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Transformer Modeling for Asset Health with CIM15

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CIM User Group
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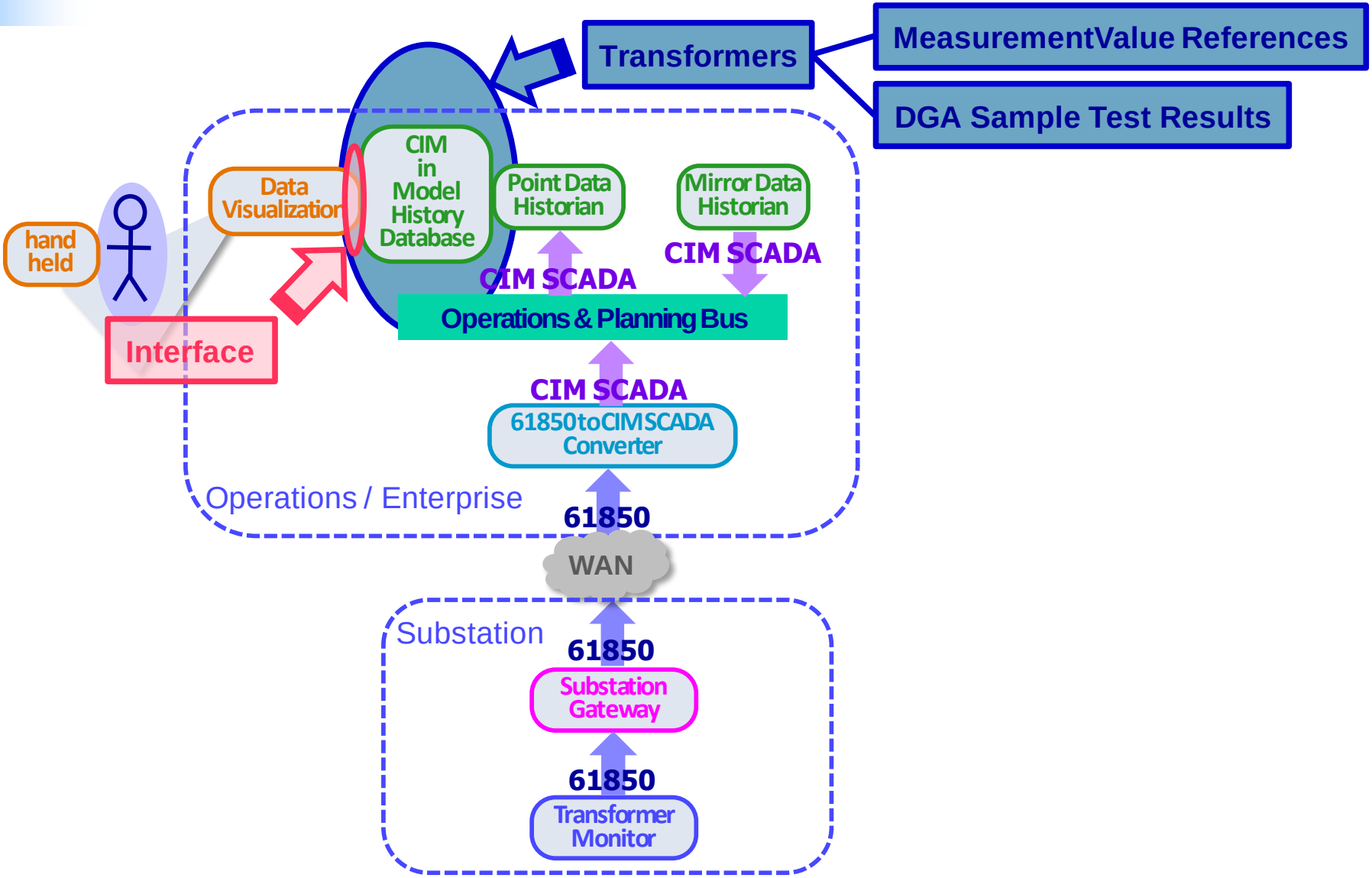
Transformer Modeling for Asset Health w/CIM15

- 2011 Project
  - Focused on transformer modeling
  - Southern Company, AEP, First Energy, CenterPoint
  - Demo in EPRI Smart Grid Substation Lab
- 2012-2013
  - Adding more test results, more real-time data, more complexity to transformer modeling
  - Including breaker modeling
  - TVA
  - Demo in EPRI Smart Grid Substation Lab

Transformer Modeling for Asset Health w/ CIM15



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Transformer Modeling for Asset Health w/CIM15

- Transformers Modeled
  - Transmission
  - 1 tank & 3 tank
- MeasurementValue references
  - “Classic” measurements – MW, MVAr, Amps, Volts
  - New (real-time DGA)
- DGA Sample Test results
  - Per tank
  - Sampled periodically

Transformer Modeling for Asset Health w/CIM15

Transformer Modeling for Asset Health w/CIM15

- Transformer Modeling for Measurements
  - No extensions needed to CIM15 transformer model
  - But…lots of instantiation assumptions – many of them new or different

- DGA Sample Test Results Modeling
  - New DGATestDataSet class (specializes TestDataSet)

Transformer Modeling for Asset Health w/CIM15

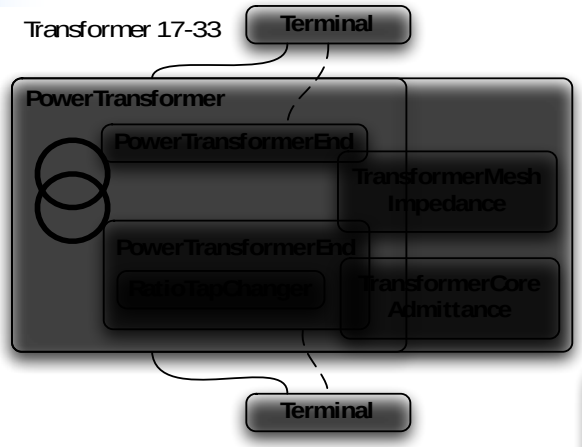
- Transformer Modeling – Instantiation Assumptions
  1. **One Asset per tank** (relationship to either PowerTransformer or TransformerTank), didn't use AssetContainer or PowerTransformerInfo, TransformerTankInfo, TransformerEndInfo

Transformer Modeling for Asset Health w/CIM15

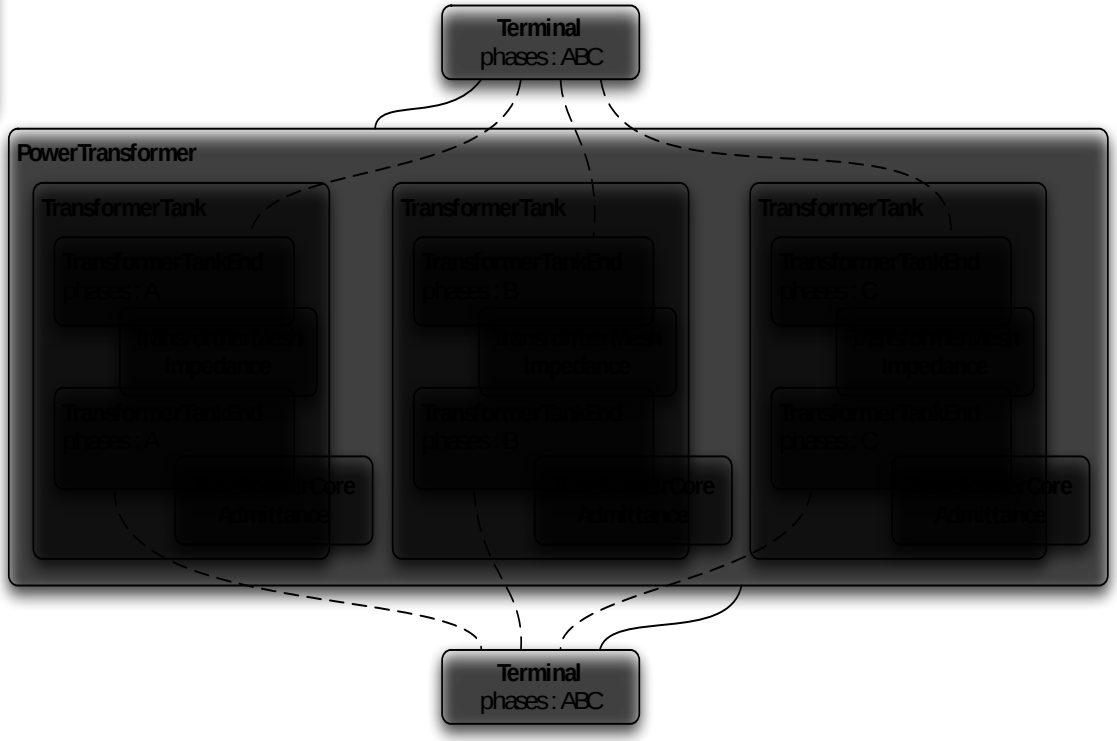
- Transformer Modeling – Instantiation Assumptions
  2. **Measurement relationships require simultaneous balanced & unbalanced view**
     - Deviates from usage to date

Class	Measurements Supported
PowerTransformer (per transformer)	asset health (oil temp, pump/fan failure) Measurements related to the whole transformer
PowerTransformerEnd (per winding)	Electrical (MW, MVAr, MVA) or asset health (winding temp) Measurements related to a winding
TransformerTank (per phase)	asset health (gas, oil temp) Measurements related to a phase (tank)
TransformerTankEnd (per winding per phase)	Electrical (voltage, amps) or asset health (winding temp) Measurements related to a phase of a winding

Transformer Modeling for Asset Health w/CIM15



Balanced
61970 CPSM



Unbalanced
61968 CDPSM

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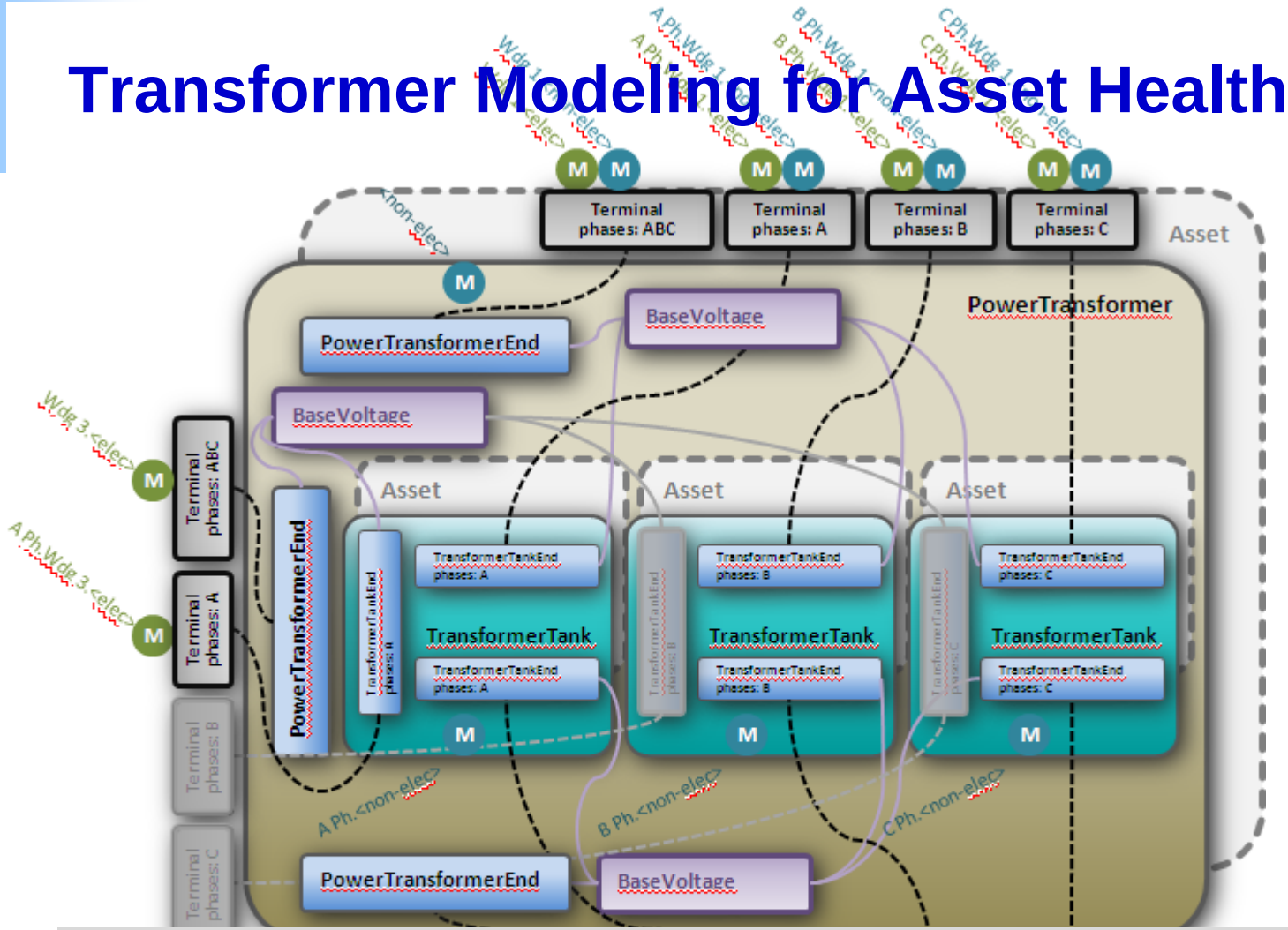


Simultaneously Balanced & Unbalanced

Necessary for this project, but yet more important in future work where network model spans Transmission & Distribution

Transformer Modeling for Asset Health w/CIM15

- Transformer Modeling – Instantiation Assumptions
  3. **Asset health Measurements used both PSR and Terminal associations**
     - Use Power Transformer or TransformerTank association for asset health Measurements that are NOT per winding
     - Use Terminal association (not PowerTransformerEnd or TransformerTankEnd) for asset health Measurements that are per winding
     - Deviates from 452 guidance

Works, but is awkward…

Should TransformerEnd be a specialization of PSR?
Should Measurements be associated to Assets?

Transformer Modeling for Asset Health w/CIM15

- Transformer Modeling – Instantiation Assumptions
  4. **Four Terminals per winding**
     - Deviates from usage to date
     - One terminal to support balanced view, one terminal for each phase of unbalanced

Allows clearer "attachment" of Measurements to specific part of transformer

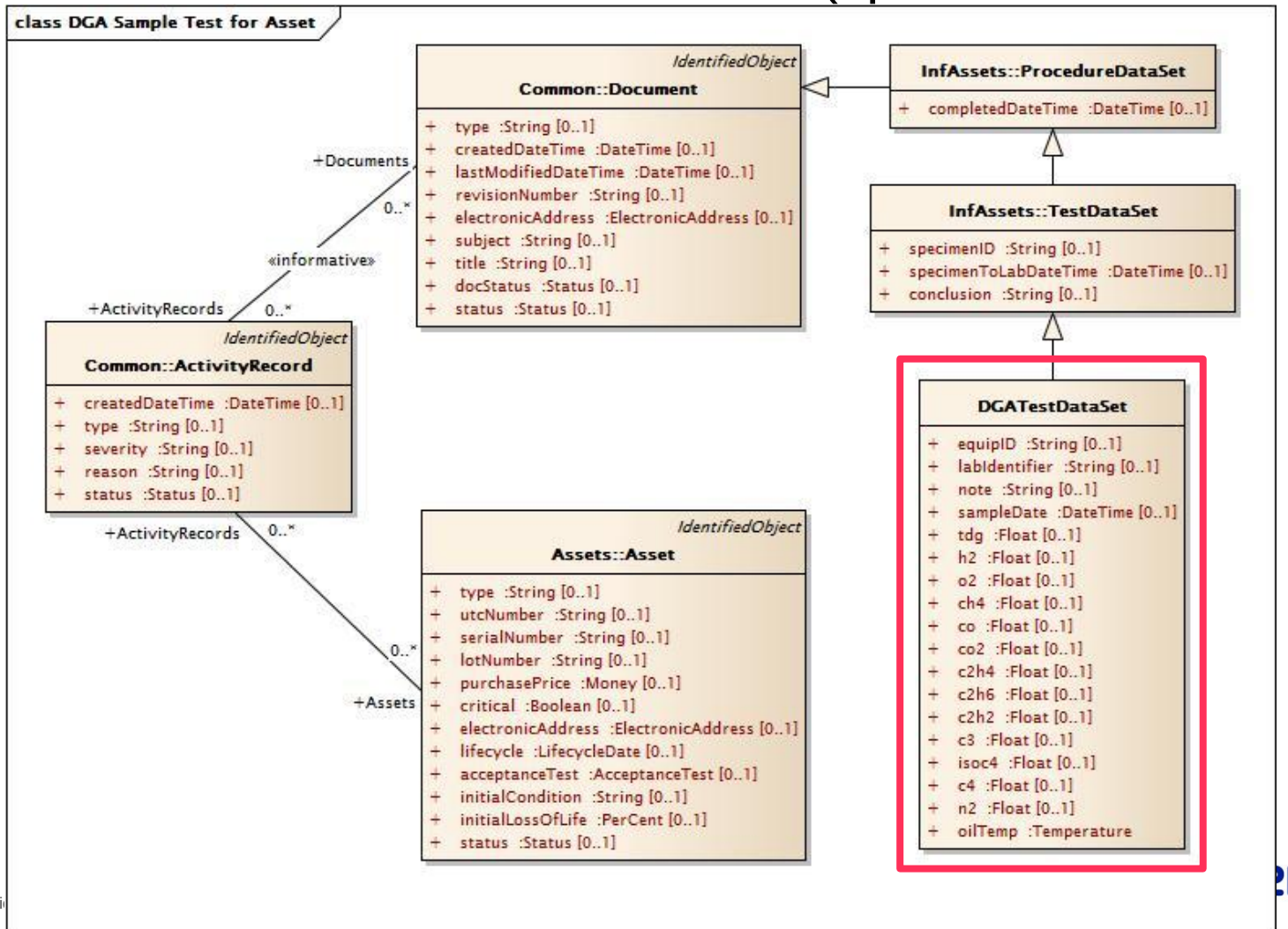
But what are the implications?

Transformer Modeling for Asset Health w/CIM15

- Transformer Modeling – Instantiation Assumptions
  - **Project didn't need it, but….**
    - Seemed odd that phase attribute was on TransformerTankEnd instead of TransformerTank
      - TransformerTank aligns with phase
      - TransformerTankEnd aligns with winding of phase

Transformer Modeling for Asset Health w/CIM15

- DGA Sample Test Results – Model Extensions
  1. New **DGATestDataSet class** (specializes TestDataSet)



Transformer Modeling for Asset Health w/CIM15

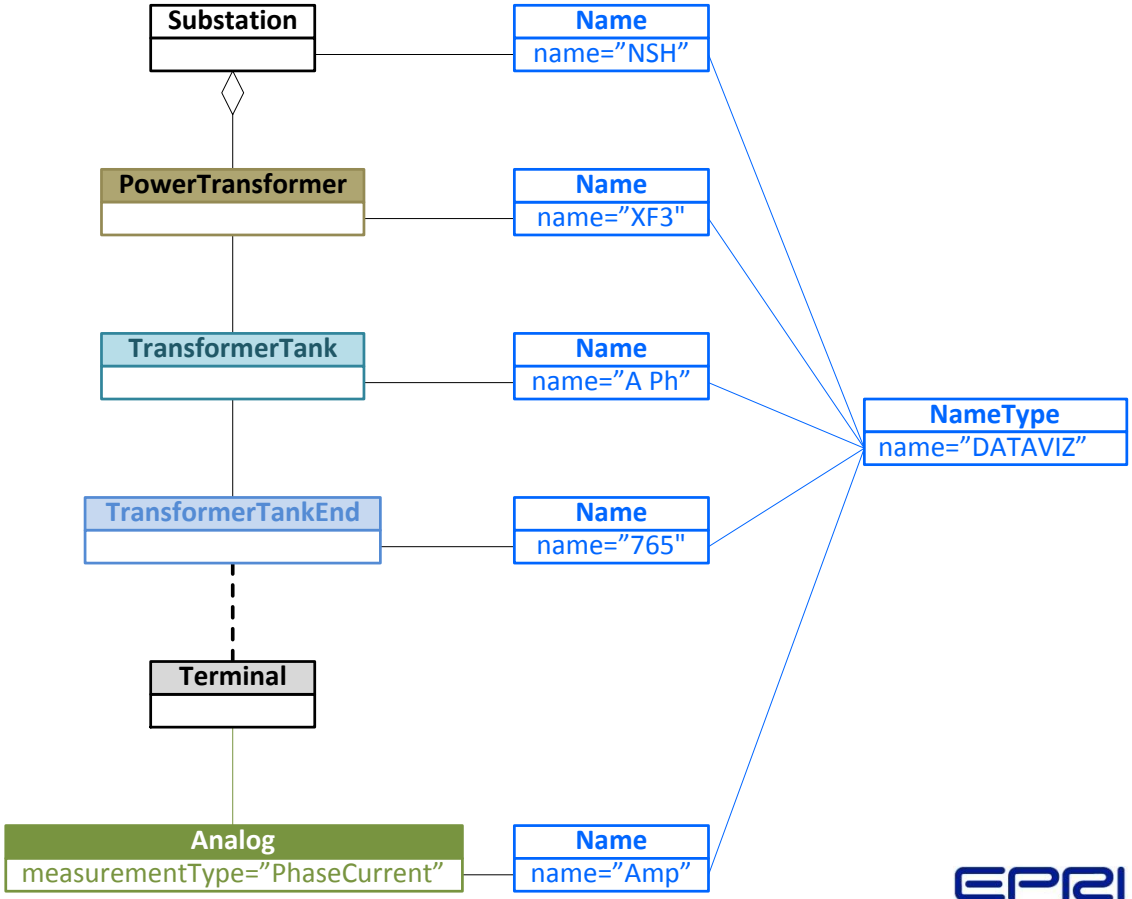
- The Interface
  - Leveraging the CIM15 naming classes
  - A profile for transformers to support asset health
  - An integration template

Transformer Modeling for Asset Health w/CIM15

- The Interface – Leveraging CIM15 Naming Classes
  - For selection
  - For application Measurement name creation

Transformer Modeling for Asset Health w/CIM15

- The Interface – Leveraging CIM15 Naming Classes
  - Using the traversal path for selection & name creation



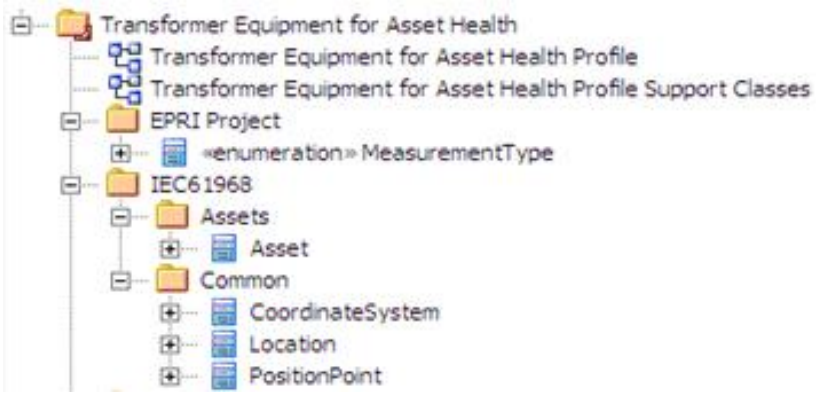
Transformer Modeling for Asset Health w/CIM15

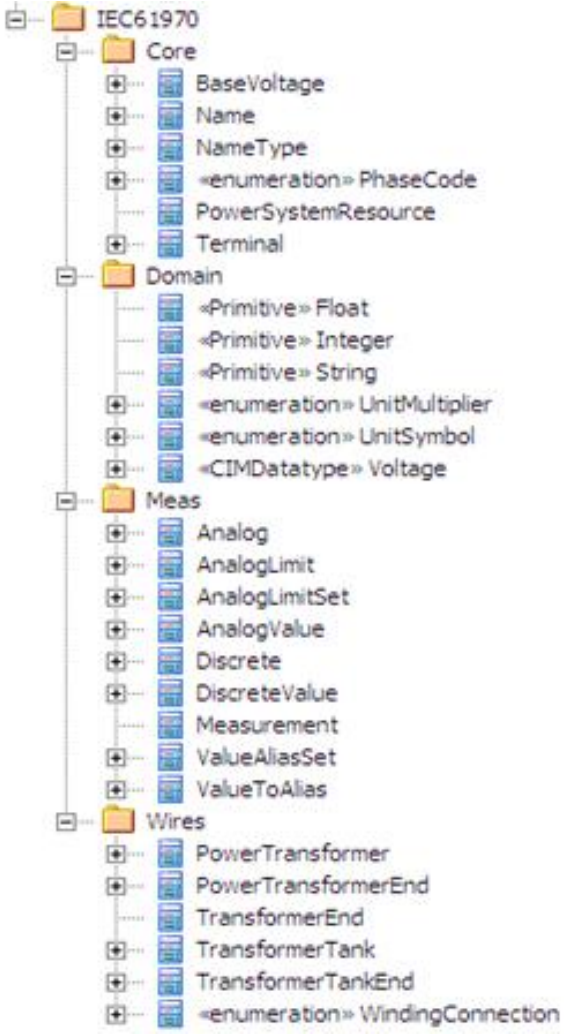
- The Interface – Leveraging CIM15 Naming Classes
  - Traversal path to MeasurementValue reference of interest

```
each Substation
    each PowerTransformer
        Discrete.measurementType=OilTemperatureAlarm
        Discrete.measurementType=FanFailureAlarm
        Discrete.measurementType=PumpFailureAlarm
        each PowerTransformerEnd
            each Terminal
                Analog.measurementType=ThreePhaseApparentPower
                Analog.measurementType=ThreePhaseActivePower
                Analog.measurementType=ThreePhaseReactivePower
                Discrete.measurementType=WindingTemperatureAlarm
        each TransformerTank
            Analog.measurementType=OilTemperature
            Analog.measurementType=DissolvedGas
            each TransformerTankEnd
                each Terminal
                    Analog.measurementType=LineToLineVoltage
                    Analog.measurementType=PhaseCurrent
                    Analog.measurementType=WindingTemperature
```

Transformer Modeling for Asset Health w/CIM15

- The Interface - TransformerProfile for Asset Health

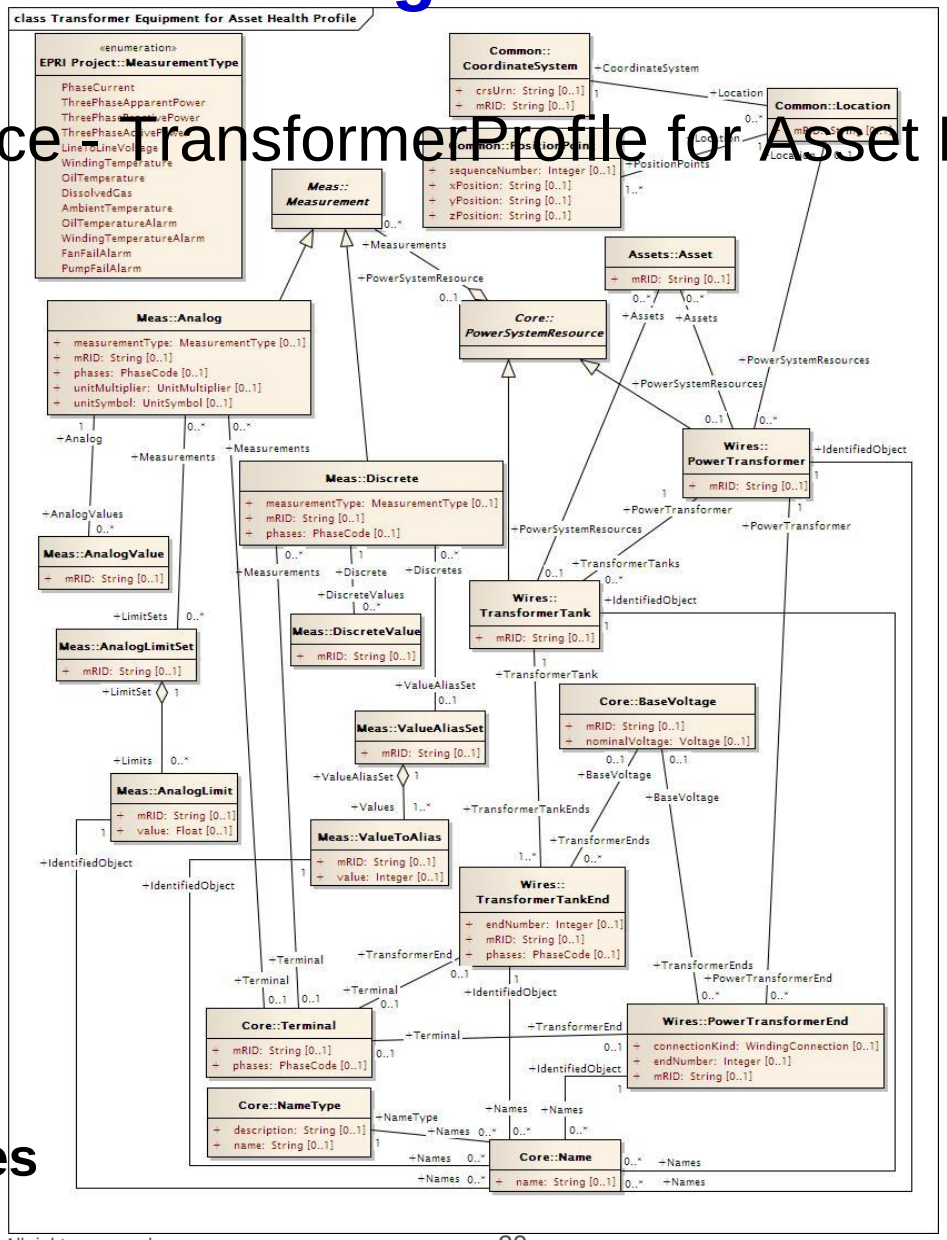




Profile Classes

Transformer Modeling for Asset Health w/CIM15

- The Interface TransformerProfile for Asset Health



Profile Attributes

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- The Interface – Transformer Profile for Asset Health

- The Location.CoordinateSystem association was restricted to reflect that a CoordinateSystem instance is required if a Location instance exists.
- The Location.PositionPoints association was restricted to indicate that at least one PositionPoint instance is needed if a Location instance exists.
- The Assets.PowerSystemResources association was restricted so that an Asset may be associated with no more than one PowerSystemResource.
- The PowerTransformer.PowerTransformerEnd association was restricted so that if a PowerTransformerEnd exists, it must be associated with a PowerTransformer.
- The PowerTransformer.TransformerTanks association was restricted so that if a TransformerTank exists, it must be associated with a PowerTransformer.
- The Terminal.TransformerEnd association was restricted so that no more than one TransformerEnd may be associated with a Terminal.

Profile Association Limitations

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- The Interface – Integration Template
  - Vendor/product specific “spec sheet”
  - Defines instance data model needed to support visualization application
  - Profile plus selection rules, limitations, population requirements spanning multiple fields
  - Independent of serialization

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- The Interface – Integration Template Sample

Data Visualization Integration Template

For any substation to be used by the Data Visualization tool, the following must be true:

Substation>Name.name must exist
Substation>Name>NameType.name must = “DATAVIZ”
Substation>Location>CoordinateSystem.crsUm must = “urn:ogc:def:uom:EPSG::4236”
Substation>Location>PositionPoint.xPosition must contain decimal longitude
Substation>Location>PositionPoint.yPosition must contain decimal latitude

Additionally, the following will be interpreted as an elevation by the Data Visualization tool, if it exists:

Substation>Location>PositionPoint.zPosition

For any transformer to be used by the Data Visualization tool, the following must be true:

PowerTransformer>Name.name must exist
PowerTransformer>Name>NameType.name must = “DATAVIZ”
PowerTransformer >Location>CoordinateSystem.crsUm must = “urn:ogc:def:uom:EPSG::4236”
PowerTransformer>Location>PositionPoint.xPosition must contain decimal longitude
PowerTransformer >Location>PositionPoint.yPosition must contain decimal latitude

Additionally, the following will be interpreted as an elevation by the Data Visualization tool, if it exists:

PowerTransformer >Location>PositionPoint.zPositionn

Transformer Modeling for Asset Health w/CIM15

- The Interface – Integration Template Sample

If present and related to a transformer being used, instances of the following classes must have the following attributes:

PowerTransformerEnd	endNumber
TransformerTankEnd	endNumber
AnalogLimit	value
ValueToAlias	value
BaseVoltage	nominalVoltage

Transformer-related measurements will be used by the Data Visualization tool if they exist and the following are true:

Substation>Analog exists where
Analog.measurementType = “AmbientTemperature” and
Analog>Name>NameType.name = “DATAVIZ”
Substation>PowerTransformer>Discrete exists where
Discrete.measurementType = “PumpFailureAlarm” and
Discrete>Name>NameType.name = “DATAVIZ”
one Discrete>ValueAliasSet>ValueToAlias>Name exists where Name.name = “ALARM” and
Discrete> ValueAliasSet>ValueToAlias >Name>NameType.name = “DATAVIZ” and
one Discrete>ValueAliasSet>ValueToAlias>Name exists where Name.name = “NORMAL”
Discrete> ValueAliasSet>ValueToAlias > Name>NameType.name = “DATAVIZ”

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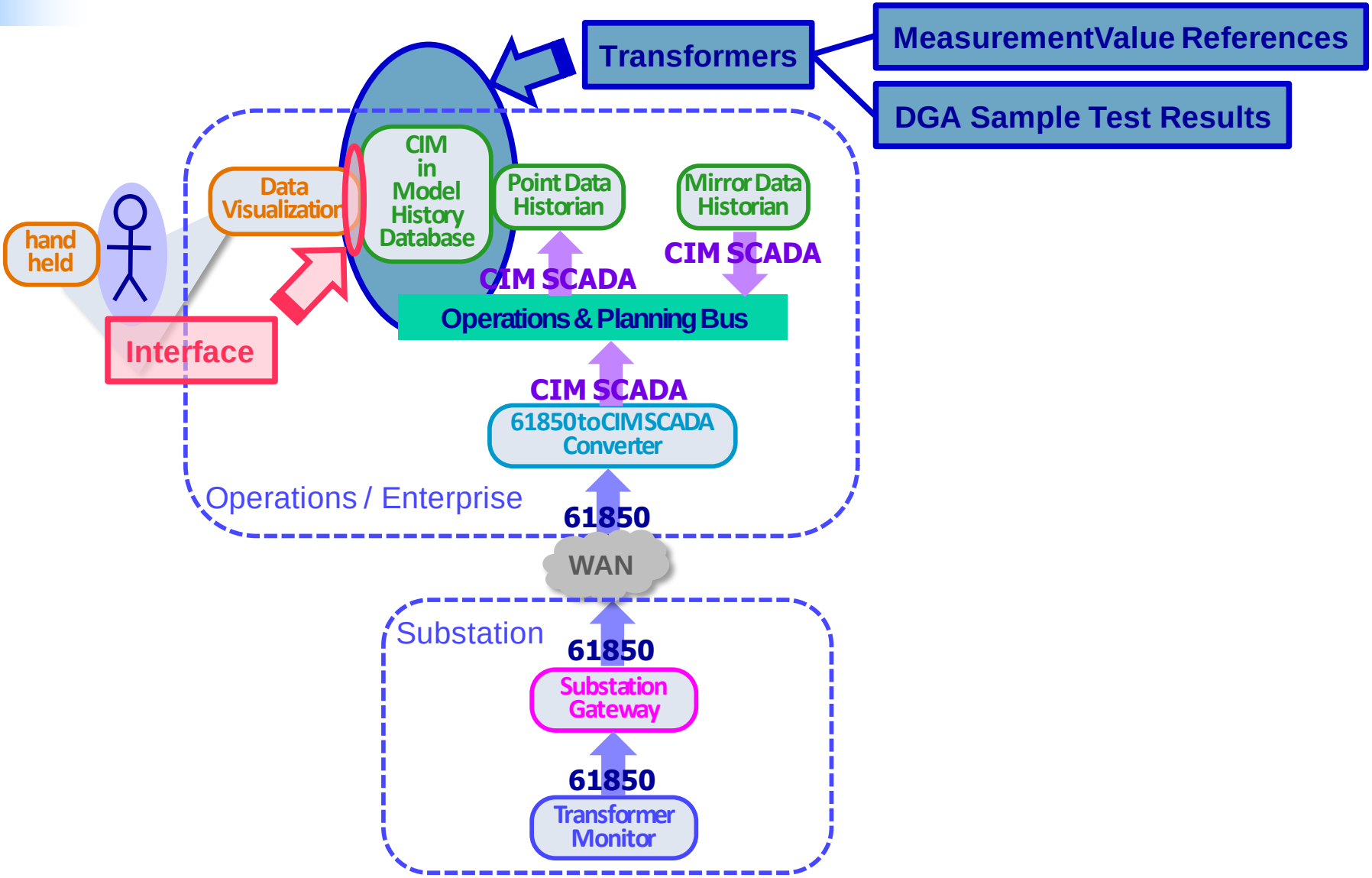

Questions?

For more information, contact:
Pat Brown, pbrown@epri.com

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