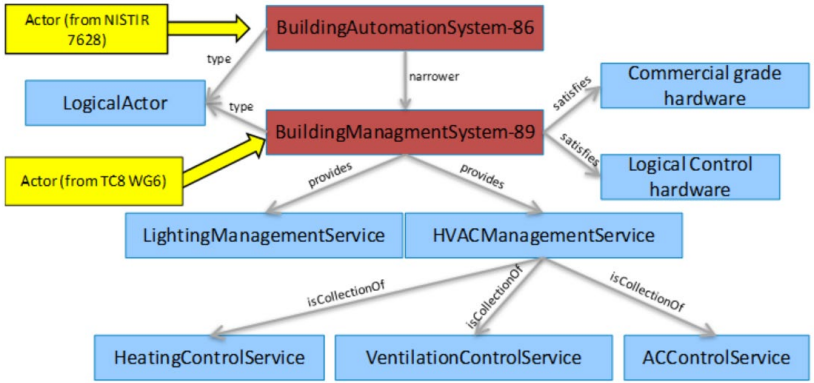

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Smart Grid Ontology Building Blocks: Aligning Business and IT/OT Architectural Elements

Tuesday, March 24, 2020

***Original recording of the webinar can be retrieved here: *https://sepapower.org/media-item/smart-grid-ontology-building-blocks-aligning-business-and-it-ot-architectural-elements/*

The Webinar Will Begin Soon

Navigation

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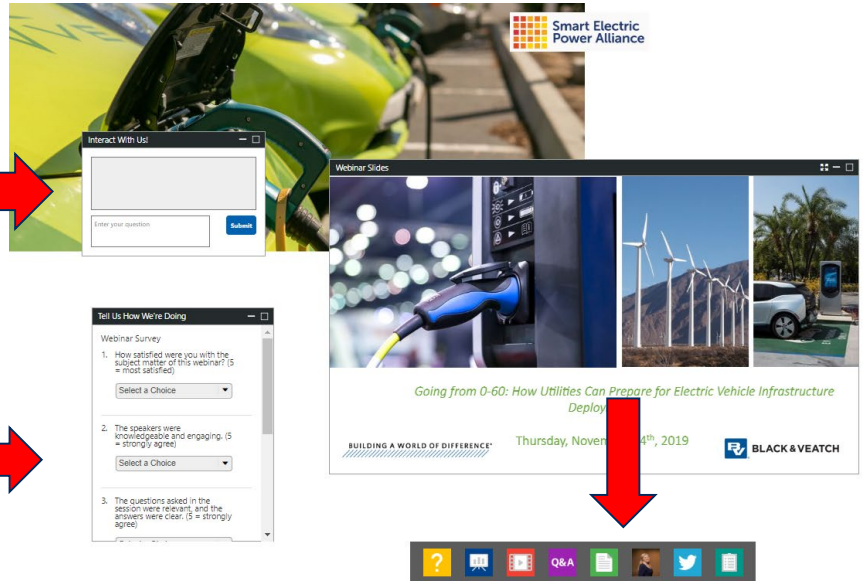

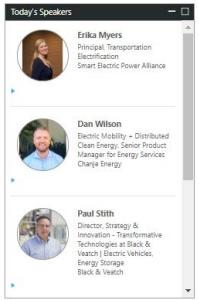

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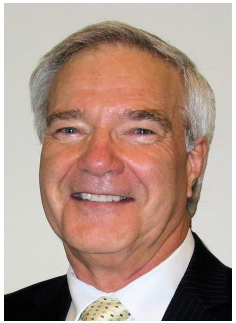
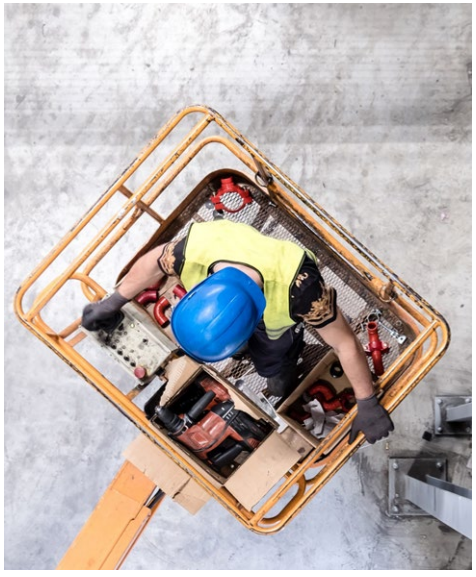


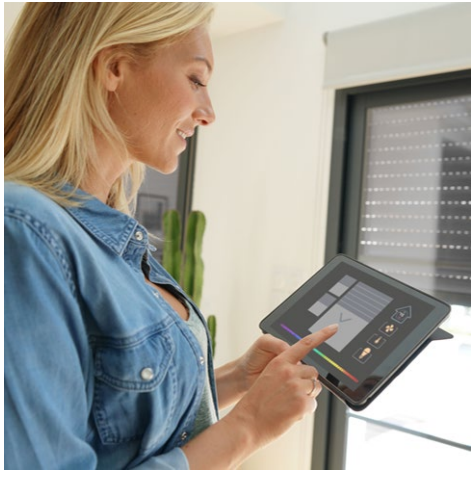
Ron Cunnigham
IT Enterprise Architect
rtcunningham@aep.com

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY™

Steve Ray
Chief Executive Officer
steveraysteveray@gmail.com

QUDT





Who Are We?

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A carbon-free energy system by 2050

- A membership organization
- Founded in 1992
- Staff of ~50
- Research, Education, Collaboration & Standards
- Budget of ~$10M
- Unbiased
- Based in Washington, D.C.
- No Advocacy – 501c3

Pathways

Utility Business Models

Sustainable Utility business models to facilitate and support a carbon-free energy future.

Grid Integration

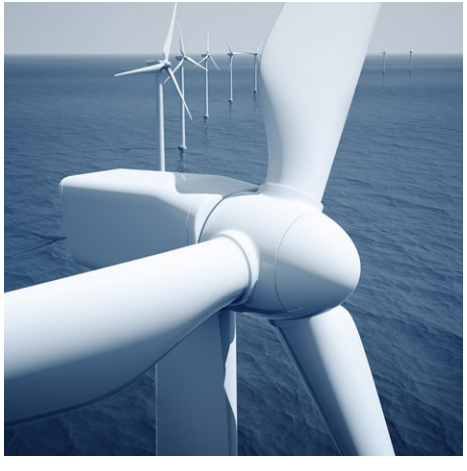
Seamless integration of clean energy yielding maintained or improved levels of affordability, safety, security, reliability, resiliency and customer satisfaction.

Regulatory Innovation

State regulatory processes to enable the timely and effective deployment of new technologies, partnerships and business models.

Transportation Electrification

The nation's fleet of light, medium and heavy-duty vehicles powered by carbon-free electricity.



Collaborative teams of member SMEs addressing important industry issues

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Working Groups

- Community Solar
- Customer Grid Edge
- Cybersecurity
- Electric Vehicles
- Energy Storage
- Energy IoT
- Grid Architecture
- Microgrids
- Solar Asset Management
- Testing and Certification
- Transactive Energy Coordination

Working Groups

Collaborative teams of member SMEs addressing important industry issues

> Grid Architecture Working Group (GAWG): Members with background and interest in grid, enterprise and other architectures associated with modernized electric power systems.

>> Electric Grid Ontology Task Force: Group interested in common set of architectural/ business elements and their relationships that can be interpreted and modeled consistently as it relates to the smart grid.

- Grid Architecture
- Microgrids
- Solar Asset Management
- Testing and Certification
- Transactive Energy Coordination

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Grid Ontology Background

The SEPA Electric Grid Ontology Project leverages earlier SGIP work and industry advances in smart grid and modernization architecture modeling efforts:

- NIST Framework and Roadmap for Smart Grid Interoperability Standards
- Ontology Intent
  - Smart grid architectural semantic modeling leveraging TOGAF, Zachman, SOA
  - Gathering and development of categorization guidance for architectural elements
  - Using advanced semantic modeling and ontology tooling and techniques
- GWAC Interoperability Layers

Work continues via the SEPA Grid Architecture Working Group and Electric Grid Ontology Task Force

What Started this Work?

...and Potential Solutions

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Original Challenge Pain Points

- **Relationships** between models are not understood – or worse interpreted incorrectly
- **Depth**: Many standards are still developing – many aspects of a model are incomplete or described more fully by another SDO, creating e.g. dups
- **Duplication**: Standards describe their environment using reference model(s). Different models quite often describe identical or similar concepts
- **Contradiction**: sometimes a model's concept describes elements that contradict how another model addresses it

An Approach – A Single Unified Model

Definition: unified model:

- Is ‘normalized’ (no duplicate modeling of the same semantic).
- Covers the entire problem scope of Smart Grid.

Challenges:

- Smart Grid large scope has to be partitioned somehow into domains so that different focus groups can operate in parallel
- Difficulty of coordinating normalized modeling goes up exponentially with the number of different domains
- Significant effort in separate domain models needed to achieve a global normalization. Stakeholder groups reluctance to change what they already have

Alternate Approach – Harmonize Semantic Models

Solution

Apply a common semantic method to document each standard's elements (formal ontology) – this defines an unambiguous definition of a standard's elements relationships to one another

Expected Results

- Identify identical element across the standards
- Infer relationships that are not explicitly defined amongst standards
- Identify conflicts between models
- Manages the complexity of emerging and evolving standards
    - Accelerates development and harmonizes change
    - Accelerates standards uptake and interoperability

Grid Ontology Terms

An Overview

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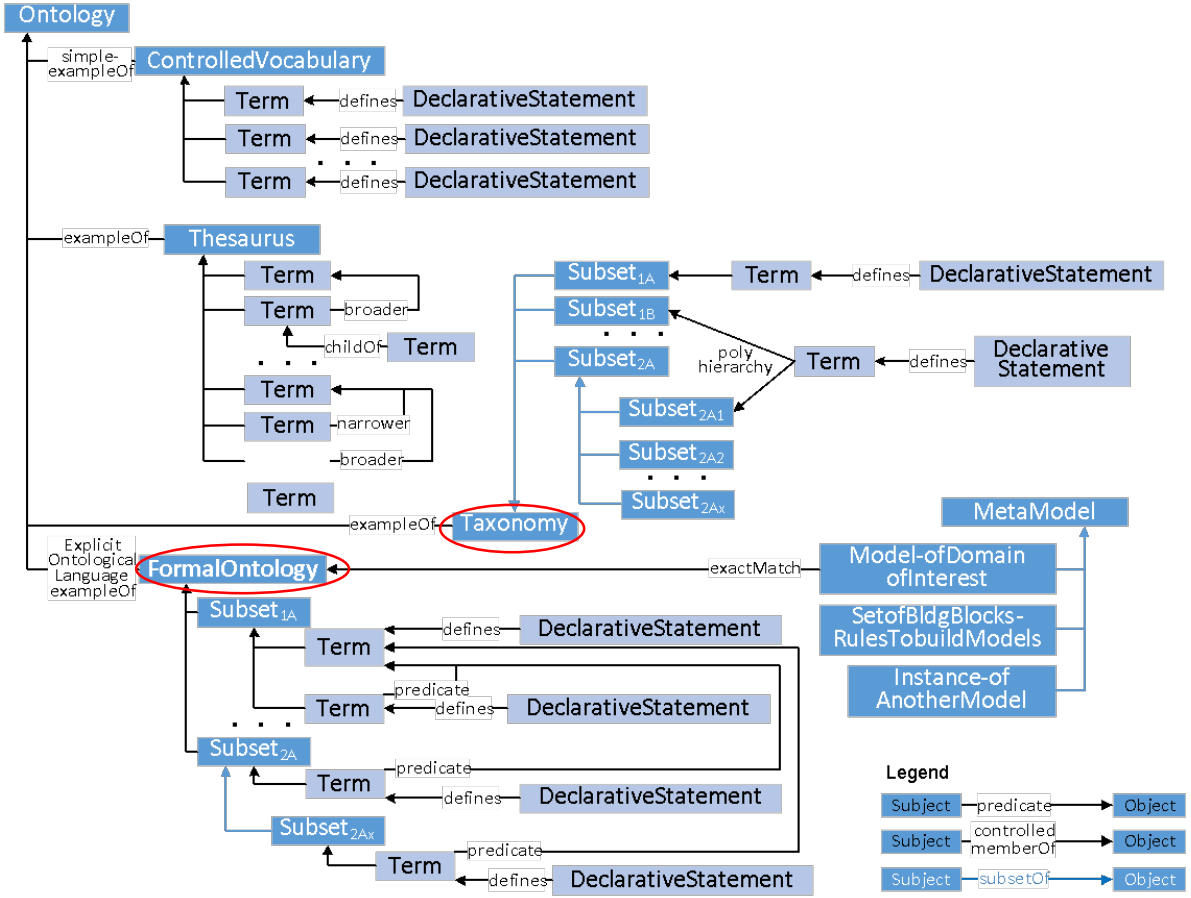
Definitions

Ontology - an explicit formal specification [language] of how to represent the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them[1]

Taxonomy – the formal structure of classes or types of objects within a domain. It organizes knowledge by using a controlled vocabulary to make it easier to find related information[2]

1) **Scott Neumann, Arnold DeVos, Steve Widergren, Jay Britton presentation DistribuTECH 2006 Use of the CIM Ontology**
2) **https://www.dataversity.net/what-is-taxonomy/**

Ontology Types and Related Terms



Smart Grid Ontology Focus:

- Taxonomy
- Formal Ontology

Terms - Architectural Abstraction Level and Element Categories

Architecture Abstraction Levels

- Conceptual, Logical, Physical, Implementation

Service Oriented Architecture (SOA) Elements

- Actors
- Services
- ServiceCompositions (~roles)
- ServiceContracts

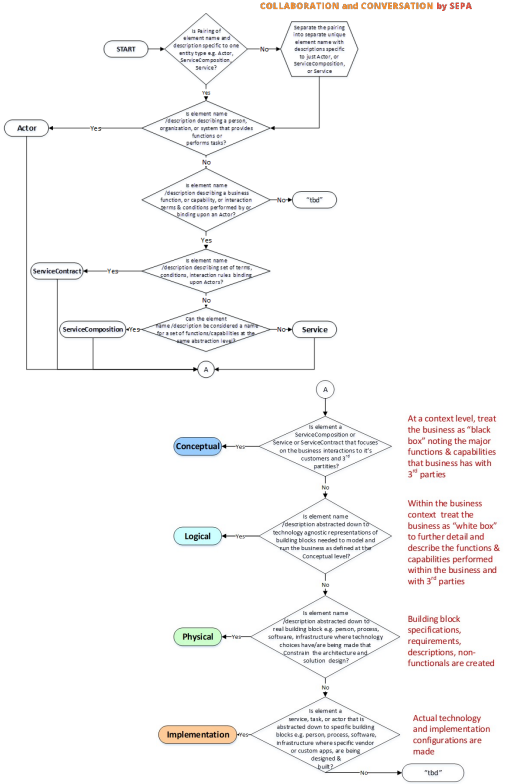
Element Abstractions:

- Conceptual:
  - Cooling Service
- Logical:
  - Temp. Mgmt. Service
  - Refrig. Cyclic-Vapor Compression Actor
- Physical:
  - Temp. Control Service
  - French Dr-Stainless Actor
- Implementation:
  - Temp.Pckg.build-AK3 Srvc.
  - Mnft. BigAppl, model 9910, s/n##### Actor

Element Categorization Guidance Decision Trees

Categorize the original elements by:

- **Element types** e.g.: Actors, Services, ServiceCompositions, and ServiceContracts
- **Architecture Levels**
  - **Conceptual** - business-to-business (B2B) relationships: B2C (consumer) and B2R (regulatory & policy). Services, ServiceCompositions, and ServiceContracts. A black-box view of the business.
  - **Logical** – White-box view of the business, showing the internal elements and their relationships. Actors, Services, ServiceCompositions, and ServiceContracts
  - **Physical** - the representation of a Specification, where the required features (functional and non-functional) are included.
  - **Implementation** – actual technology instantiations and implementation configuration decisions are made



Results To Date

- SGAC Architecture Development Working Party (ADWP), gathered set of Use Case elements from 18 organizations and performed initial categorization of elements to Conceptual, Logical, Physical architecture abstraction levels, resulting in:
  - **Grid Ontology OWL metamodel** (SOA focused), that shows the relationships of the elements across the Conceptual, Logical, Physical abstraction levels
  - **Grid Architectural Element Categorization Guidance**
- "**Neutral Concepts**" model via OWL introduced with simple use case example
- SEPA Electric Grid Ontology Task Force (EGOTF) continued work of SGIP ADWP and completed categorization of elements **Grid Architecture Taxonomy**

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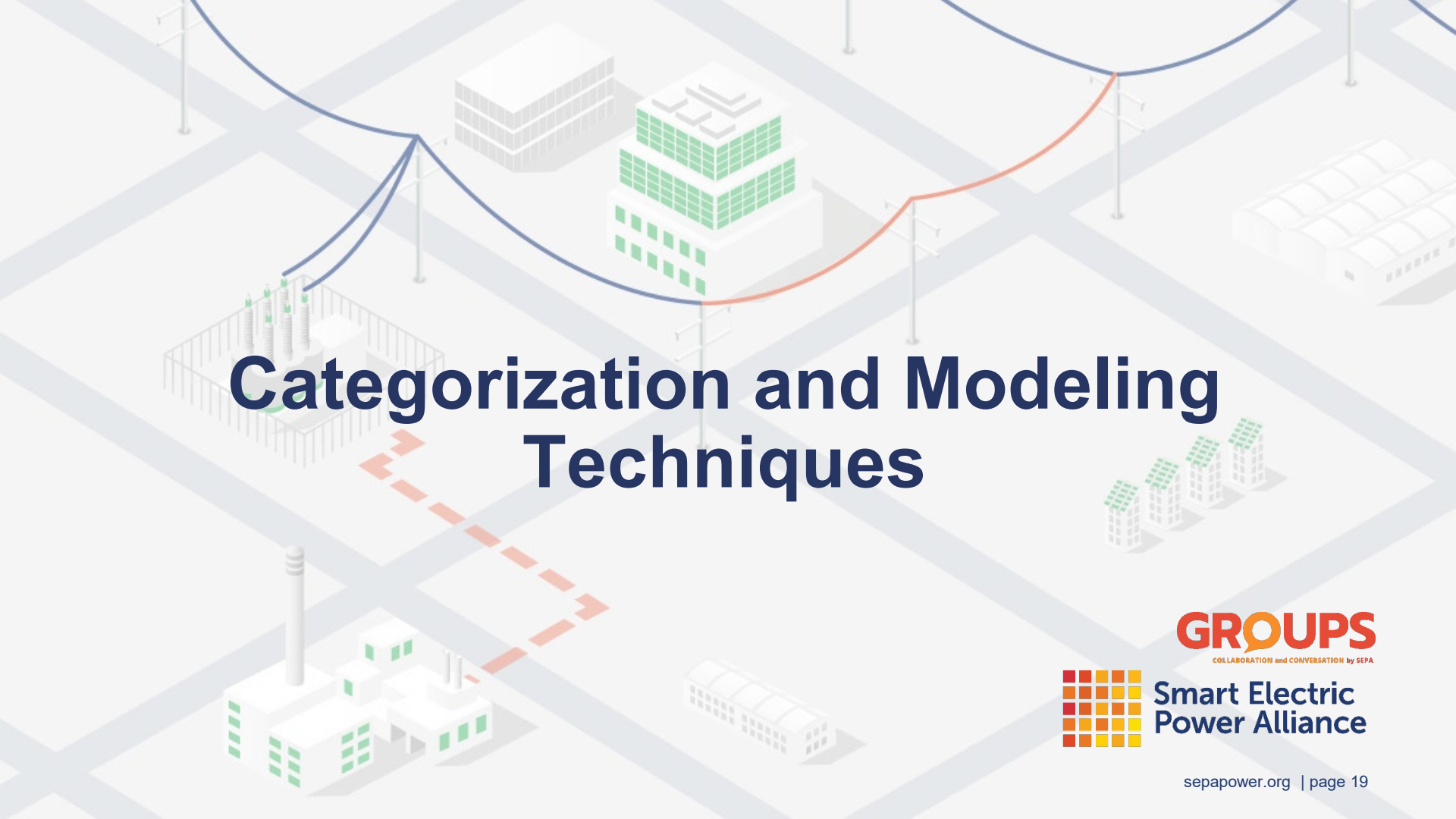
Grid Architecture Taxonomy contains:

- ~ 180 Actors
- ~ 230 Service-Compositions (~role)
- ~ 800 Services

Categorization and Modeling Techniques



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Shifting from UML to Semantic Modeling

UML and ArchiMate (UML based) models use **element objects and connector line specific styles to convey meaning** via: line types, end terminations, some annotation, and object outline form styles-icons.

Semantic Technology allows the meaning of and associations between concepts to be represented precisely and, used in a run-time environment. E.G. semantic **Web Ontology Language (OWL) is more expressive than UML**.

Semantic Technology represents information in a neutral form called **Triples that consist of a Subject, a Predicate and an Object**. Each of these can have properties that infer new information. Each has a unique identity (web addressable), enabling:

- Formal verification across diverse vocabularies
- merging of different datasets
- Inference and analysis of data and concepts

Meta Object Modeling Approach

Meta Classes - Used to categorize classes

- Actor
- Service
- Service Composition (Role)
- Service Contract

…with relations between them

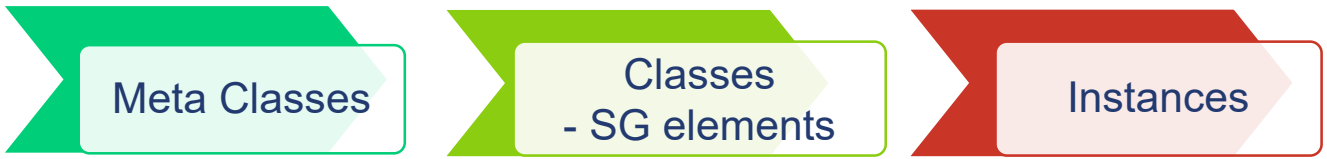
Classes - Used to represent terms e.g.

- Smart Grid Elements
- Premise Management
- Communication Network

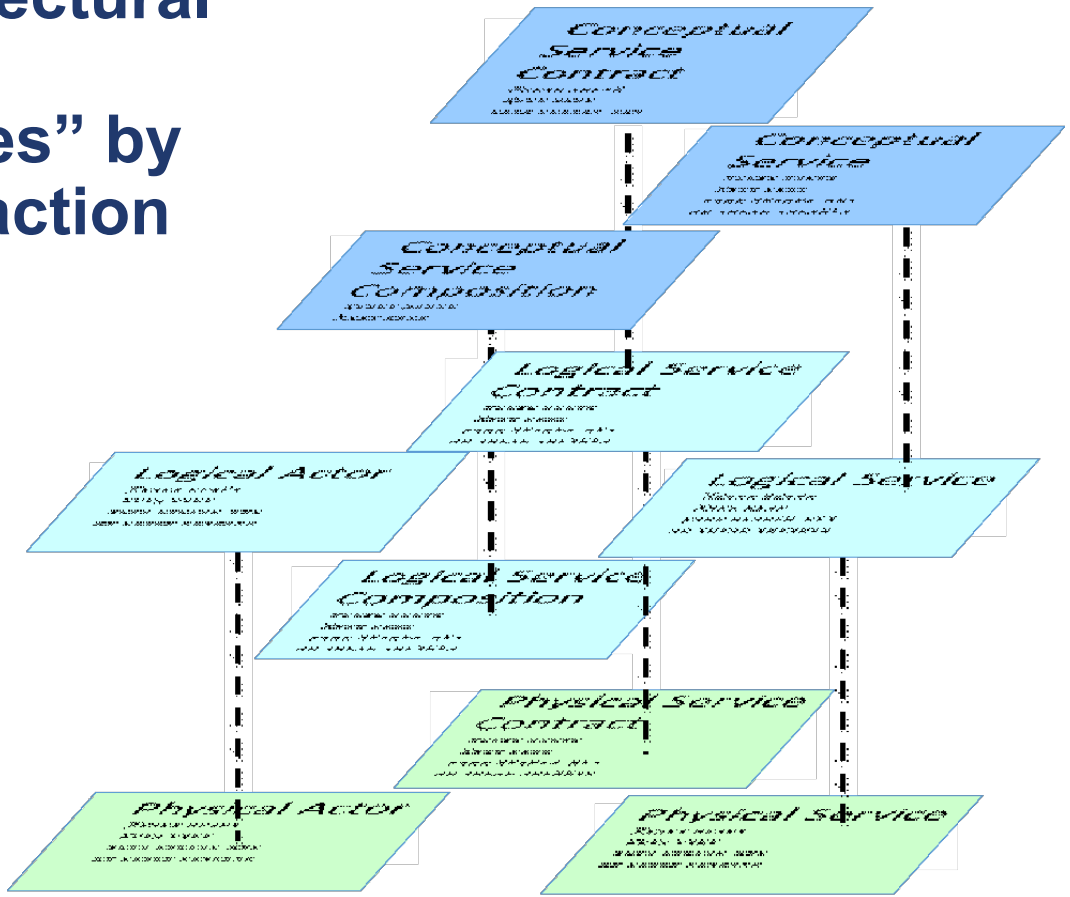
… categorized by the Meta Classes

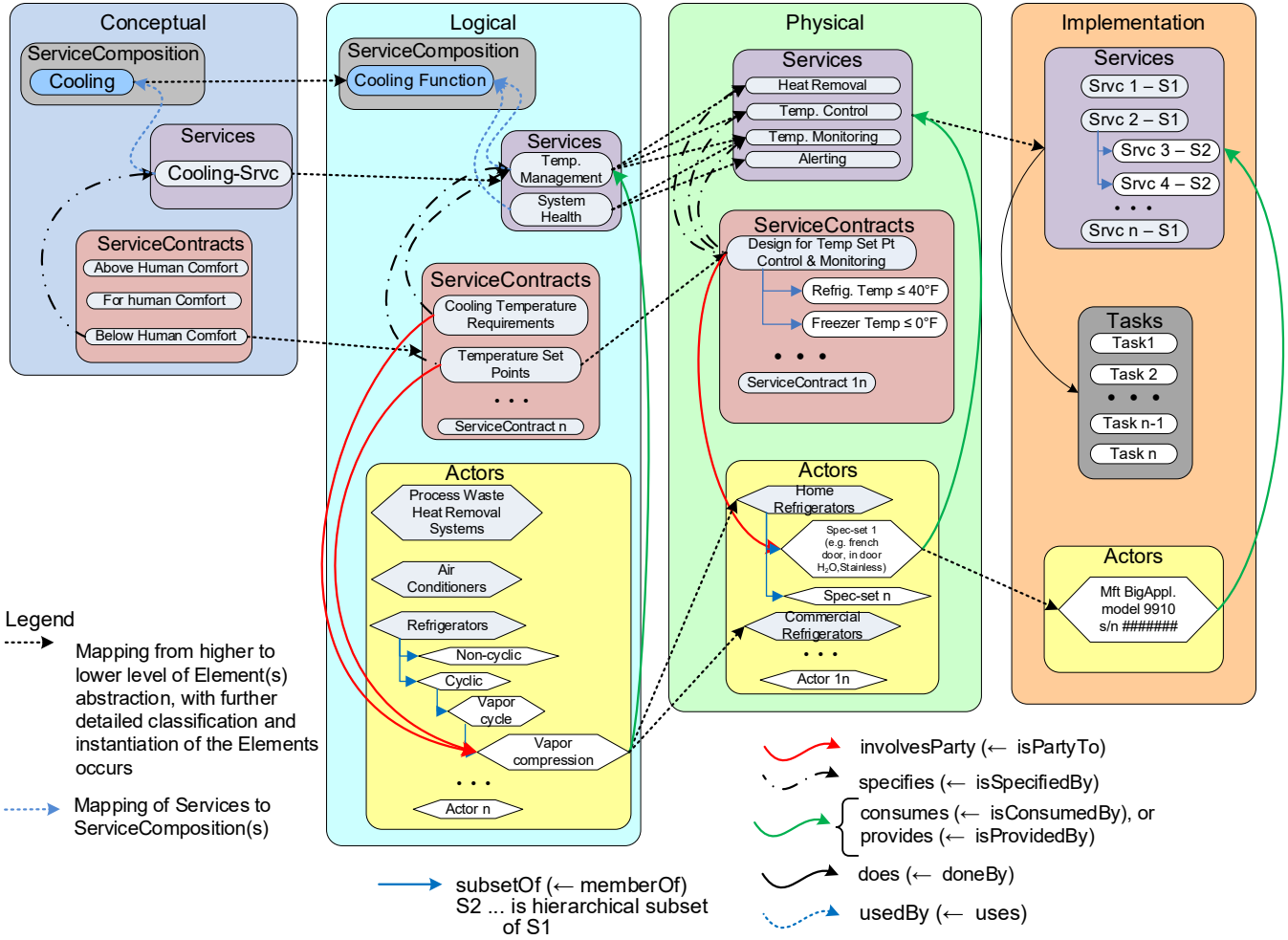
Instances - Used to inventory specific Systems and Services e.g.

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



Architectural "Meta Classes" by Abstraction Level

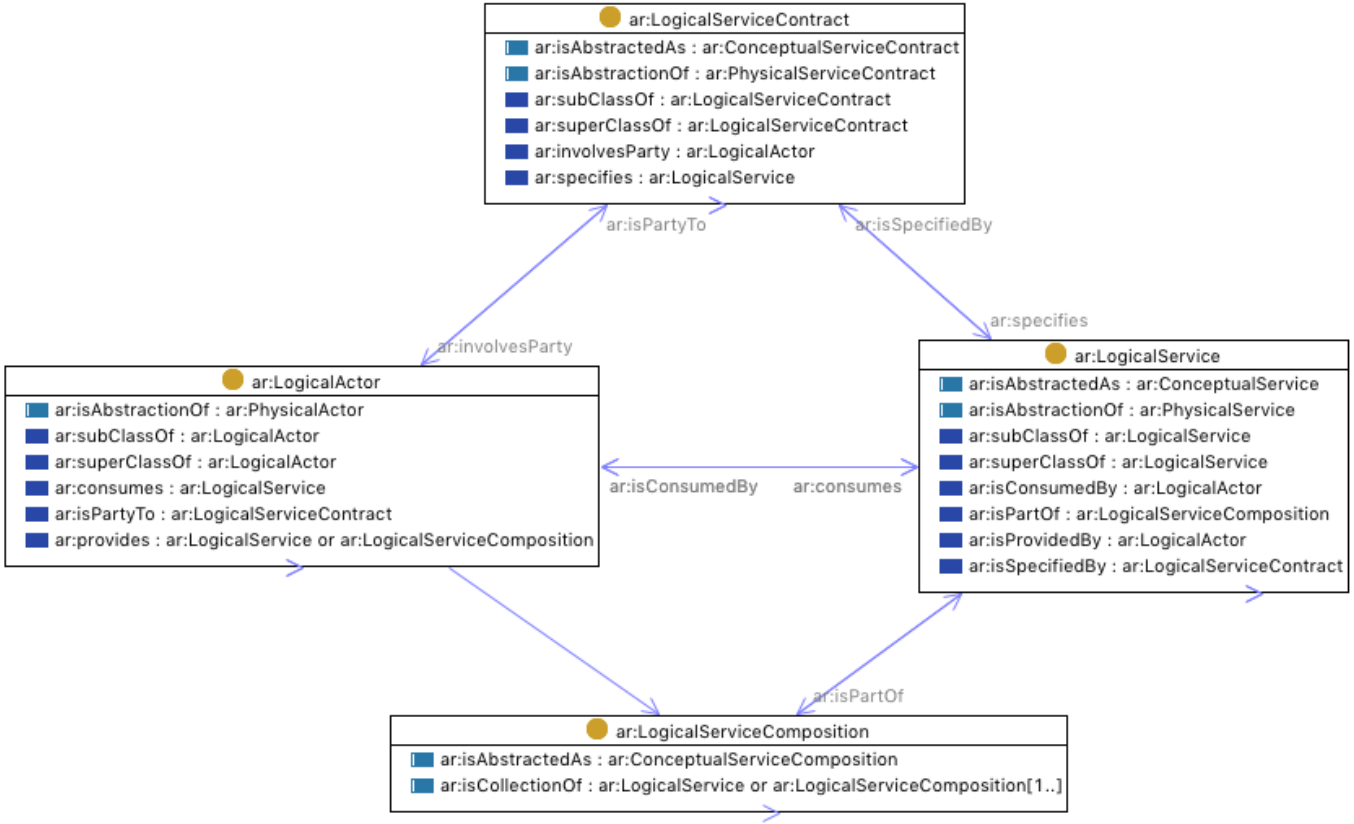




Ontology Graph
illustrative

Cooling Example

Smart Grid Ontology - Metadata Model extraction at Logical Abstraction Level



Taxonomy Illustrative from OWL Tool

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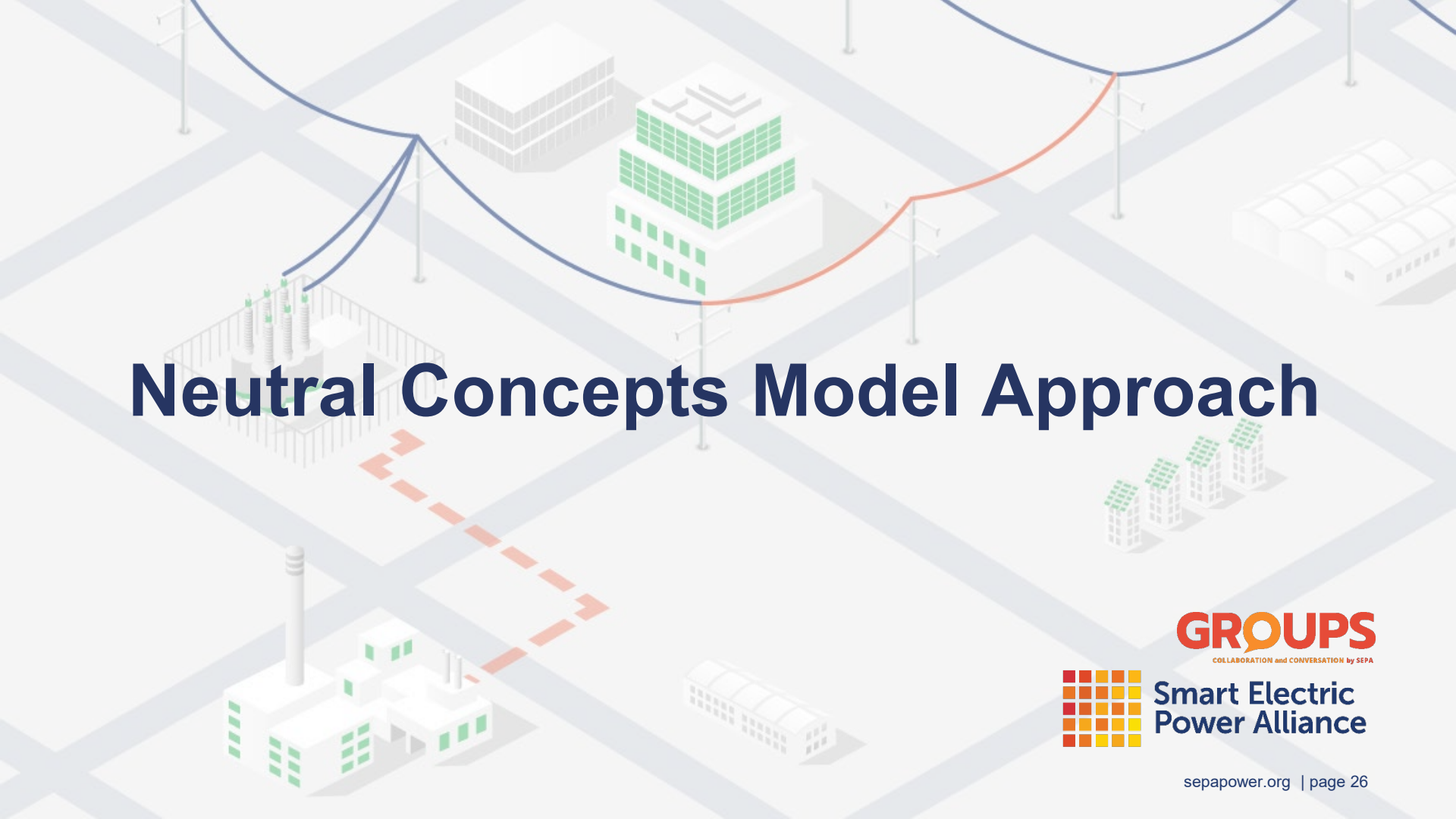
Entity Name	Description	Abstraction Level	Element Type	skos	NAESB	CSWG NISTIR 7628	CSWG Actors	IEEE P2030 Draft 3	EIS	EU Commission	EU WGSP Vers 0-5	SGAC Conceptual Arch
Aggregator	offers services to aggregate energy production from different sources (generators) and acts towards the grid as one entity, 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	Logical	Actor	TBD							X	
AMI Service	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	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.

Neutral Concepts Model Approach



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What is the Neutral Concepts Model?

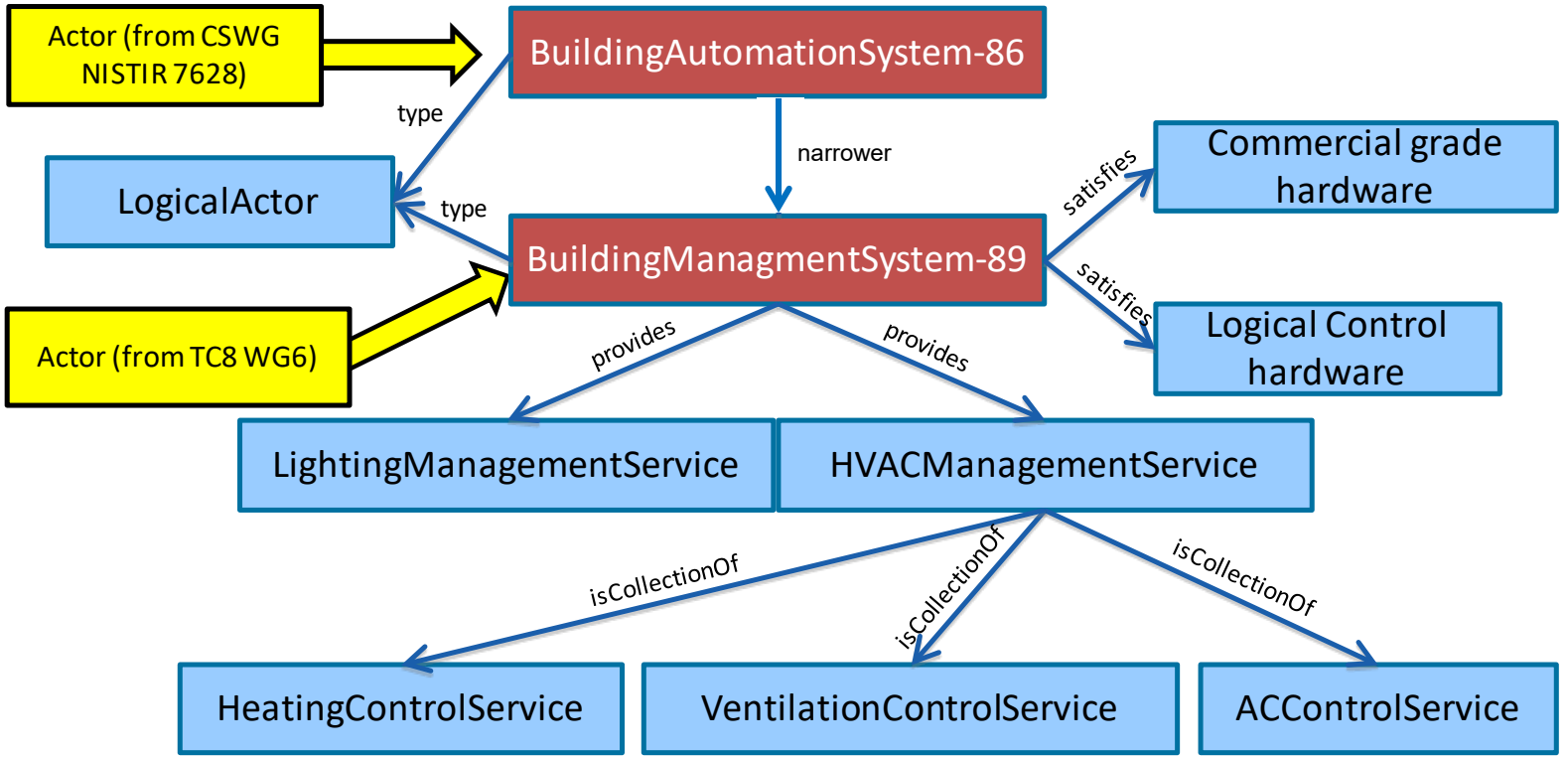
Definition – It is a semantic model, (an ontology), designed to capture each element's unambiguous definition and relationships with other elements in the context of the smart grid. It is called "Neutral" because it is intended to be independent of any specific standard in the smart grid, to be used as an "interlingua" – a bridge that relates terms across all the smart grid standards and communities.

The Neutral Concepts Model can be used :

- As a "Rosetta Stone" to show how other stakeholders' business scenarios or use-case elements relate (or not) with other stakeholder or business scenario / use-case model elements
- To identify missing concepts and aid in modeling them
- To compare two solutions/applications to see if they are interchangeable without loss of functionality

"BuildingAutomationSystem" use of Neutral Concepts model - example

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



There are Missing Concepts

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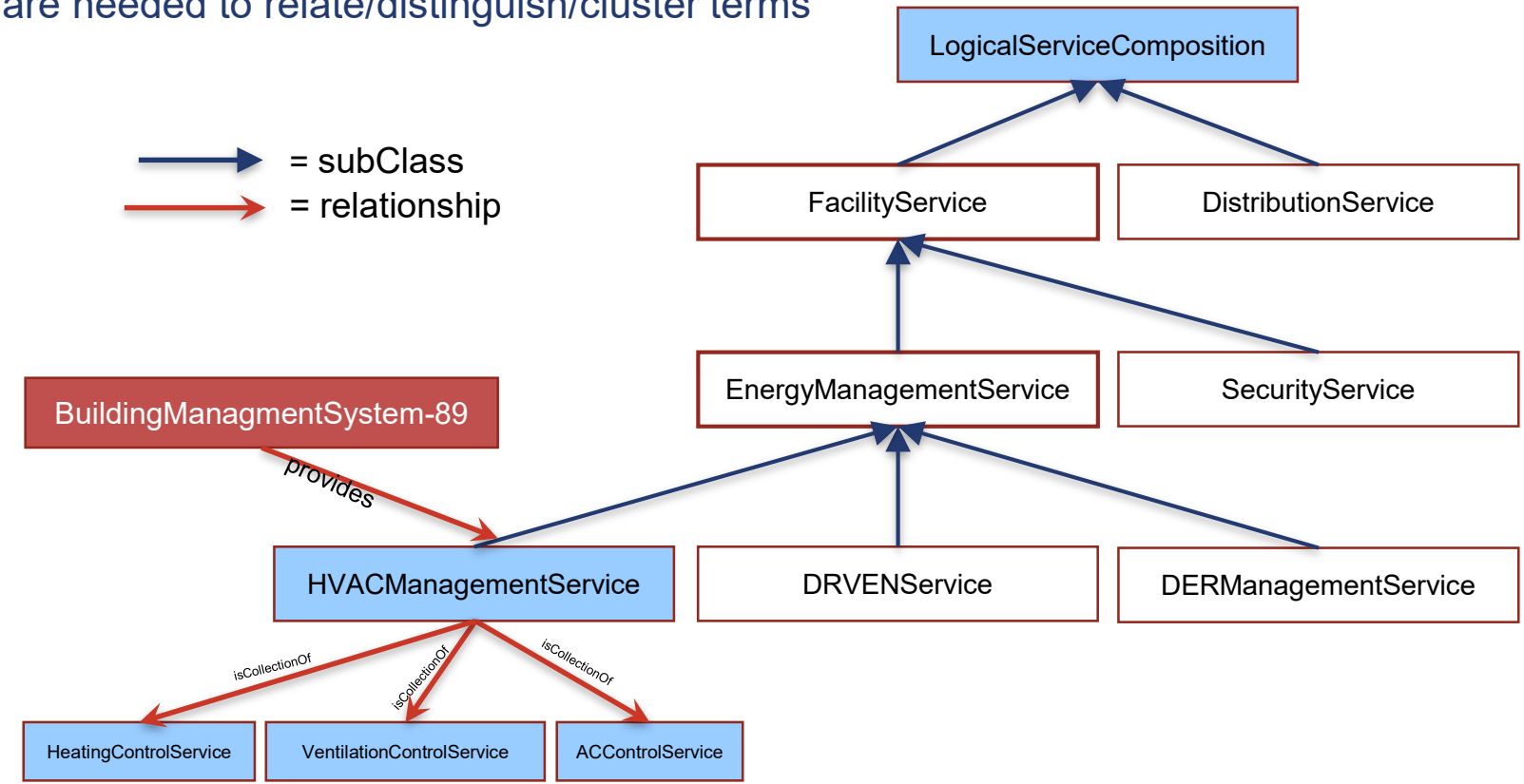
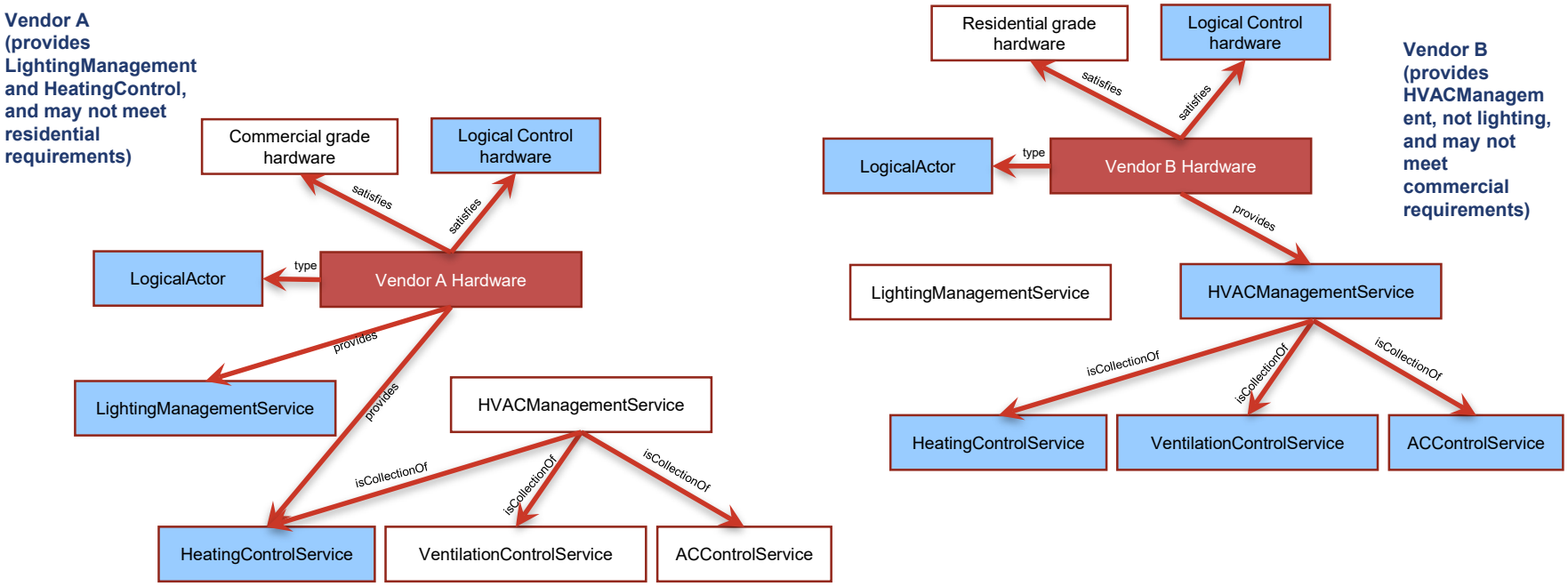
They are needed to relate/distinguish/cluster terms



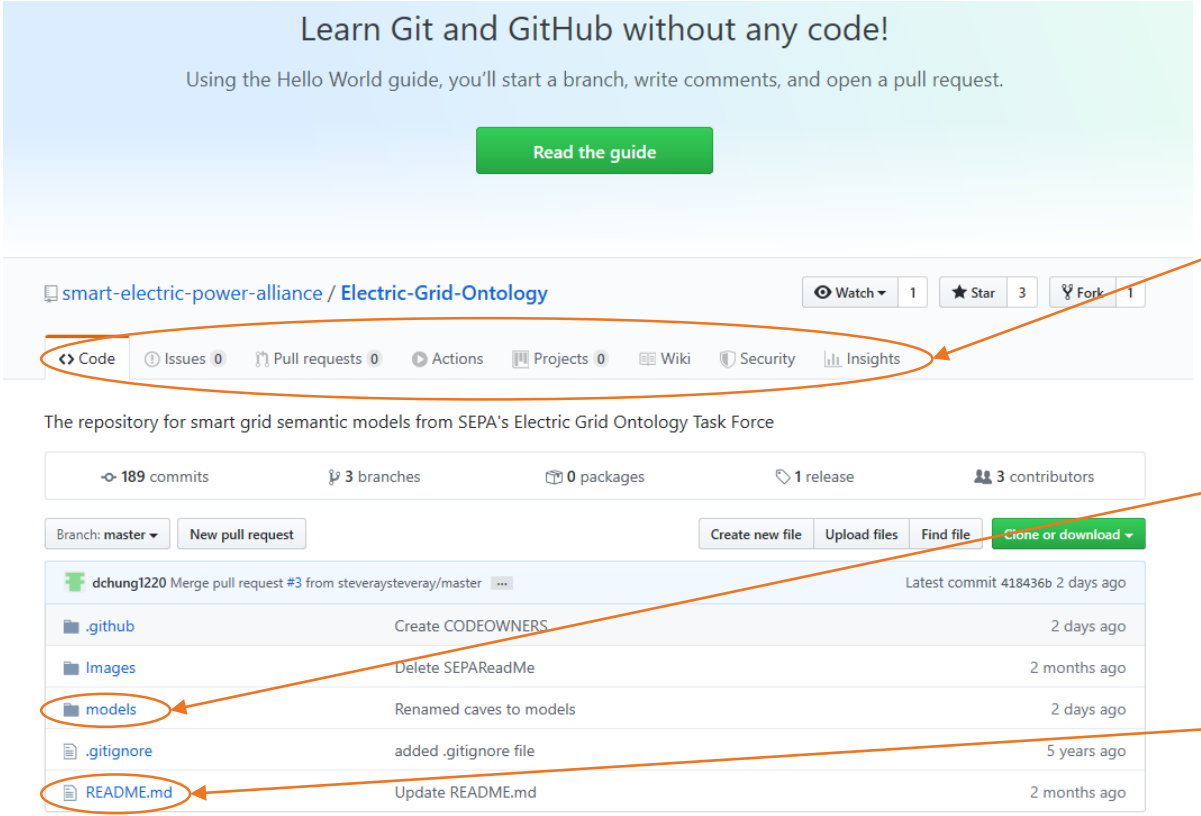
Implications

If we correctly categorize systems and services, we can begin to automatically identify where interoperability is possible, and where there will be problems.



Glimpse of the Grid Ontology Project: Landing Page

Grid Ontology GitHub Landing Page



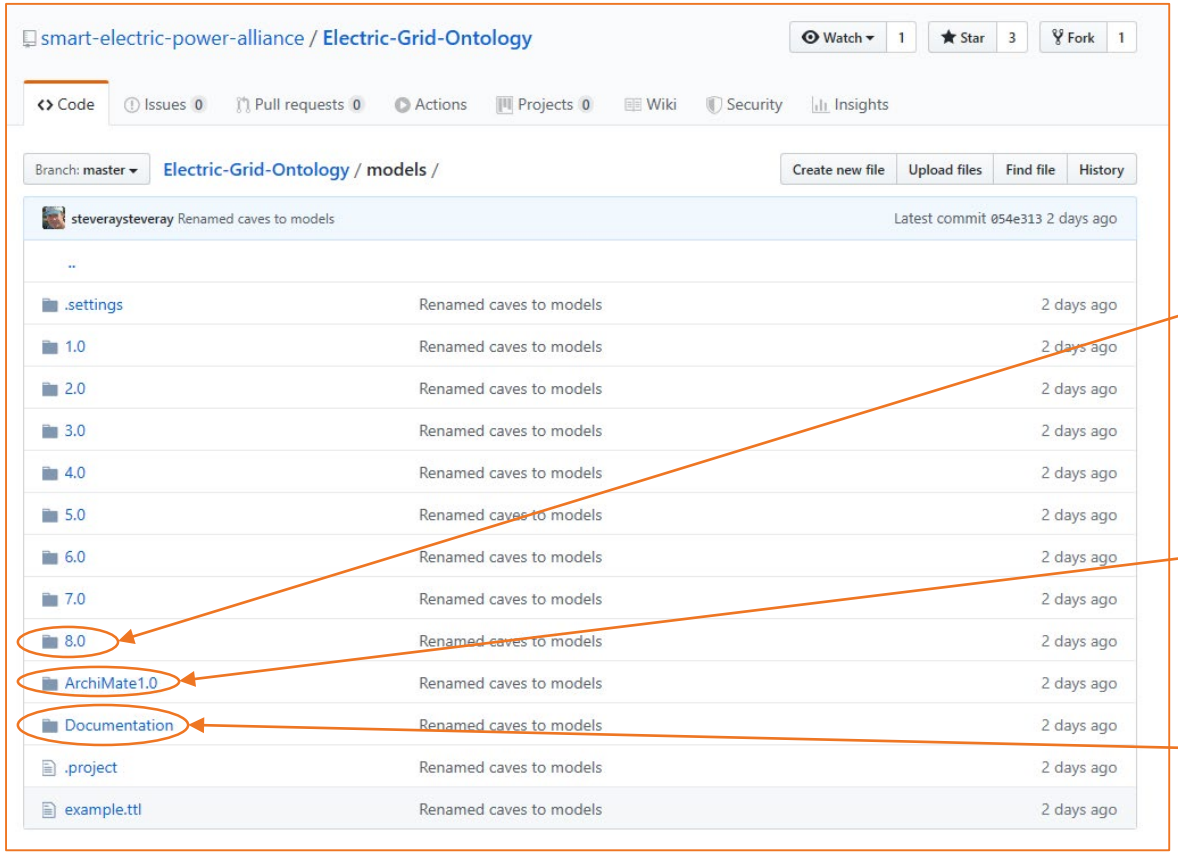
https://github.com/smart-electric-power-alliance/Electric-Grid-Ontology

GitHub drop down of tasks and information about this section of the GitHub universe

Entry point to the main set of Grid Taxonomy & Ontology Building Blocks. This is a work-in-progress area, and more content coming

"Rosetta Stone" prose that is the bottom portion of the landing page

“models” GitHub Page



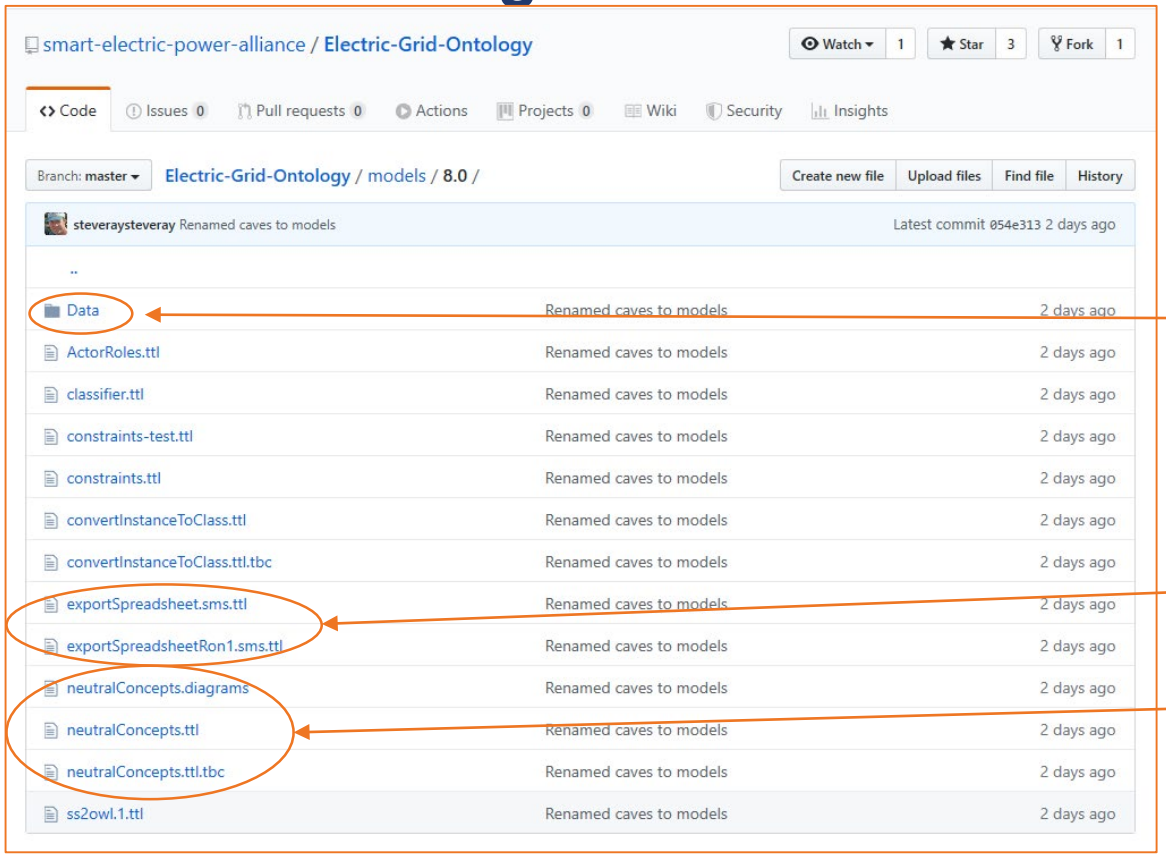
Current set of Grid Taxonomy, Grid OWL metamodel, Neutral Concepts example model, Scripts, queries

Collection of testing moving data and model aspects amongst table data, Archi, TopBraid Composer

Collection of presentations, guidance, procedures

github /tree/master/models/

“8.0” GitHub Page



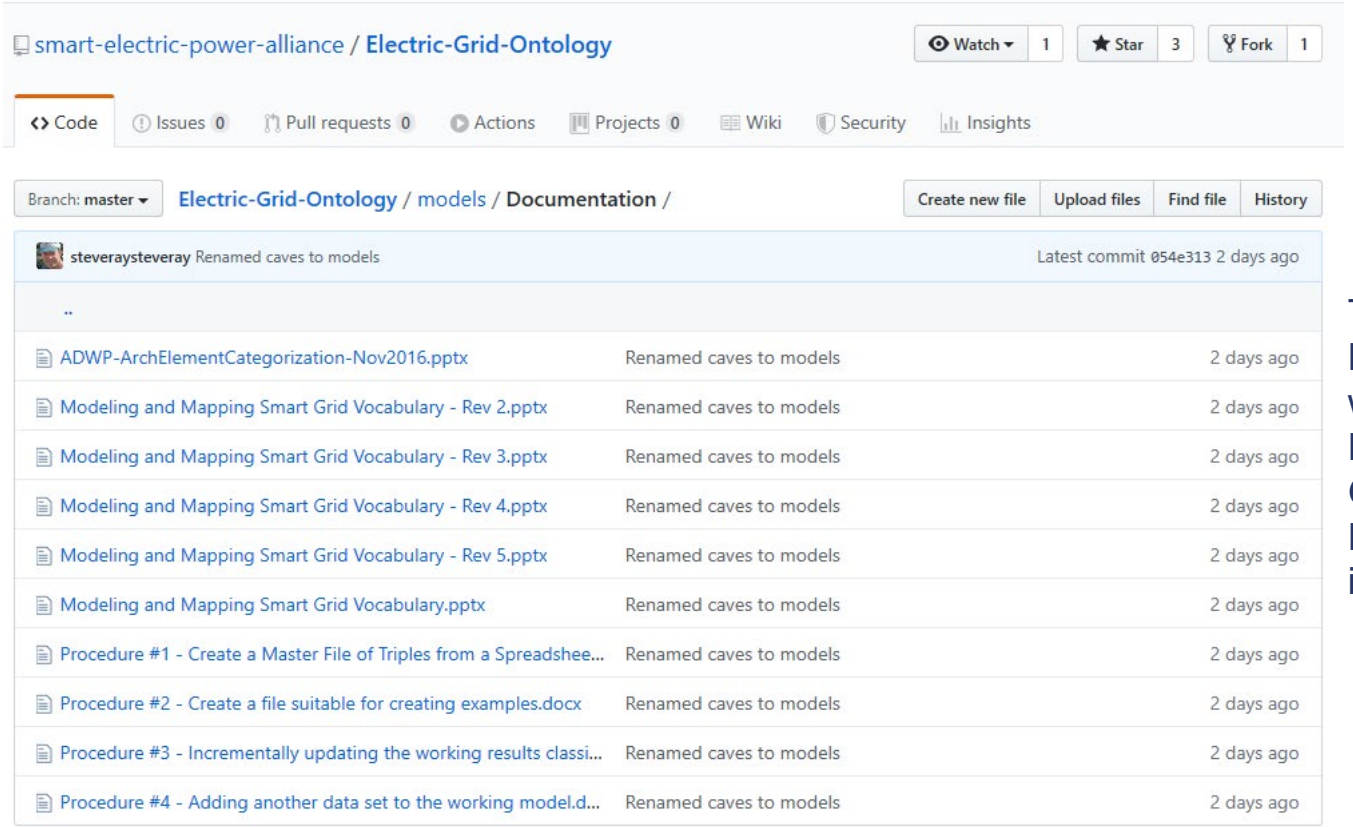
Input data and intermediate working models and code

Exporting model information back into tables

Neutral Concepts

github /tree/master/models/8.0/

“Documentation” GitHub Page



This collection of Presentations and documents will contain the bulk of the Element Categorization Guidance, the What’s and How-To information. A work-in-progress

github /tree/master/models/Documentation/

Grid Ontology Next Steps

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Grid Ontology Project Next Steps

- Setup routine TF meeting cadence with existing and new active collaborating members
- Determine what proof-of-concept project (from existing and new business scenarios/use cases submissions), to demonstrate effective use of the Grid Ontology building blocks to produce a useful for ontology for that business scenario
- Scope out the work plan and resources to work the POC project
- Execute the plan and communicate the results
- If sufficient interest and resources, extend the Grid Taxonomy with recent business scenarios/use cases
- Eventually determine if another POC project necessary for the SEPA EGOTF Incubator phase of this effort

Value Proposition: Tomorrow

S&P Global
Ratings

Industry Top Trends 2019

North America Regulated Utilities

November 8, 2018

Key assumptions

1. Conservation has reduced demand tied to economic growth

Historically, a strong correlation existed between economic growth and the demand for electricity. Since 2011, conservation has significantly curtailed sales growth, leading to a very weak correlation between utility sales and economic growth. Our base case incorporates flat to slightly negative sales growth over the next three years, reflecting new customer growth offset by conservation. To achieve growth, we expect that utilities will pursue mergers with other utilities as well as acquisitions of slightly higher-risk businesses outside of the direct utility industry.

To achieve growth, we expect that utilities will pursue mergers with other utilities as well as acquisitions of slightly higher risk businesses outside of the direct utility industry

Taking this information to the next level with pilot projects:

- **How do I merge divisional data systems ?**
- **How do I merge two utility's data systems?**
- **How do I enhance my interoperability ?**

Get Updates, Stay in Touch

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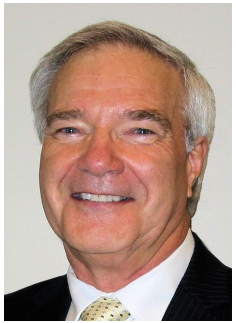
How to Participate…

1. **Join the SEPA Grid Architecture Working Group:**
   - Connect with the Electric Grid Ontology Task Force to pilot your Ontology with their help
   - Meet other utilities IT engineers / architects, Info analysts, system designers *https://groups.sepapower.org/home*
2. **Explore available resource**
   - GitHub: *https://github.com/smart-electric-power-alliance/Electric-Grid-Ontology*
   - General information: *https://sepapower.org/smart-grid-ontology/*

Be a part of SEPA !! Contact *membership@sepapower.org* for more information.

Questions



Ron Cunnigham
IT Enterprise Architect
rtcunningham@aep.com

Steve Ray
Chief Executive Officer
steveraysteveray@gmail.com

Thanks for Attending

Daisy Chung
Manager, Industry Solutions
Dchung@sepapower.org
202.559.2027

Aaron Smallwood
Vice President, Research
asmallwood@sepapower.org
202.871.7414

HEADQUARTERS

Smart Electric Power Alliance
1220 19th Street, NW, Suite 800
Washington, DC 20036-2405
202.857.0898

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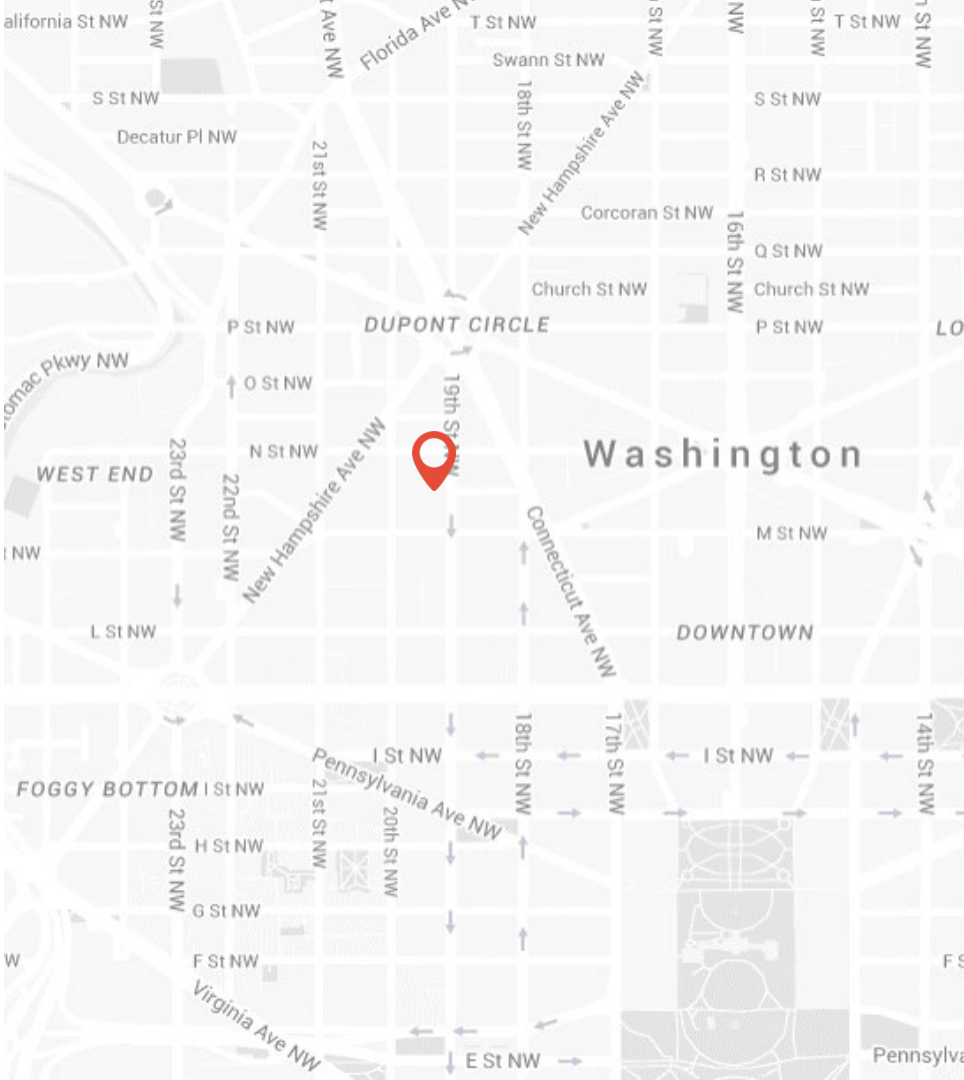

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Supporting Slides

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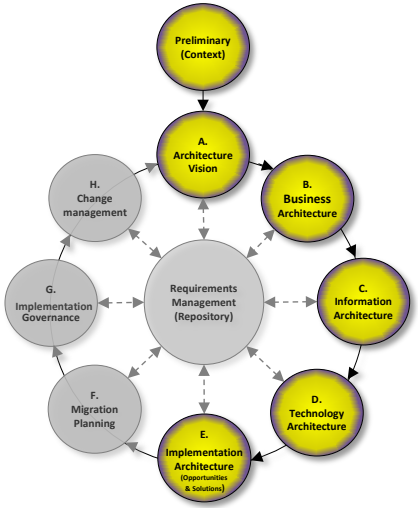
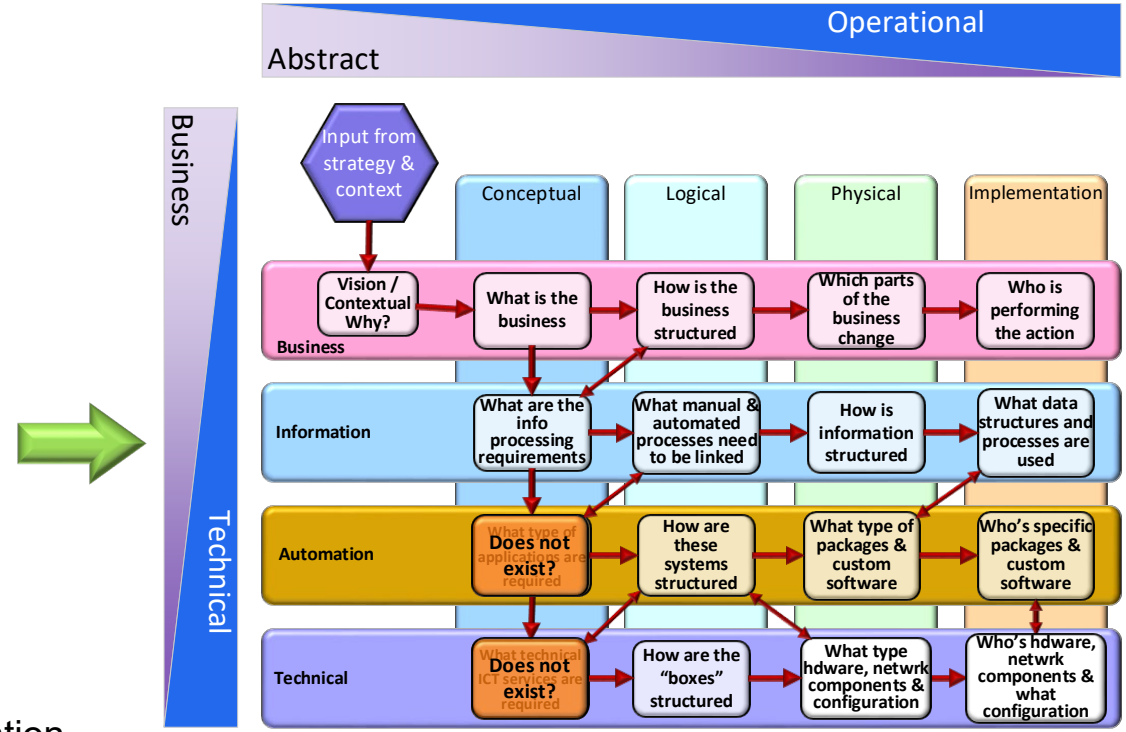
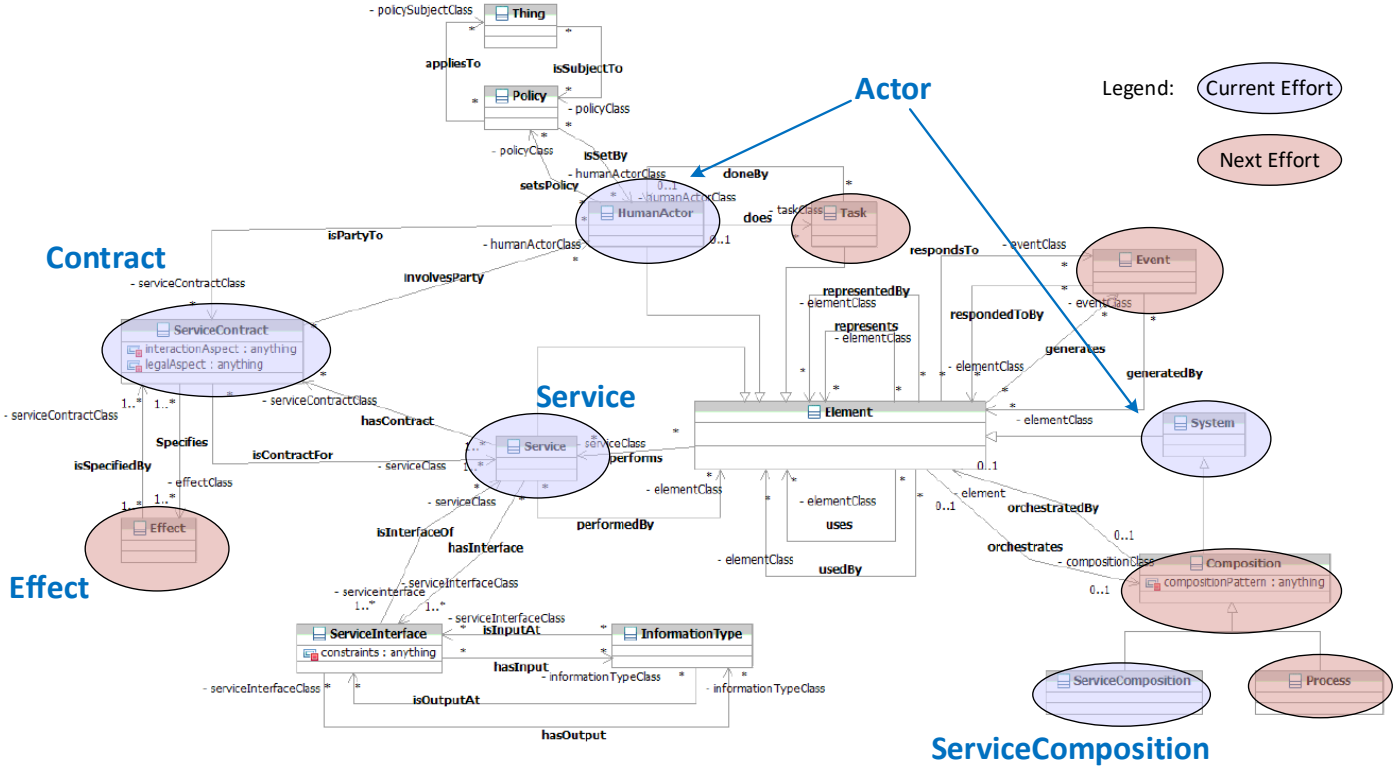
Conceptual, Logical, Physical, Implementation applied to Zachman Levels

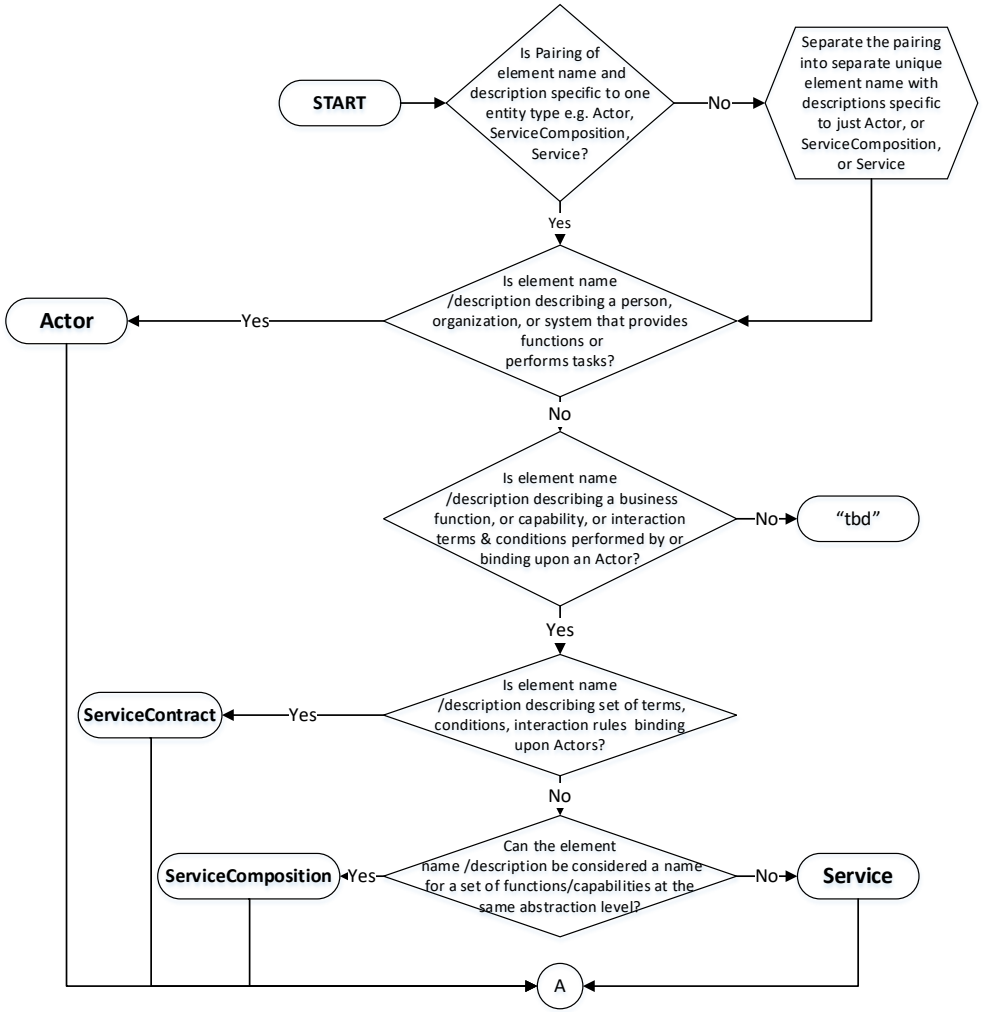




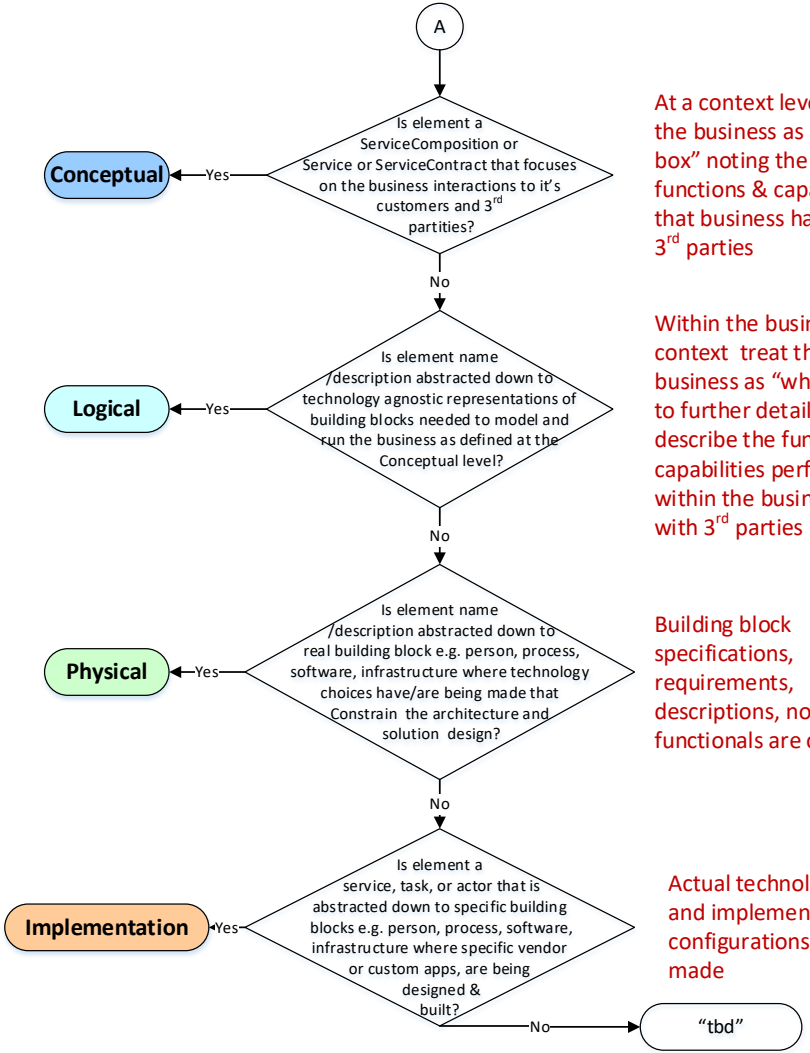
Note: TOGAF Phase C maps into Zachman Information and Automation

Full Open Group SOA Ontology Mappings to Grid Ontology Metamodel





Architectural Element Categorization Decision Tree



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

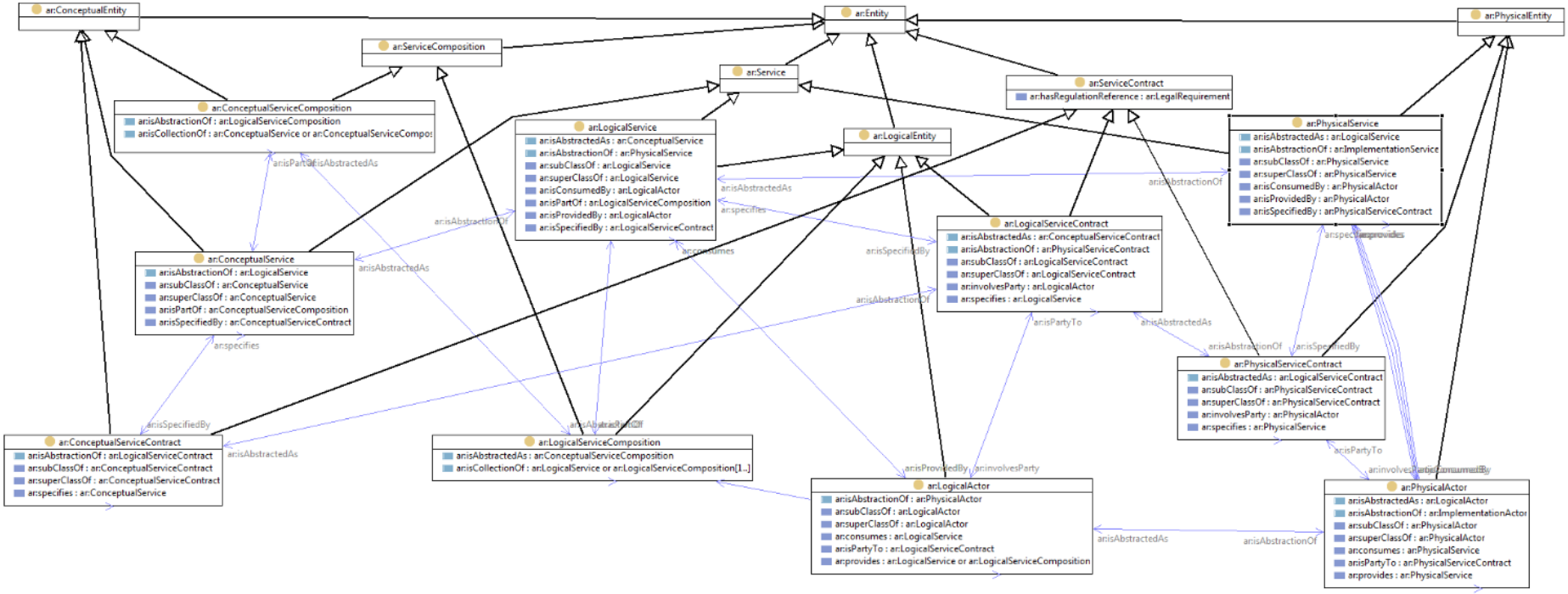
Within the business context treat the business as "white box" to further detail and describe the functions & capabilities performed within the business and with 3rd parties

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

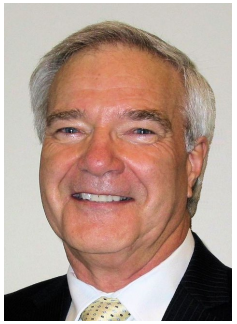
Actual technology and implementation configurations are made

Architectural Abstraction Level Categorization Decision Tree

Grid Ontology OWL metamodel



Today's Speakers



Ron Cunnigham
IT Enterprise Architect
rtcunningham@aep.com

Steve Ray
Chief Executive Officer
steveraysteveray@gmail.com

BUILDING A WORLD OF DI

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Thanks for Attending

Daisy Chung
Manager, Industry Solutions
Dchung@sepapower.org
202.559.2027

Aaron Smallwood
Vice President, Research
asmallwood@sepapower.org
202.871.7414

HEADQUARTERS

Smart Electric Power Alliance
1220 19th Street, NW, Suite 800
Washington, DC 20036-2405
202.857.0898

GROUPS
COLLABORATION and CONVERSATION by SEPA