybe, wants the business to be. Treat the business as “black box” noting the major functions & capabilities that business has with customers and other 3rd parties		Some users of ArchiMate have: conceptual abstraction elements positioned in the Business layer; logical abstraction elements positioned in the Application layer; physical abstraction elements in the Technology layer. Some also equate the Business layer to Conceptual.
<i>Logical</i>	models of the “systems” of the Business, and treats the business as “white box” to further detail and describe the functions & capabilities performed within the business and with 3rd parties. How the Architecture is (ideally) structured?		EA can absolutely mix UML class diagrams to behavior diagrams. When some diagramming concepts are complementary: draw a business process, then decompose into an activity diagram and/or sequence diagrams. How does ArchiMate support this: doesn't care, not using it to generate other artifacts. E.G.: business layer's inactive objects (meter reading), application layer (map to CIM UML class diagram for the application layer data objects), then technology layer (map the technology data object to DDL - database definition language). Different UML diagrams complement the ArchiMate diagrams. Informational links, hyperlinks, drag&drop to create a hyperlink to so the diagrams are related.
<i>Physical</i>	the technology-constrained, physical implementation design of the systems of the business. Documents the Building block specifications, requirements, descriptions, non-functionals.		[note that the ArchiMate architecture diagrams services are associated with interfaces, components, functions, and objects (where information is stored/passed). ArchiMate 2.1 metamodel does not explicitly support the associations or linkages across the conceptual, logical, physical abstraction levels as ADWP illustrates in the SOA Visio illustration. ArchiMate does support relationships from e.g. business service to an application service via derived relationships.]
<i>Implementation</i>	This is where the systems specialize and document the processes and software and actual technology and implementation configurations used to execute. E.g.: –For ICT these are the vendor offerings or custom applications –For organizations is the personnel, and workflow execution		

**Work-in-progress**

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Conceptual level models the actual business as the Owner conceptually thinks the business is or maybe, wants the business to be. Treat the business as “black box” noting the major functions & capabilities that business has with customers and other 3rd parties      Some users of ArchiMate have: conceptual abstraction elements positioned in the Business layer; logical abstraction elements positioned in the Application layer; physical abstraction elements in the Technology layer. Some also equate the Business layer to Conceptual.

EA can absolutely mix UML class diagrams to behavior diagrams. When some diagramming concepts are complementary: draw a business process, then decompose into an activity diagram and/or sequence diagrams. How does ArchiMate support this: doesn't care, not using it to generate other artifacts. E.G.: business layer's inactive objects (meter reading), application layer (map to CIM UML class diagram for the application layer data objects), then technology layer (map the technology data object to DDL - database definition language). Different UML diagrams complement the ArchiMate diagrams. Informational links, hyperlinks, drag&drop to create a hyperlink to so the diagrams are related.

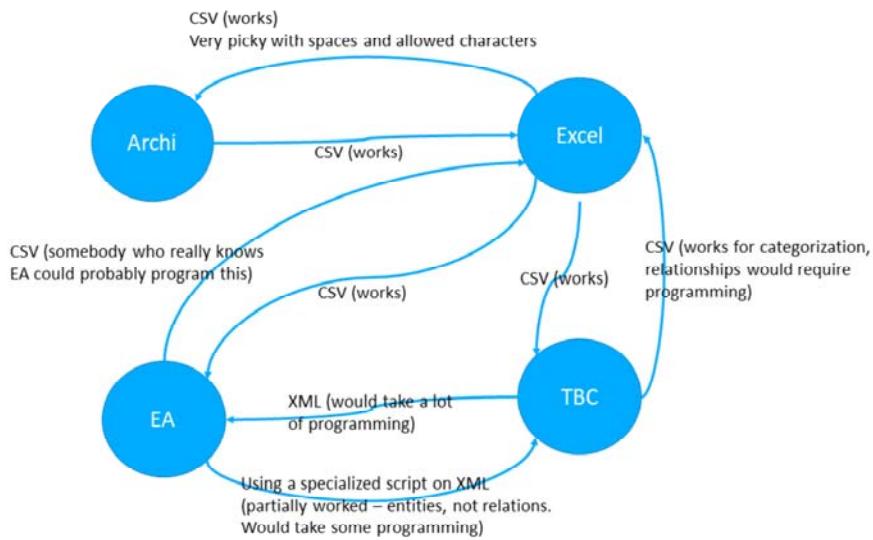
[note that the ArchiMate architecture diagrams services are associated with interfaces, components, functions, and objects (where information is stored/passed). ArchiMate 2.1 metamodel does not explicitly support the associations or linkages across the conceptual, logical, physical abstraction levels as ADWP illustrates in the SOA Visio illustration. ArchiMate does support relationships from e.g. business service to an application service via derived relationships.]

Logical level models of the “systems” of the Business, and treats the business as “white box” to further detail and describe the functions & capabilities performed within the business and with 3rd parties. How the Architecture is (ideally) structured?

Physical level models the technology-constrained, physical implementation design of the systems of the business.

Documents the Building block specifications, requirements, descriptions, non-functionals.

## Tools: Exchange Experiments



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ArchiMate – is a specification by The OpenGroup. Several vendors have built tools that provide varying degrees of conformance to a specific ArchiMate spec release.  
ArchiMate tools tested included: a) Archi, b) Sparx EA including tool support for ArchiMate  
The modeling tools being used by ADWP includes: Top Quadrant's TopBraideComposer – Maestro edition, Sparx EA, spreadsheets e.g. Microsoft's Excel

## Tools: Archi v3.x Export Format



ID	Type	Name
5544b54c	ArchimateModel	(new model)
b5995997	BusinessActor	Business Actor 3
fef227a6	BusinessActor	CustomerAppliance
d89934c8	BusinessFunction	Business Function
59de4964	BusinessRole	Business Role
8066cb08	BusinessRole	Business Role 2
9cdbbc83	BusinessService	ApplianceControl
ff57a9b5	ApplicationService	Application Service
8ff1067d	InfrastructureService	Infrastructure Service
d5d8a675	Junction	Junction

## Tools: Archi Import Format



ID	Type	Name	Documentation
1	BusinessRole	EnergyDispatcher	Actor Role in charge of dispatching Electricity usually at the transmission level
2	ApplicationComponent	Access Point ie. Data Aggregation Point	Collects and aggregates all data fromto end devices through Neighbourhood andor Field Area andor AMI networks. These devices are IEEE 802.11n compliant. They interface the Backhaul WAN.
3	BusinessService	Account Management	Business function or service that manages supplier and customer business accounts.
4	ApplicationComponent	Account Management System	Business function or service that manages supplier and customer business accounts.
5	BusinessRole	Actuator	An actuator is a transducer that accepts a signal and converts it to a physical action. In other words
7	BusinessRole	Aggregator	The role that combines curtailment
8	ApplicationComponent	AMI Head-end	Provides the Interface to the Advanced Metering Infrastructure and manages the information exchanges between third party systems. The head-end is the command application for AMI solution. Optionally it manages required or desired meter reading schedules
9	ApplicationComponent	AMI Operator	General operator of the AMI system
10	ApplicationComponent	AMI Service Engineer	External actor responsible for the installation

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## Tools: Valid Sparx EA 12.1 Import Types – Partial List



Type	String	ReadWrite The element type (such as Class, Component). Note that Type is case sensitive inside Enterprise Architect and should be provided with an initial capital (proper case); valid types are:
		Action Activity ActivityPartition ActivityRegion Actor Artifact Association Boundary Change Class Collaboration Component Constraint Decision DeploymentSpecification Diagramframe EmbeddedElement Entity EntryPoint Event ExceptionHandler ExitPoint ExpansionNode ExpansionRegion Feature GUIElement InteractionFragment InteractionOccurrence InteractionState Interface InterruptibleActivityRegion Issue Node Note Object Package Parameter Part Port ProvidedInterface Report RequiredInterface Requirement Screen Sequence State StateNode Synchronization Text TimeLine UMLDiagram UseCase

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## Tools: TBC Format (sample subset)



Entity Name	Description	Abstraction Level	Element Type	skos	NAESB	CSWG NISTIR 7628	CSWG Actors	IEEE P2030 Draft 3	EIS	EU Commission	EU WGSP Ver 0.5	SGIC Conceptual Arch
Aggregator	offers services to aggregate energy production from different sources (generators) and acts towards the grid as one entity, including local aggregation of demand (Demand Response management) and supply (generation management). In cases where the aggregator is not a supplier, it maintains a contract with the supplier.	Conceptual	ServiceComposition	TBD								
AMI Operations	General operator of the AMI system ServiceComposition responsible for the installation, operation, maintenance and de-installation of the system components. It may access, if properly identified and authorized, those components either directly, via local operation and maintenance interfaces, or from a system component from a higher hierarchical level (e.g. meters may be accessed for maintenance purposes via NNAPs or the HES).	Logical	Actor	TBD							X	
AMI Service		Logical	ServiceComposition	TBD							X	

The Entity Name and Description were key to determining the abstraction level and element type. The submitting organization's identity was imported for traceability.

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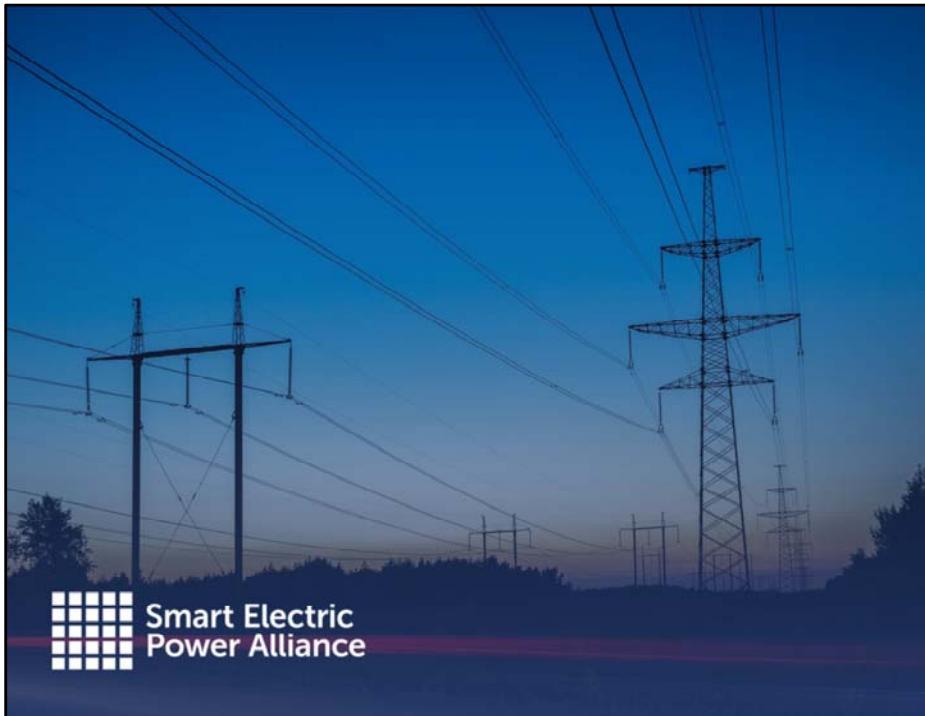
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This is a small sample of the Excel spreadsheet that contains the data from the 18 submitting organizations, showing Entity Name, Description, and submitting organization. The ADWP modelers added the Abstraction Level, and Element Type as described in this slide deck. The skos field would show the relationship to ADWP Neutral Concepts Model, as planned but TBD.



Thank you

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