SGIP Nashville 2011 Meeting

Semantic Working Party

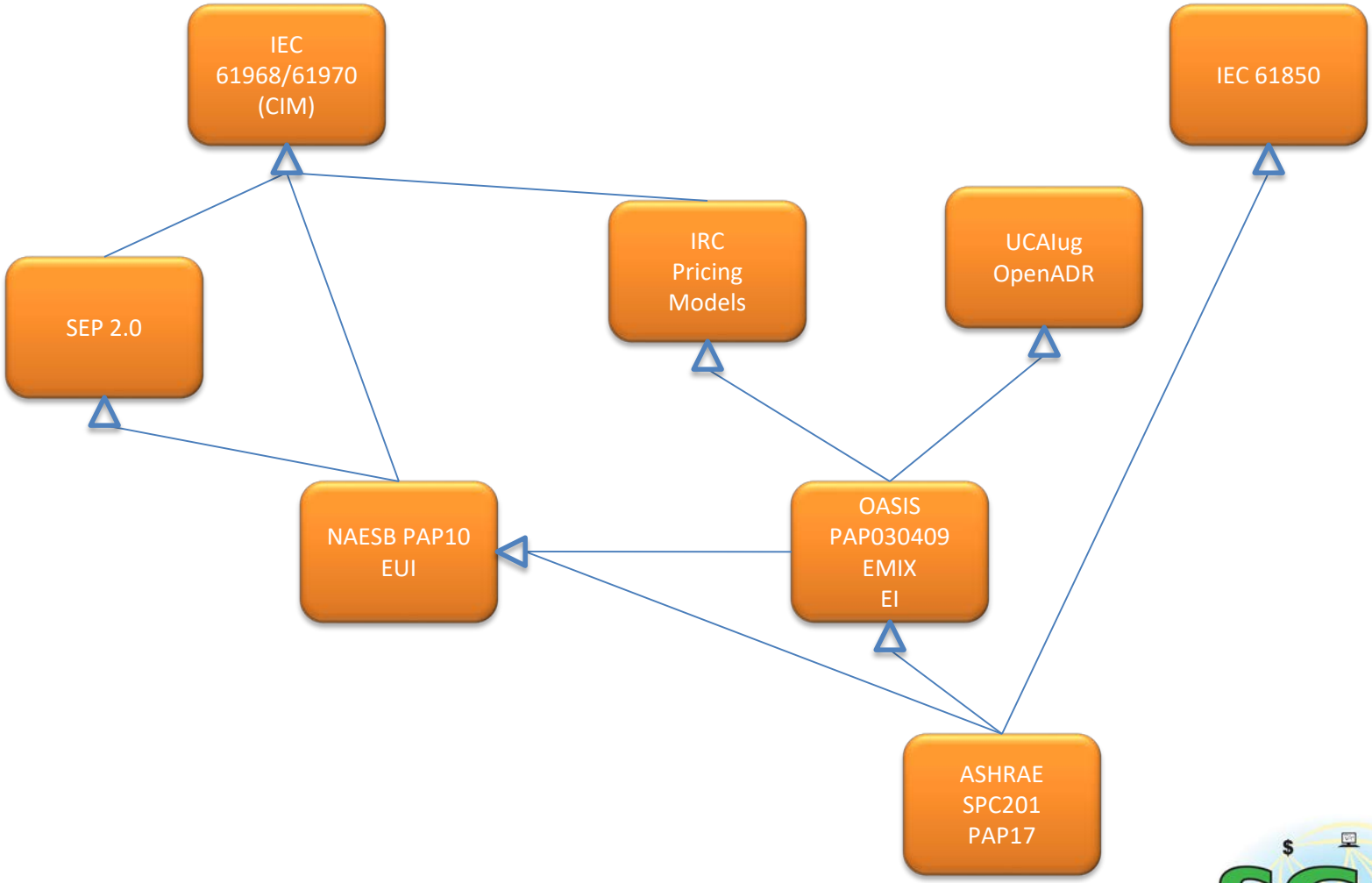
AGENDA

The SGAC Semantic Modeling Working Party will be meeting to further discuss topics related to harmonizing various semantic models primarily under construction by the PAPs and Working Groups of the SGIP. The following topics will be discussed:

1. [20 min] Managing a Smart Grid semantic model repository containing CIM, 61850, C12.19, SEP2.0, EMIX, ASHRAE 201, ...
2. [20 min] Defining the relationship between models based on CIM and CIM itself
3. [30 min] Determining role of OWL and other semantic tools in semantic working party – primary or accessory
4. [20 min] Fleshing out further the SGAC Semantic Framework paper that describes how to determine where alignment exists and where translations need to occur.
5. [15 min] PAP14 – Overview of priority process to identify key Use Cases necessary for Smart Grid in the T&D Domains.
6. [60 min] Dig into specific examples of semantic harmonization use cases in more detail - We are inviting attendees to bring examples to discuss.

MANAGING A SMART GRID SEMANTIC MODEL REPOSITORY CONTAINING CIM, 61850, C12.19, SEP2.0, EMIX, ASHRAE 201, …

Semantic Models in the Customer Demand Side Management PAPs

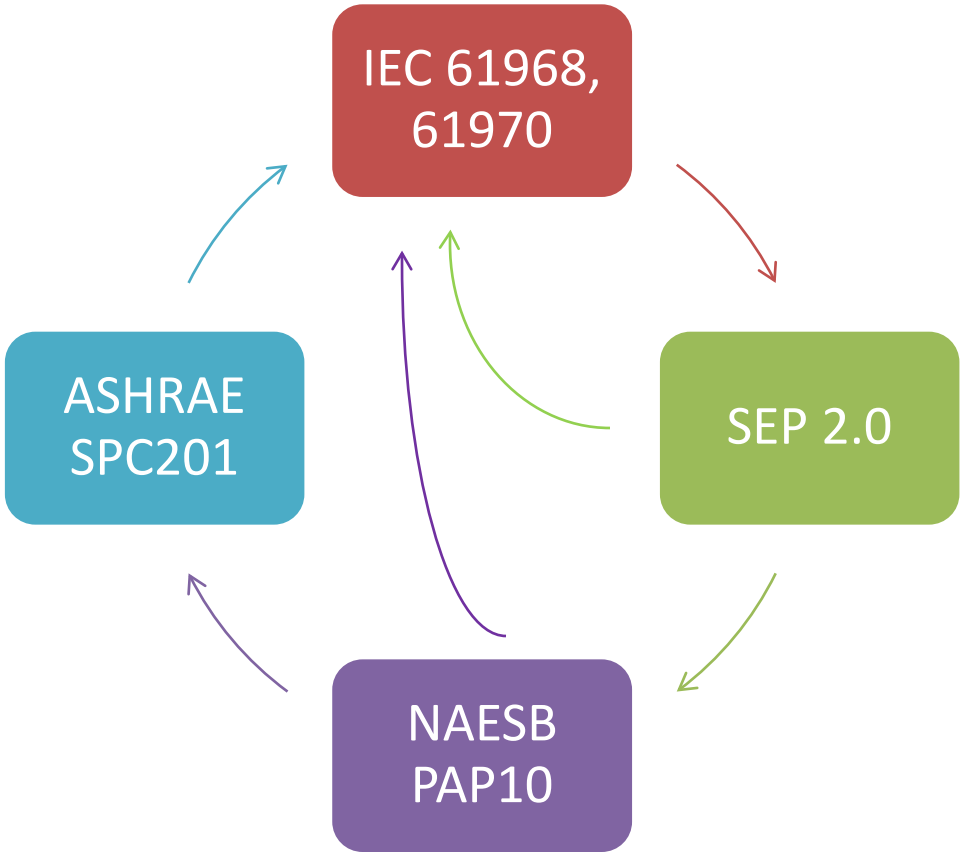


What Should a Library Look Like

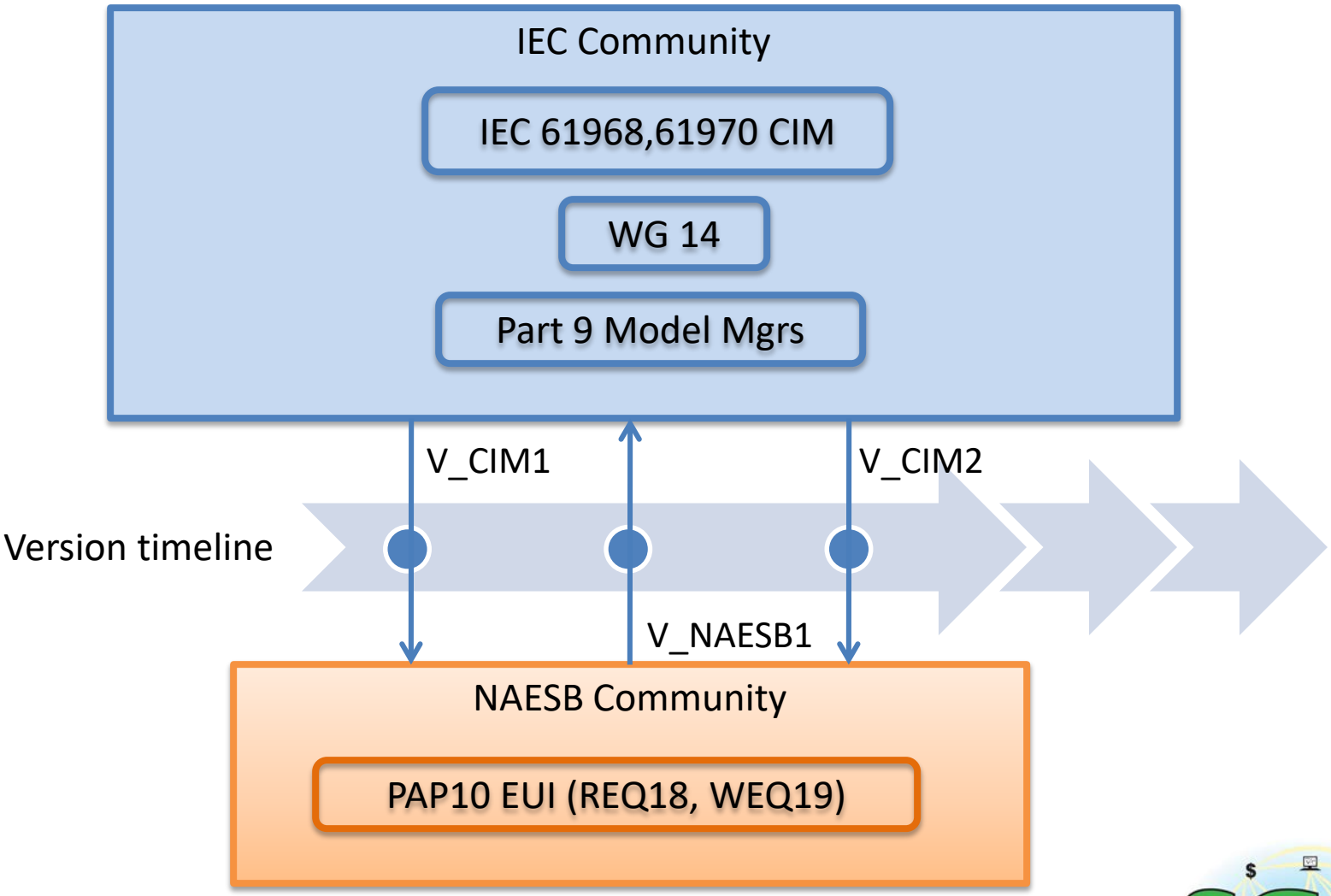
- Components
  - CIM, 61850, SEP2.0, FSGIM, NAESB, …
- Versioning
- Disclaimers and copyright notices
- What else????
  - Mapping from model to model
  - What do we need to do to facilitate how to use these standards
- Repository vs. Registry?
  - Needs for current version (reference) as well as frozen version (copy)
  - How to distinguish between working copies and reference copies.
- What is use case for such a library?
  - For study of standards and their relationships
  - What kind of uses people have made of the models

Defining the relationship between models based on CIM and CIM itself

Model Evolutions



Model Roullette



Methodology

- Inheriting from CIM, 61850
  - Profile definitions
  - Continuous interaction with the “model managers” to help maintain semantic quality
  - “Style guide” for extending CIM
- Versioning
  - Normative models vs. models in flight
- Handback
  - Repository of outstanding extensions that have not been reabsorbed
- Document differences
  - See “style guide”
- High level coordination?

DETERMINING ROLE OF OWL AND OTHER SEMANTIC TOOLS IN SEMANTIC WORKING PARTY – PRIMARY OR ACCESSORY

Challenge: How to reconcile vocabularies, concepts and relations among all the smart grid standards?

- Currently 82 standards in the SGIP Catalog of Standards
  - Overlapping, different, sometimes contradictory vocabularies and definitions
- We need a way to manage
  - Differences
  - Constraints on usage
  - Relationships between vocabularies

How to proceed?

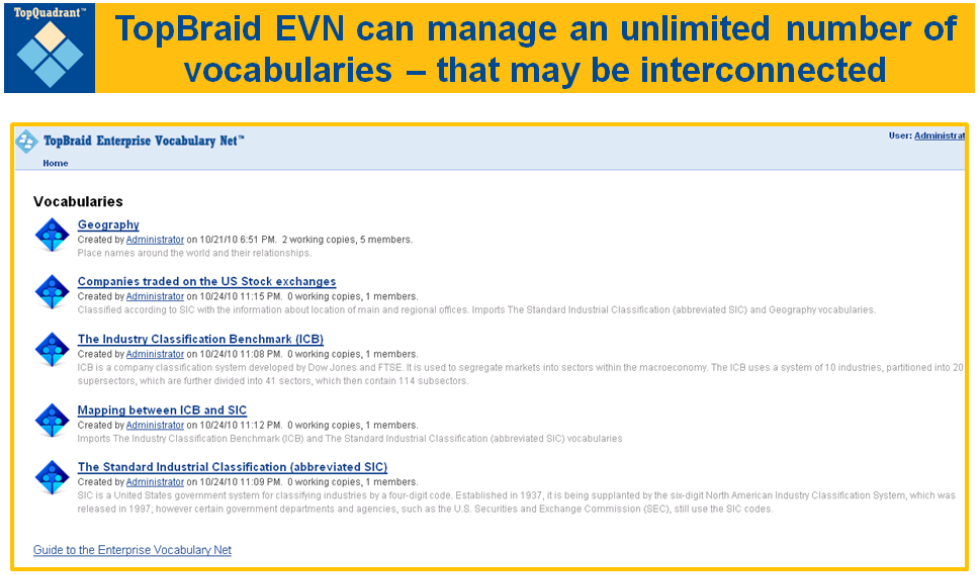
1. Align vocabularies
2. Capture relationships and constraints
3. Create mappings among standards

What are the alternatives?

- Spreadsheets
- UML tools
  - Enterprise Architect (Sparx Systems)
  - Rational Software Architect (IBM)
  - MagicDraw (No Magic)
  - Visual Ontology Modeler (Sandpiper)
- Other semantic tools haven't tackled vocabulary management among multiple models
  - Protégé (Stanford)
  - Anzo (Cambridge Semantics)

ONE OPTION:

- TopBraid's Enterprise Vocabulary Net (EVN)
  - Runs from the cloud



TopBraid EVN Features include:

- **Intuitive graphical user interface**
- **Multi-user support**
- **Editing and review of multiple working copies is supported**
  - Working copies of a vocabulary can be provisionally changed and reviewed without affecting the production vocabulary until changes are published
- **Controlled role-based access**
  - staff members can be provided appropriate access to vocabularies and working copies depending on their assigned roles
- **Change tracking**
- **Built-in and custom rules**
- **Support of all relevant W3C standards**
  - e.g., SKOS and RDF
- **Import/Export and seamless integration using web services**
- **Easy extensibility of features**
  - using TopQuadrant's TopBraid platform

TopBraid EVN Capabilities include:

- **Vocabulary Editing:** Cloning, merging, repositioning and re-numbering of concepts; global edit operations for selected groups of concepts
- **Easy Customization:** Easy customization of user interfaces, custom validation rules and processing via SPARQL Rules and SPARQLMotion
- **Unlimited Work-in-Progress Copies:** Virtual work-in-progress copies of vocabularies enable controlled publishing, review and approval
- **Reporting:** Built-in reports as well as advanced query-building tools and reporting through graphical interfaces
- **Merging, Importing, and Exporting:** From and to RDBMs, spreadsheets (CSV & Excel), XML, RSS feeds, SPARQL endpoints, RDF and OWL
- **Systems Integration:** Integrates with existing enterprise or vocabulary management systems via Web Services interfaces and APIs
- **Enterprise-ready:** Scalable architecture offers a choice of relational and RDF database repositories with LDAP integration for access control

How can the output be used?

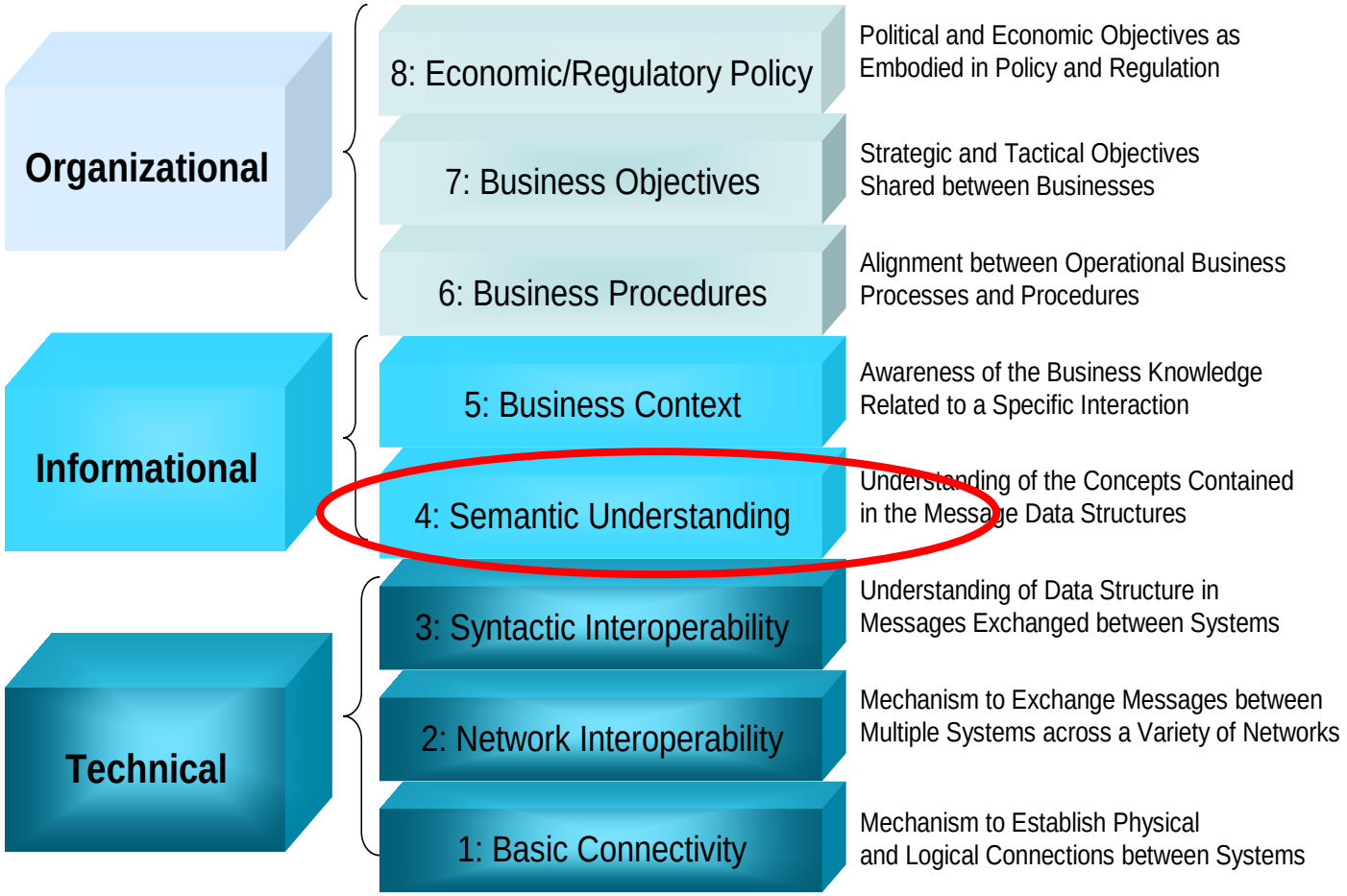
- What is the output?
  - SKOS, RDF, OWL -- **W3C standards**
  - UML diagrams, XML Schema, XSD
- How can the output be used without EVN?
  - Resulting models can be imported into other mainstream modeling tools

- TopQuadrant is in discussions with the SGIP PMO-EnerNex to formally offer the EVN free of charge to SGIP.
- Philip Bane from TopQuadrant is at SGIP meeting if you have any questions.

Fleshing out further the SGAC Semantic Framework paper that describes how to determine where alignment exists and where

GWAC Stack

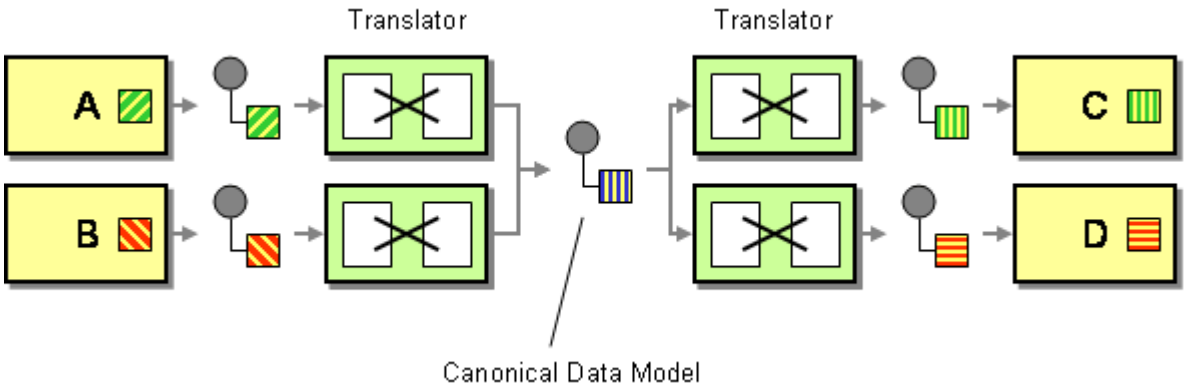
Interoperability Categories

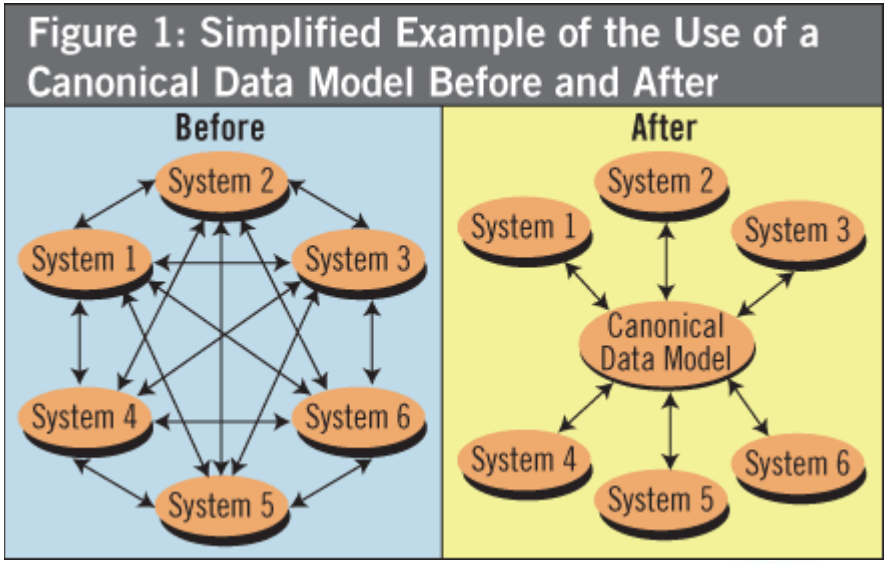


SOME DEFINITIONS…

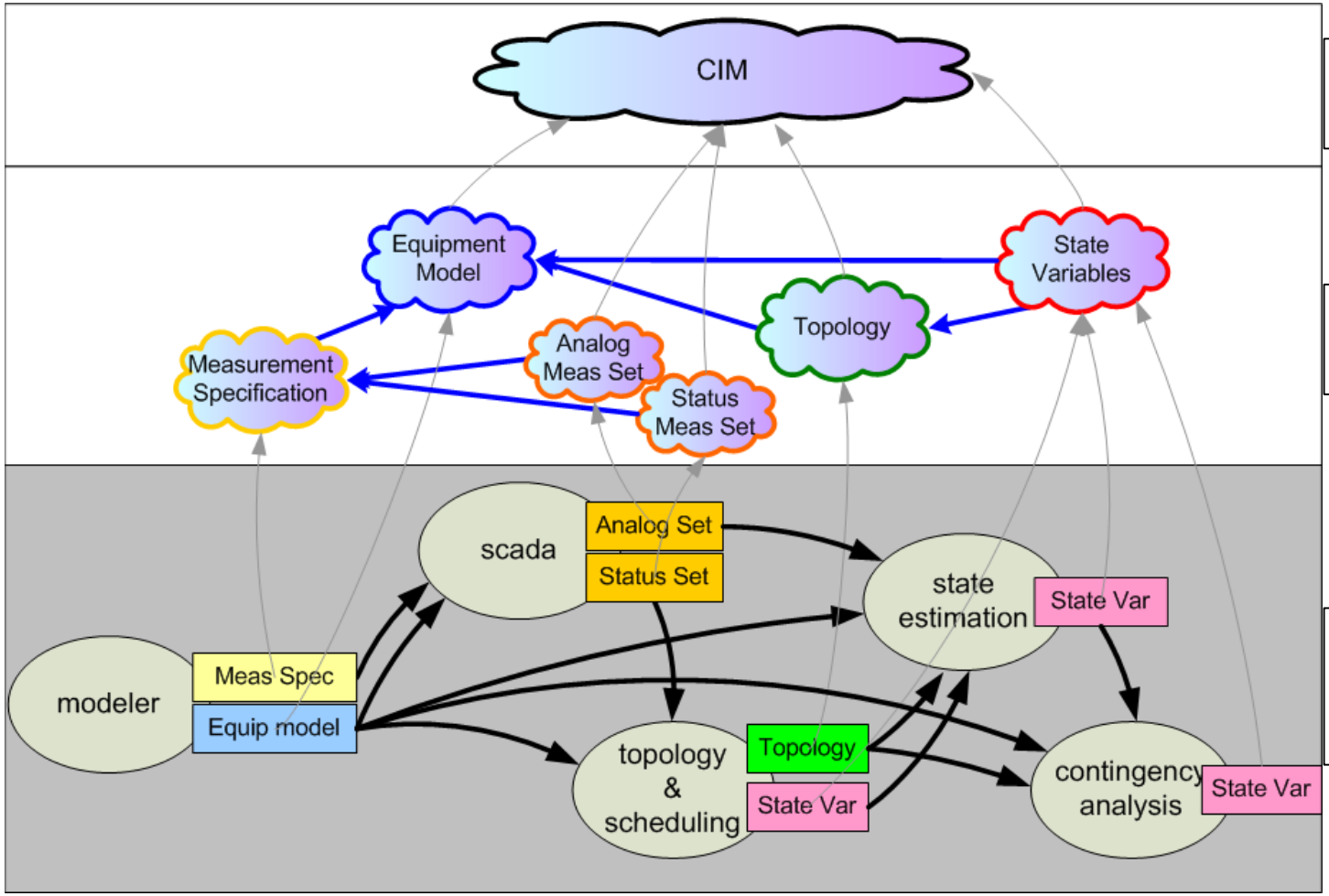
- ***Semantics*** refers to the meaning of a set of information.
- A ***semantic model*** is a structured description of the semantics of a set of information, using some information modeling language (e.g. UML).
  - A semantic model contains 'metadata'.
  - Many different semantic models are possible for the same semantics, even within one modeling language.
  - Semantic modeling only represents information content – it does not include formatting/encoding (syntactical) specifications.
- A ***semantic transformation*** is a procedure for converting a given semantic from one semantic model representation to another.
  - This is to be distinguished from a syntactic transformation that would convert a set of information governed by one semantic model from one format to another.

A *CANONICAL DATA MODEL* (CDM) IS A SEMANTIC MODEL CHOSEN AS A *UNIFYING* MODEL THAT WILL GOVERN A COLLECTION OF DATA SPECIFICATIONS.





Example usage of CDM to define a collection of standard interfaces.



Canonical Data Model

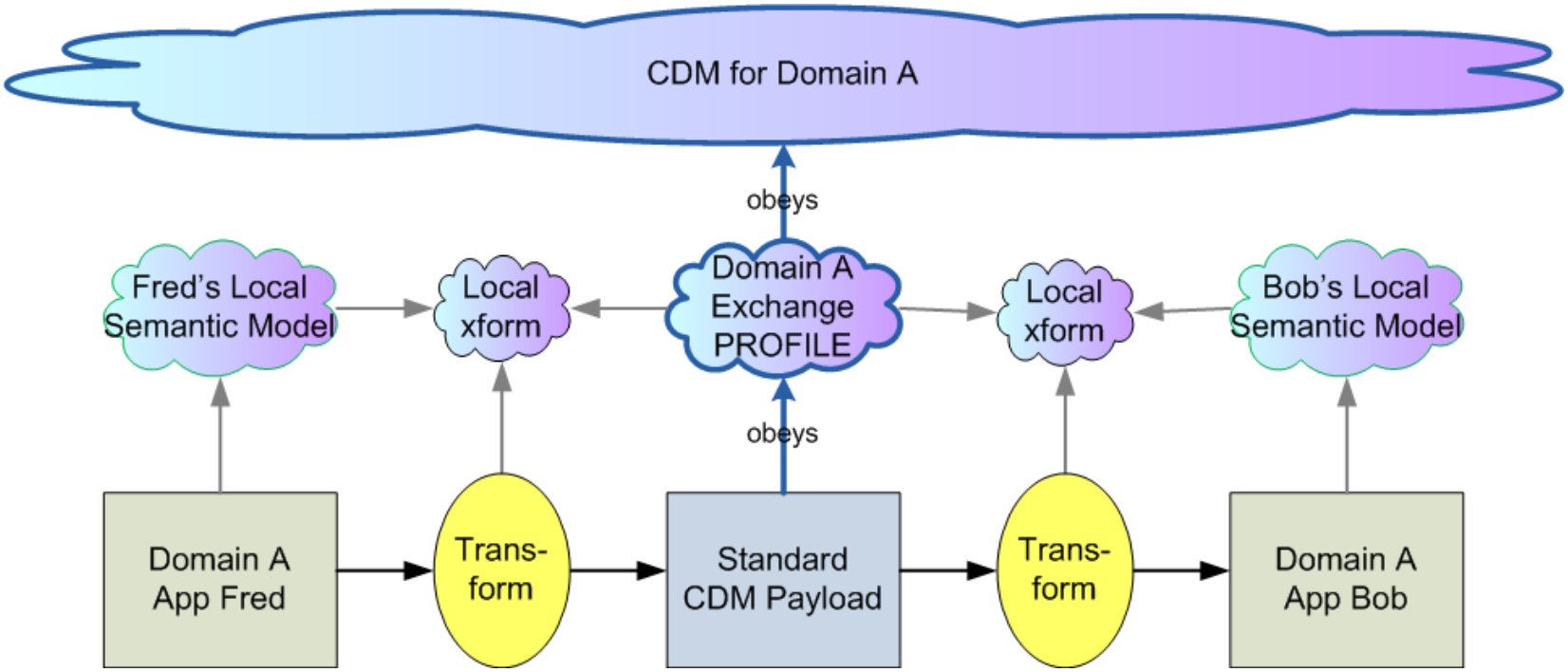
derived from

Exchange Profiles

defined by

Exchange Payload Instances

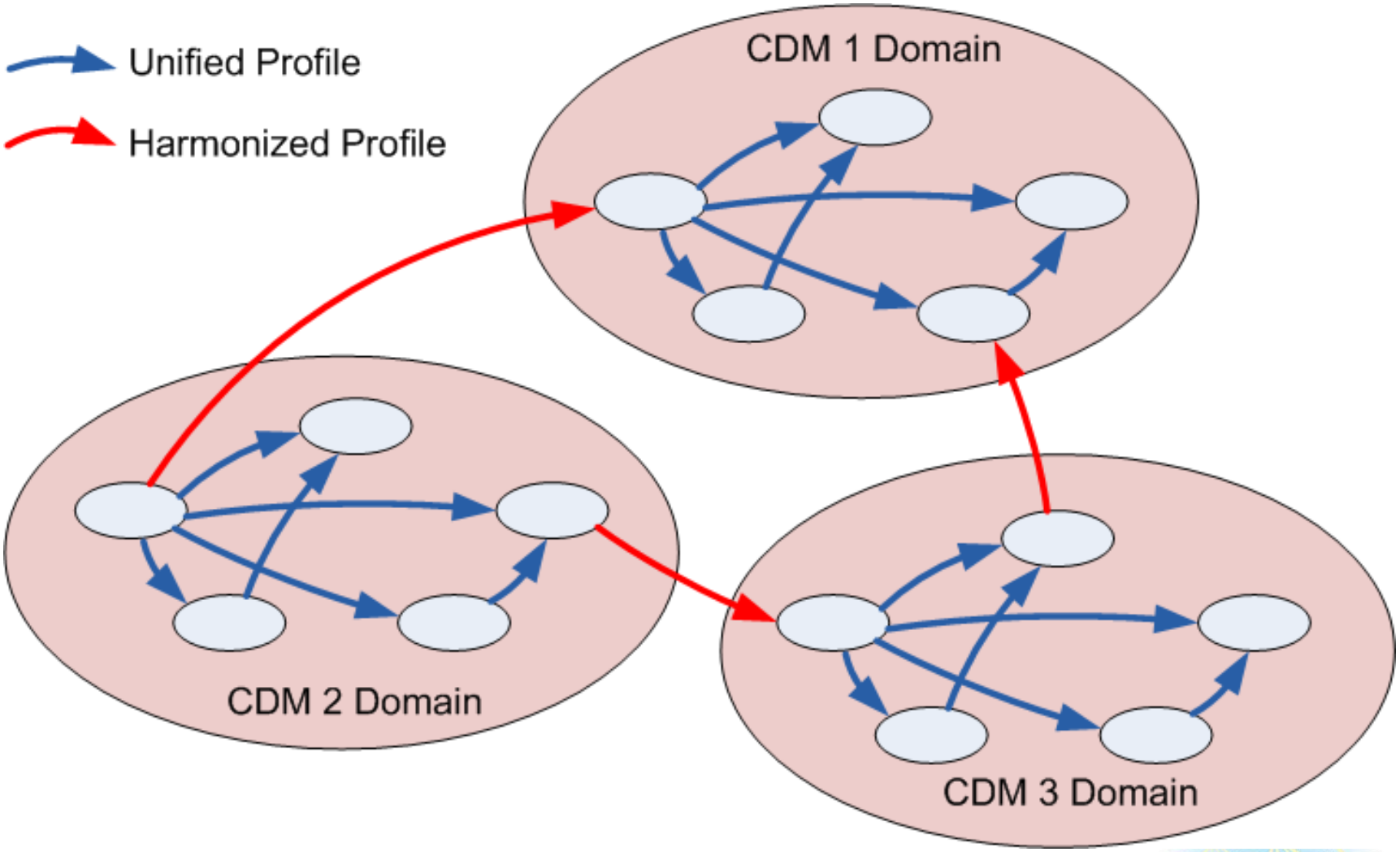
Standard semantic integration within a unified domain – one CDM.



Considering the possibility of a single unified model.

- Definition: a ***unified*** model:
  - Is 'normalized' (no duplicate modeling of the same semantic).
  - Covers the entire problem scope of Smart Grid.
- Challenges:
  - A scope as large as Smart Grid has to be partitioned somehow into domains so that different focus groups can operate in parallel.
  - The difficulty of coordinating normalized modeling goes up exponentially with the number of different domains.
  - There is already significant investment in separate domain models which would have to be changed to achieve a global normalization.

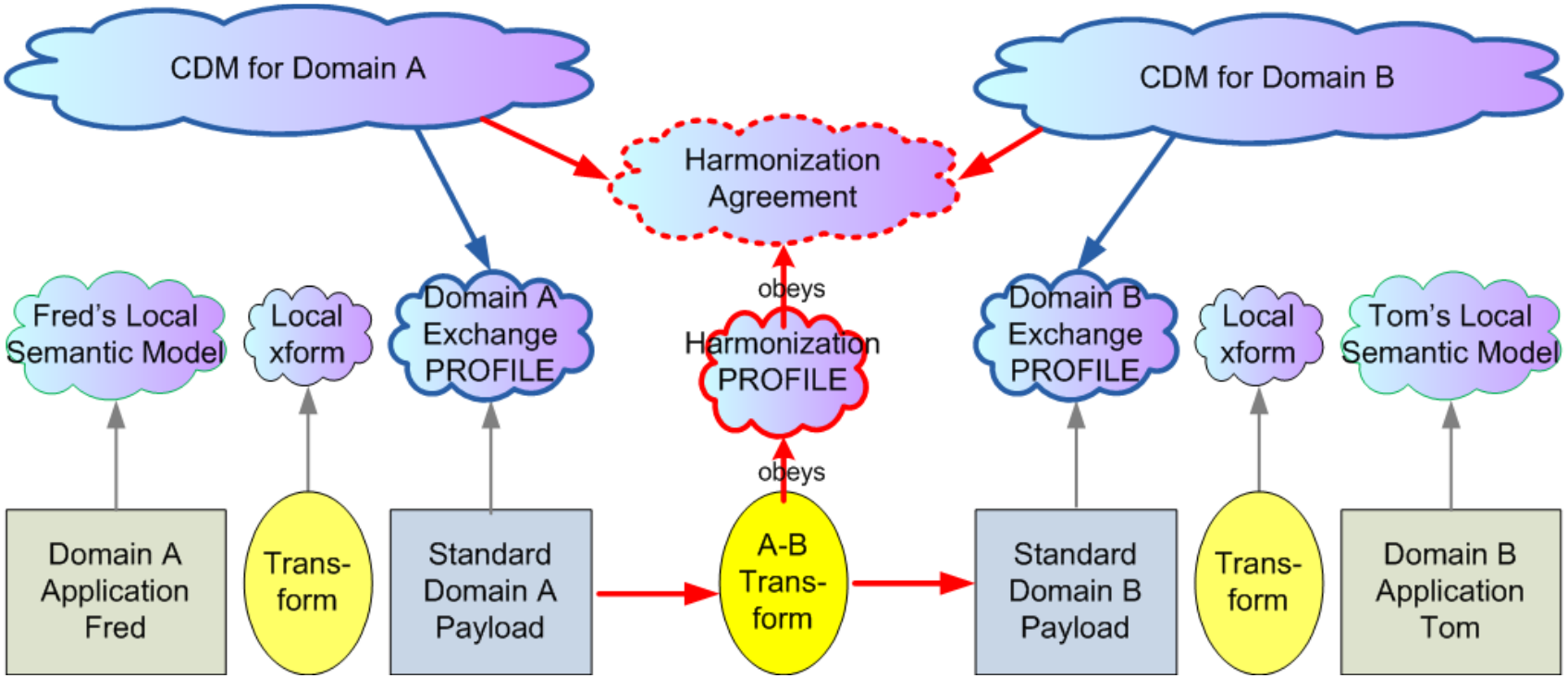
In the real world, there are multiple CDMs.



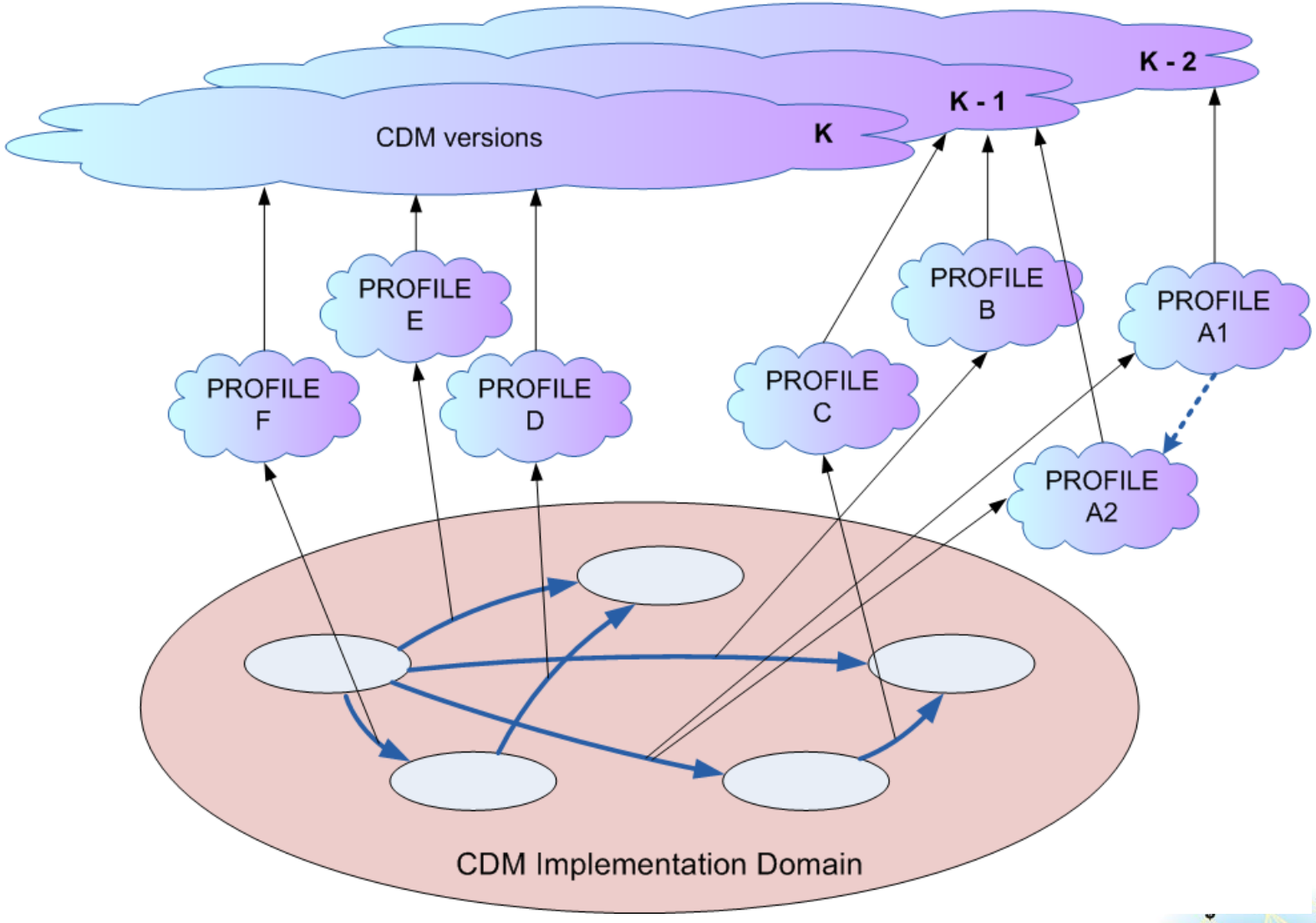
Harmonization: the next best thing for coordinating CDMs.

- Definition: two CDMs are ***harmonized*** if:
  - There is a lossless transformation defined between all duplicated semantics.
  - Both sides undertake to maintain the harmony, once established.

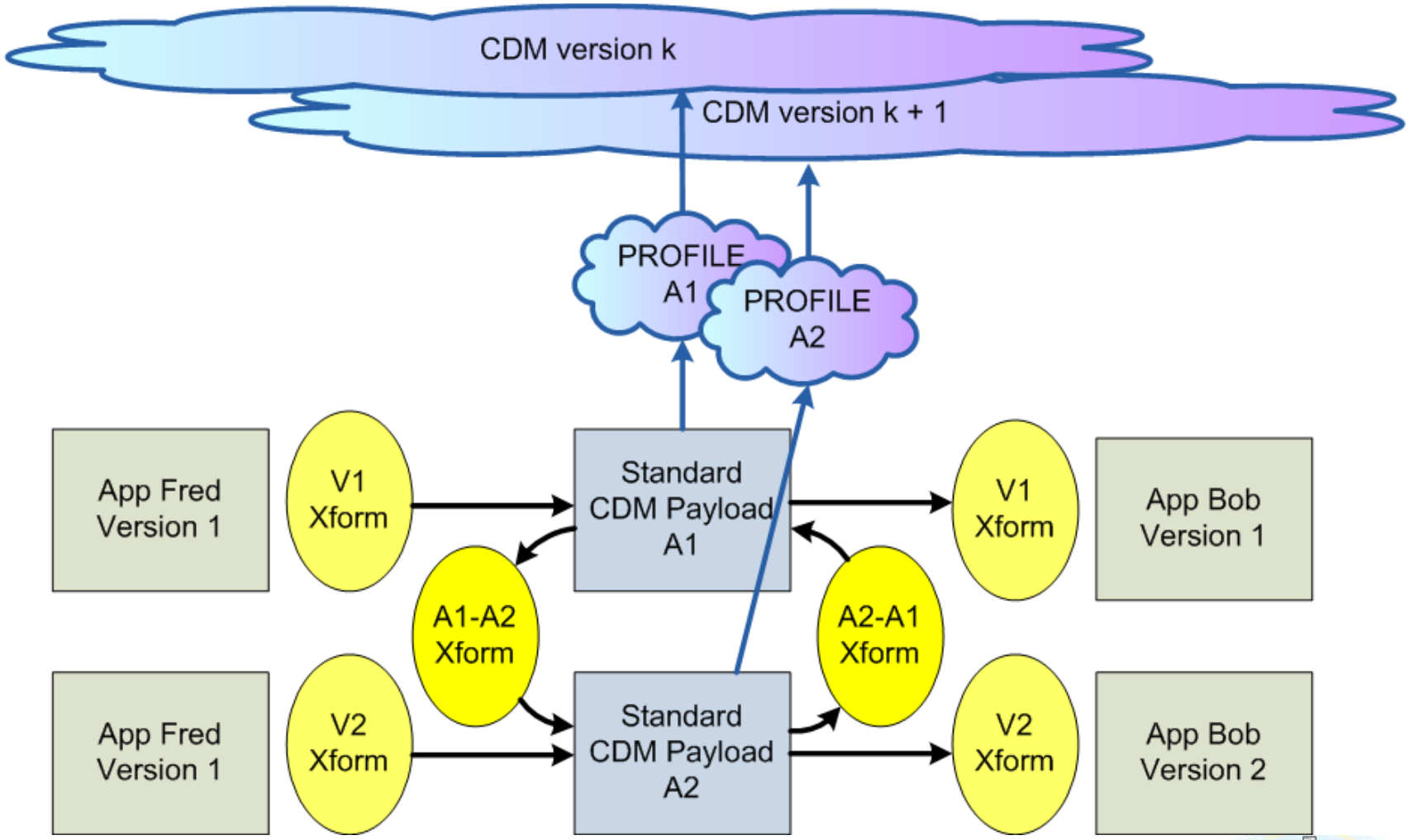
Standard semantic integration between harmonized domains – two CDMs.



IN THE REAL WORLD, SEMANTIC MODELS AND STANDARDS NEED TO EVOLVE.



VERSION MIGRATION WITHIN A PROFILE.



IEC Profile Group

- IEC TC57 has recently launched an effort to define more precisely the notion of a ‘profile’.
- This comes from a growing recognition that:
  - Profiles have a different purpose than CDMs.
  - Profiles are where the software investment is made.
  - Profiles are what is tested.
  - Profiles are where backward compatibility and versioning must be dealt with.
- The group is reporting to WG19 with membership from a variety of WGs.

How many CDMs does it take to screw in a light bulb?

Problem:

- You want to standardize a new exchange.
- After researching requirements:
  - No single CDM has everything you need.
  - Several CDMs have useful content.
- What do you do?

Objective:

- Each exchange payload derives from one CDM.

Rationale:

- Coordinating a profile with one SDO is challenge enough!

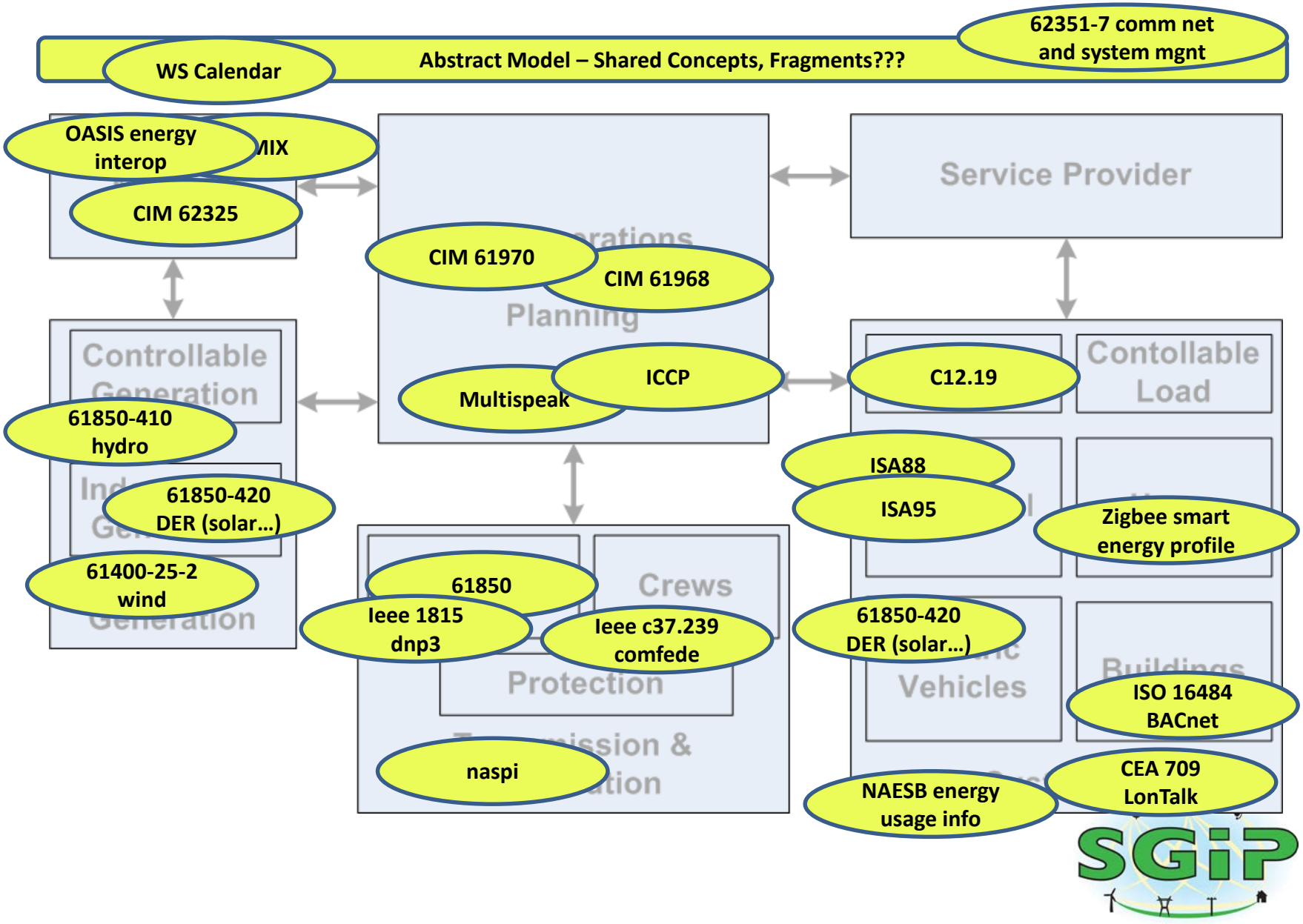
Discussion:

- In addition to asking what your SDO can do for you, ask also what you can do for your SDO.
- The short-term is the enemy of the long-term.

The Semantic Framework aims to provide:

- Methodology Guidance for Smart Grid
  - CDMs
  - Profiles
  - Version Management
  - Harmonization
- Implementation Map of Smart Grid Semantic Standards
  - What CDMs by what SDOs
  - What exchanges require profiles by what SDOs.
  - What CDMs have what harmonization agreements.

Draft Semantic Mapping

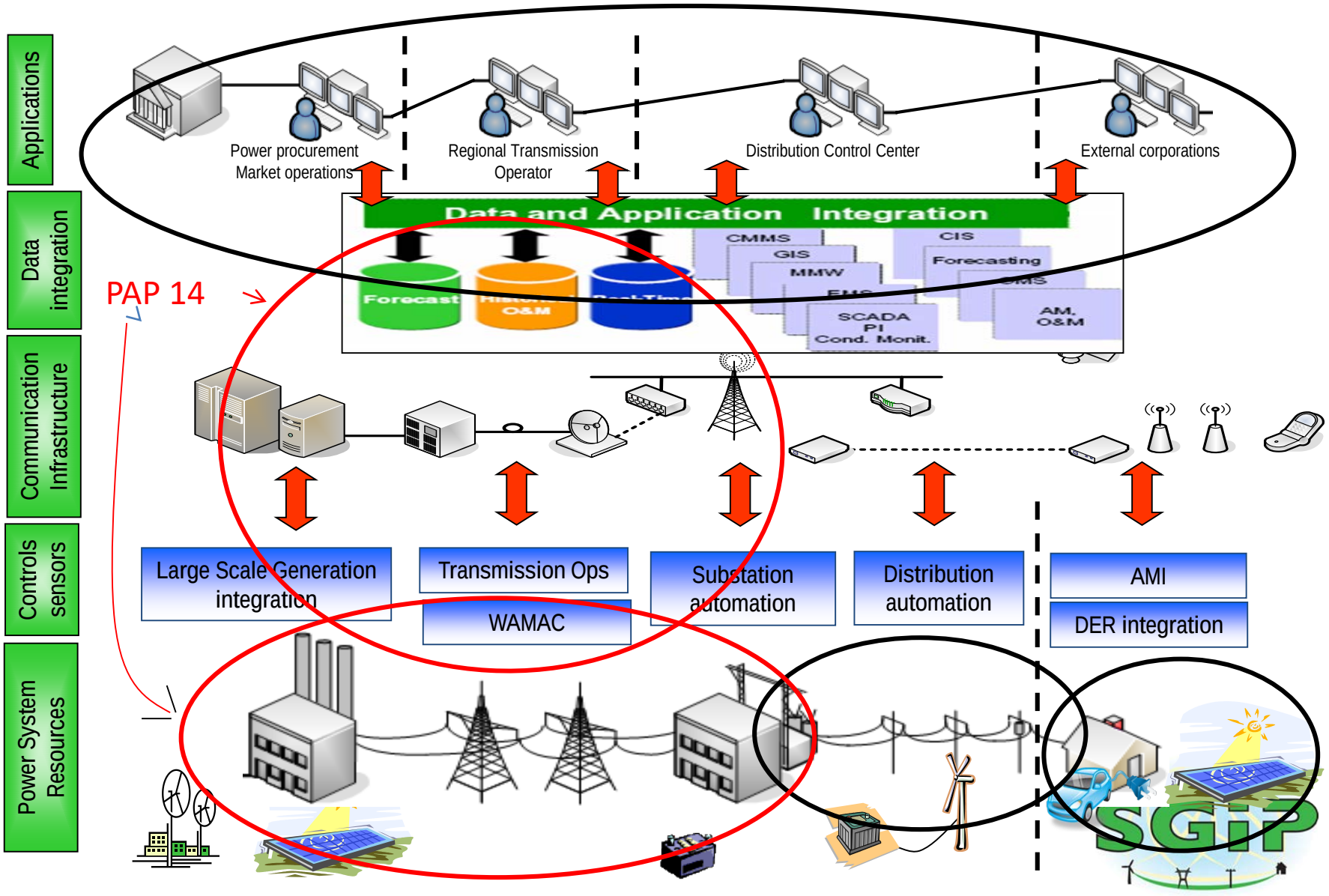


PAP14 – Overview of priority process to identify key Use Cases necessary for Smart Grid in the T&D Domains.

Agenda

- PaP 14 Overview
- Priority Process Release Version
- Status of PAP 14 Specific Development Areas

PAP 14: Transmission and Distribution Power Systems Model Mapping: Scope Perspectives



SDOs and Consortia Related to PAP 14

CSWG Liaison: Stan Klein, [[stan@osecs.com]

SGAC Liaison: Jay Britton

SDO Lead: Christoph Brunner, Convenor IEC TC57, WG10

Other SDOs:

IEEE Power Systems Relay Committee (PSRC)H3 Committee Chair Bill Dickerson
IEEE PSRC H2 Committee Chair Mark Simon
IEEE PSRC H5 Committee Chair Jürgen Holbach
IEEE PSRC H16 Committee Chair Mark Adamiak
IEEE PSRC Communications Subcommittee: Veselin Skendzic
IEC WG13 Convenor Terry Saxton
IEC WG14 Convenor Greg Robinson,
IEC TC 57 WG 19 Paul Skare Convenor, Herb Falk, Harmonization
Multispeak: Gary McNaughton

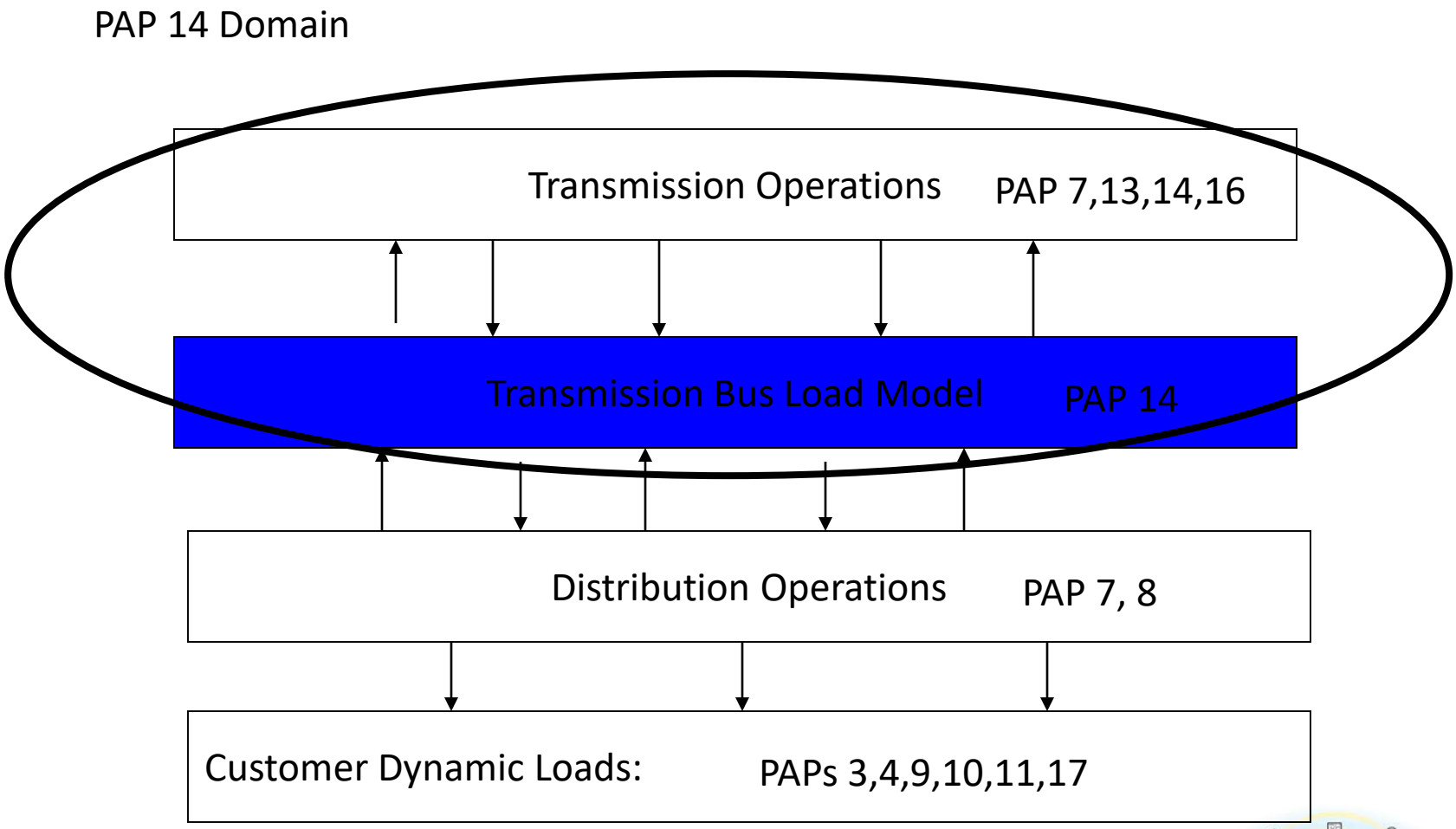
Users Groups:

UCAIug, Mark Adamiak

Technical Team:

Alex Apostolov (Member IEC TC57, WG10, 19, IEEE PSRC H3, H5 and H16)

PAP 14 Revised Scope..



PAP 14 Priority Criteria: Dual Track Priority Criteria

Key Application Needs

- Key Application Needed by the Industry
- Cross Cutting Applications
- Don’t replicate, complement those addressing key needs
- PAP 14 “breadth” to other related PAP “Depth”

Key Standards Gaps

- Integration, Harmonization, Unification of Field Equipment and Back Office*
- Event Model Integration*
- Relay Setting Standards*
- Electronic Tagging
- Transmission Bus Load Model Development
- Other

*Initial PAP 14 Scope

PAP 14 Goals

- Narrow Focus to Key Transmission Related Application and Associated Standards Development Issues
- Select a small number of transmission operations functions which have:
  a. Address Needs for Key needed applications
  b. Address Significant Standards Development and Integration Needs
  c. Address cross-cutting needs
  d. Are architecturally significant, i.e.
     - Involve most of the actors
     - Require critical performance characteristics

PAP 14 SpreadSheet Priority Tool Criteria

Scoring from 0 to 5 points

Criteria for Prioritizing PAP 14 (T&D System Models) Use Cases (DRAFT Instrument)									
Track 1: Key Applications Criteria				Track 2: Standards Development Criteria					Comment /Lead SDOs
1A. Addresses Critical Application(s) Needed for smart grid Development	1B. Supports Cross Cutting Applications	1C. Addresses Architecturally Significant Issues	1D. Addresses Application(s) Not Addressed by Others	2A. Supports critical areas of needed standardization development i.e.relay settings	2B Defines specific strategies to integrate/harmonize existing standards	2C. Develops Standards that Support Multiple Applications i.e. Event Models	2D. Addresses specific critical technical issues necessary for standards integration	Total Score	

FORMAT OF PAP 14 SPREADSHEET PRIORITY TOOL

Note: Blue=Ops Driven Sources (Ops), Green=Standards Driven Sources (STD), Blue/Gray=Other Contributions(Cont)		Track 1: Key Applications Criteria				Track 2: Standards Development Criteria					Comment /Lead SDOs
Use Case Title/Category	**Relationship to Other Use Cases**	1A. Addresses Critical Application(s) Needed for smart grid Development	1B. Supports Cross Cutting Applications	1C. Addresses Architecturally Significant Issues	1D. Addresses Application(s) Not Addressed by Others	2A. Supports critical areas of needed standardization development i.e.relay settings	2B Defines specific strategies to integrate/harmonize existing standards	2C. Develops Standards that Support Multiple Applications i.e. Event Models	2D. Addresses specific critical technical issues necessary for standards integration	**Total Score**	
Transmission Bus Load Model (TBLM)	Information Support for WASA, OPF-SCD, SCA, DSA, WAMCS, REST										IEC TC 57 WG 13
Wide Area Situational Awareness (WASA, incl. SE)	Uses TBLM information; information suppport for OPF-SCD, SCA, DSA, WAMCS, REST										IEEE PSRC
Optimal Power Flow and Security Constraint Dispatch (OPF-SCD)	Uses TBLM and WASA information; information suppport for SCA, WAMCS, REST										IEC TC 57 WG 10, 19/IEEE PSRC

PAP 14 Additional Use Cases From Twiki Contributions

- Fault Location
- Automated Fault Analysis
- Back-up protection
- Protective relay application testing
- State Estimation
- Electronic Tagging

Applications Driving Standards Harmonization

- Planning
  - System Engineer adds a new transmission line with IEC 61850 protection
  - Protection Engineer plans wide-area protection schemes based on system model
- Configuration
  - System Engineer retrofits a substation
  - System Engineer creates CIM model from IEC 61850 configurations
  - Sub-scenario of "System Engineer creates CIM model from IEC 61850 configuration"
  - Protection Engineer sets bus protection based on topology of substation
- Commissioning
  - Protection Engineer verifies protection models from IEC 61850 configuration
  - Protection Engineer simulates protection using CIM model and relay settings

Applications Driving Standards Harmonization Continued

- Operation
  - Protection Engineer changes settings across network
  - System Operator switches feeders based on contingency analysis
  - Application adjusts load to meet system capacity based on settings from System Operator
  - System Operator identifies, locates, isolates and restores service after a fault
  - Adaptive Protection Algorithm adjusts protection settings based on overall system state
  - Centralized Application separates grid into islands to prevent blackout
  - Protection Engineer analyzes run-time data and protection model after fault event
  - Volt VAr Dispatch, a Subfunction of Operator Switches Feeder.
- Asset Management
  - Maintenance Engineer monitors health of primary equipment
  - Asset manager verifies equipment location

IEEE PES Power Systems Relay Committee (PSRC) H2 Use Cases

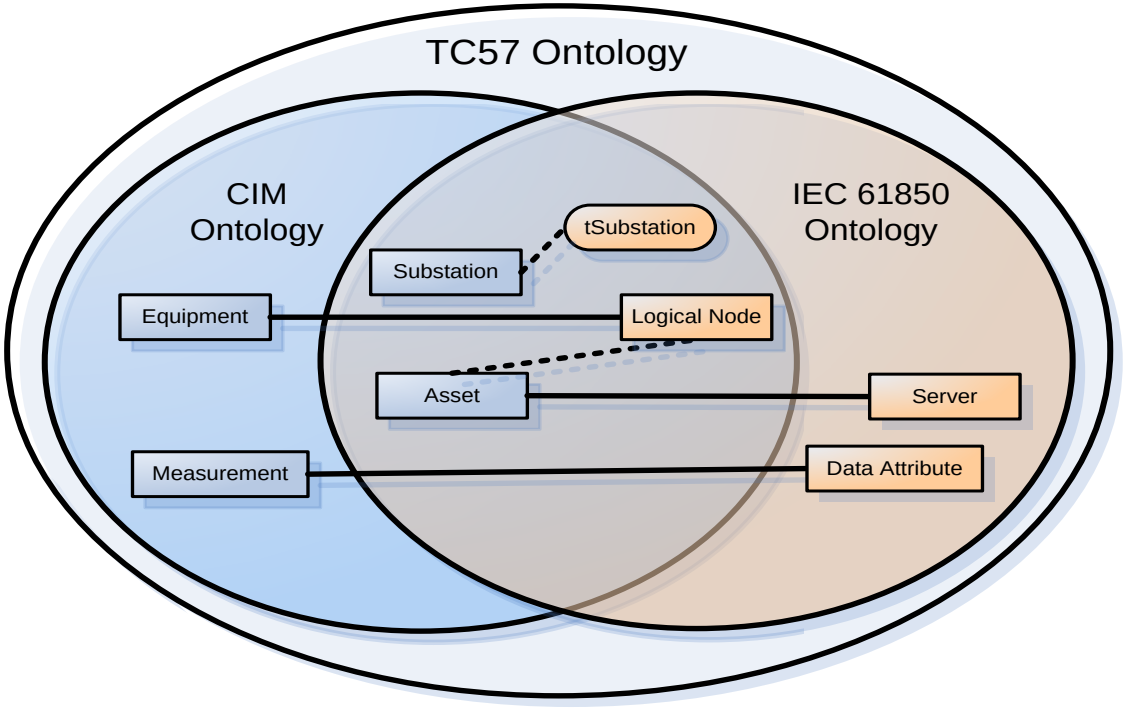
H2 Applications for Smart Grid, Chair Mark Simon

- Dynamic Settings based on Real-Time Conditions
- Reclosing Supervision Based on Smart Grid Data
- Conservation Voltage Reduction
- Fault Location
- Applications of Power Quality Data
- Time Management (Local and Wide Area)
- Applications of GOOSE
- Distributed Energy Resources Protection
- Load Shedding and Load Based Applications

Use Cases from Prior Work (EPRI IntelliGrid Posted on SGIP Interoperability Knowledge Base)

- •AdvancedAutoRestoration.doc
- •AutomatedControlBaseline.doc
- •ContingencyAnalysisBaseline.doc
- •ContingencyAnalysisFuture.doc
- •EmergencyOperationsBaseline.doc
- •Inter-AreaOscillationDamping.doc
- •Self_healing_grid.doc
- •SynchroPhasorDomainDescription.doc
- •VoltageSecurity.doc
- •Wide-Area_Wind_Generation_Forecasting.doc
- •EnterpriseManagementGenericUseCase.doc
- •System Wide Automatic Voltage Control (SAVC)

Generic Standards Integration Harmonization Issues



No Overlap or Conflict between Definitions:
Model Association using UML

Possible Overlap or Conflict between Definitions:
Model Association using OWL

Possible Conflict: Class Modeled in OWL

No Conflict: Class Modeled in UML

Proposed Priority Process

- Finalize Initial List of Candidate Use Cases
- Complete Criteria for Prioritizing
- Reach out to T&D DEWG, SDOs and Consortia, S for participation
- If you are interested in participating please send an email to Joe Hughes: email reefarch.gmail.com

Dig into specific examples of semantic harmonization use cases in more detail - We are inviting attendees to bring examples to discuss.

6 Dig into specific examples of semantic harmonization use cases in more detail

- [15 min] CIM harmonization and mapping with MultiSpeak
- [15 min] ASHRAE SPC201 Information Modeling
- [15 min] Transmission Bus Load Model Use Case
- [15 min] PNW project and its deliberation about semantic standards (i.e. message payload models)

CIM – MultiSpeak® Harmonization Progress

Why are we doing this?

- Give utilities more choices in application selection
- Provide a level playing field for vendors
- Support NIST PAP 8
- Support IEC TC 57 WG 14 (CIM for Distribution)

Challenges

- Both IEC 61968/61970 and MultiSpeak have very robust models
- Mapping the entire models is impractical
  - Lack scope and context
- Using the CIM profiles is a better starting point
  - Provides message exchange context
- There are no equivalent MultiSpeak profiles

Tools

- Sparx Enterprise Architect
  - Both CIM and MultiSpeak have EA reference models
- CIM EA (www.cimea.org) – freely available add-in to Enterprise Architect
  - Facilitates the creation of CIM equivalent MultiSpeak profiles
  - Used to generate XSDs based on the created profiles
- Altova XMLSpy – edit and validate the XSDs
- Altova MapForce – used to generate point-to-point maps

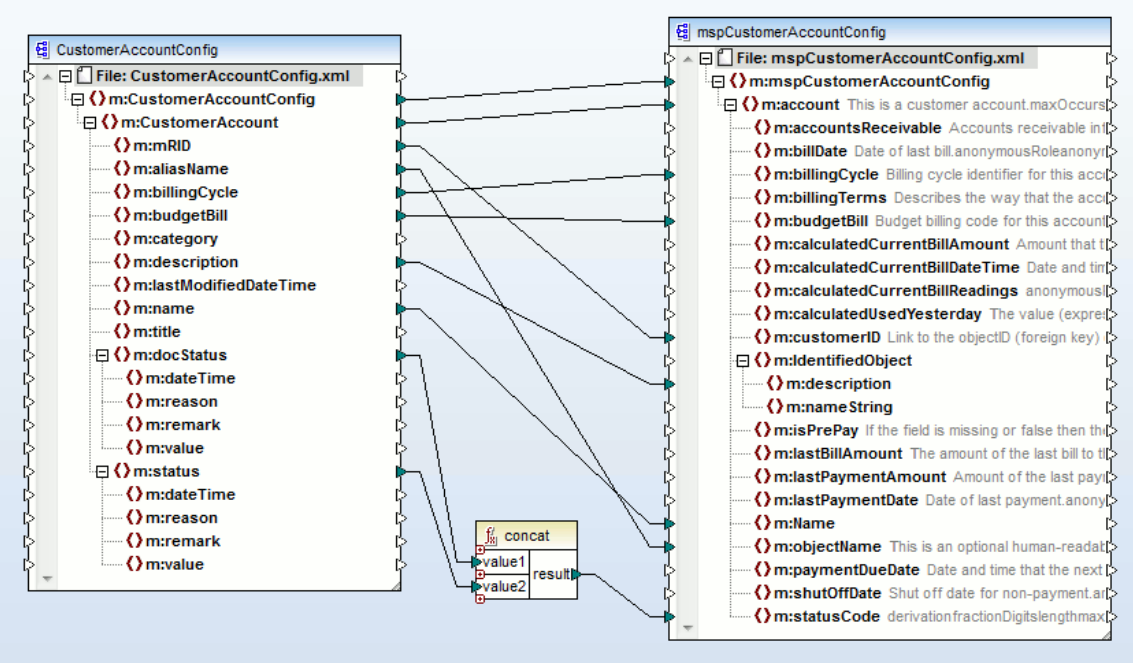
Profile Status

- 23 profiles to be mapped (IEC 61968/61970)

Profile	Status	Profile	Status
EndDeviceAssets	In Progress	ServiceDeliveryPointConfig	
PricingStructureConfig		MeterAssetConfig	
CustomerMeterDataSet	In Progress	MeterAssetReading	
TransactionRecord		CustomerAgreementConfig	In Progress
MeterServiceRequests		MeterSystemEvents	
AuxiliaryAgreementConfig		MeterReadSchedule	In Progress
ServiceLocationConfig	Ready for review	EndDeviceFirmware	In Progress
SDPLocationConfig		EndDeviceControls	In Progress
MeterReadings		CustomerAccountConfig	Completed
CustomerConfig	In Progress	EndDeviceEvents	In Progress
ReceiptRecord		ServiceCategoryConfig	In Progress
SupplierConfig			

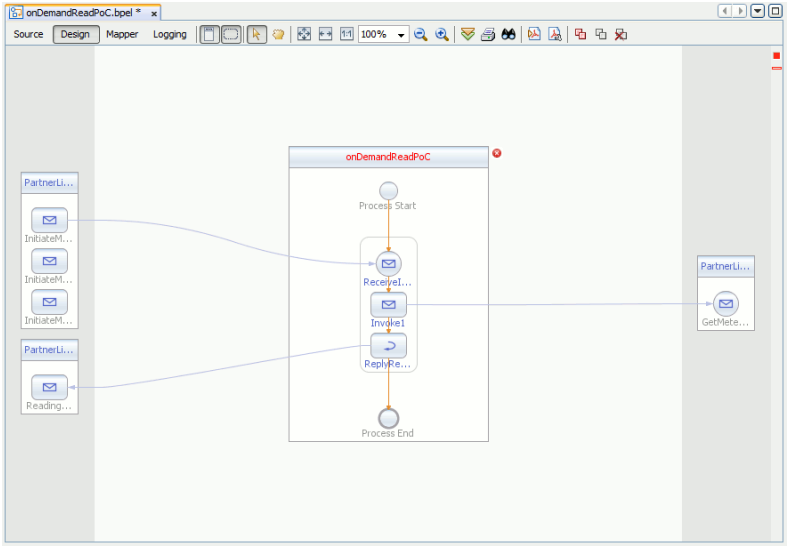
CustomerAccountConfig

- Preliminary assessment
  - Some profiles show considerable correlation
  - However, some significant gaps identified
    - e.g. Document class (no MultiSpeak equivalent)



CIM-MultiSpeak Proof of Concept

- Using OpenESB (based on GlassFish application server and NetBeans)
- Mapping MultiSpeak InitiateMeterReadingsByMeterID to CIM GetMeterReadings, with a return to MultiSpeak
- Demonstrate how MultiSpeak can be mapped to CIM in a practical application
- Leverages the on demand meter read use case



WG14-14 documentation

- Created initial draft IEC 61968-14-1 which will document findings from the CIM-MultiSpeak Proof of Concept and the strategy employed
- Created initial draft of IEC61968-14-9-1 which will document the profile mappings from CIM Part 9 1st Ed. to MultiSpeak v4.1

Together…Shaping the Future of Electricity

ASHRAE SPC201 Information Modeling

THE CASE OF ASHRAE SPC201 USING CIM, 61850, SEP, NAESB, & OASIS INFORMATION MODELS.