Redmine Issue #7034 Background:

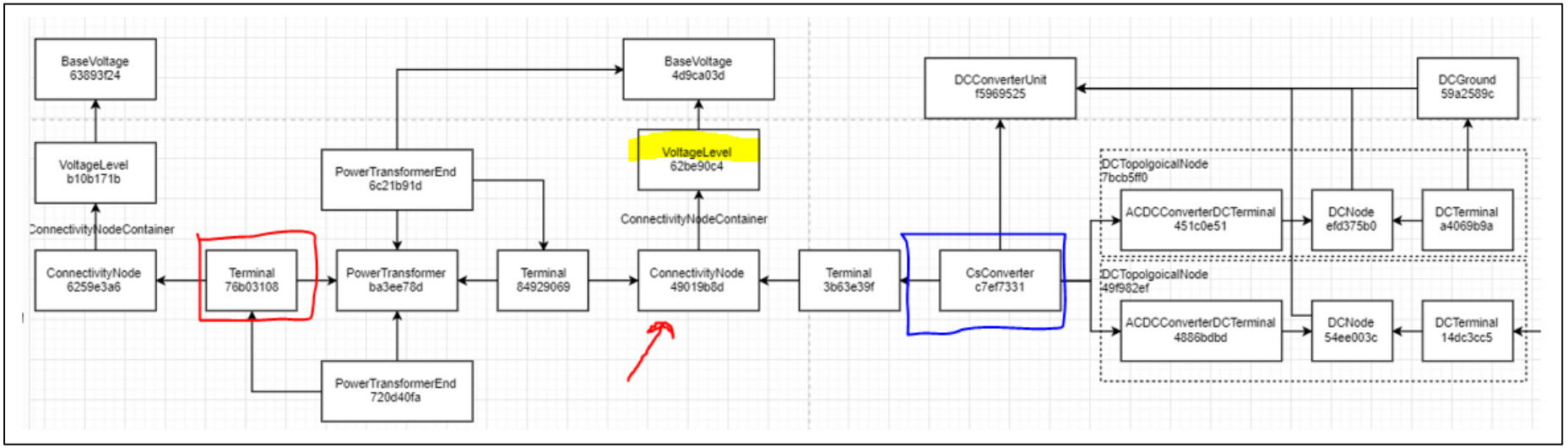
When fielding implementation-related questions for the 456 TP profile, Chavdar and I identified that we currently have ambiguity and two interpretations (that conflict) expressed across current standards publications.

Specifically, a question came up pertaining to ConnectivityNodes, ConnectivityNodeContainers and containment. The background for the question being how to identify the particular **BaseVoltage** to be associated with the **TopologicalNode** in the TP profile (where TopologicalNode → BaseVoltage is required). This would be the TopologicalNode corresponding to **ConnectivityNode** (i.e. 49019b8d) in the Figure 1 / Figure 2 examples.

Question Posed:

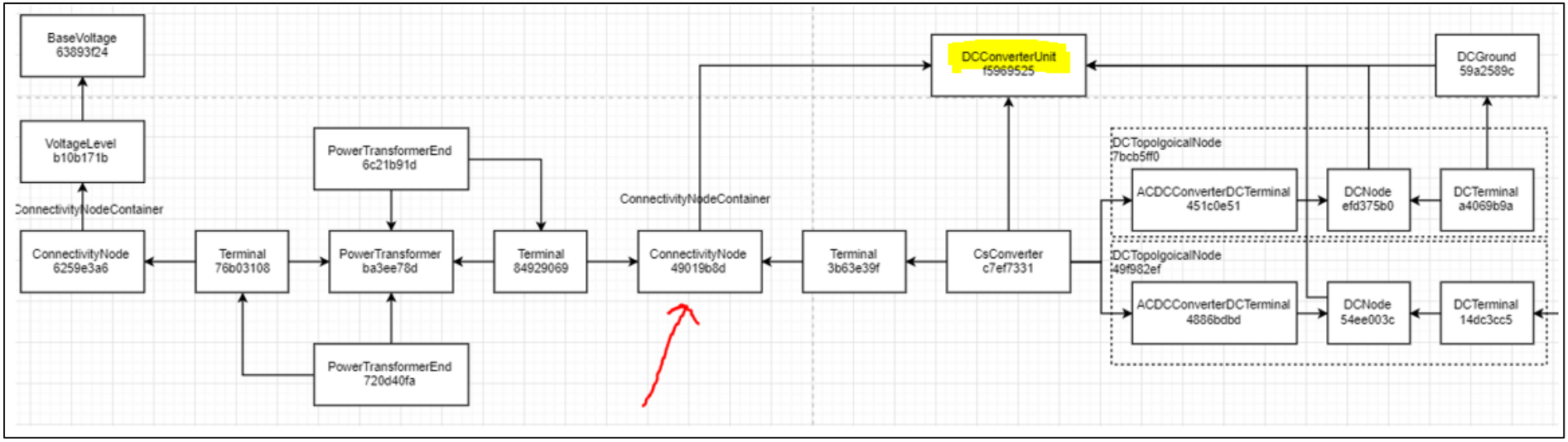
In reviewing some of the CGMES Attestation example models, a question came up pertaining to the **ConnectivityNodeContainer** assigned to the **ConnectivityNode** that lies between the **ACDCConverter** (bordered in blue) and the **PccTerminal** (bordered in red). Now, in CGMES sample data, it appears like this ConnectivityNodeContainer is always a VoltageLevel (Figure 1).

Figure 1: MicroGrid Type 2 CGMES model (for Belgium EQ MAS)



However, in other instances exchanges observed is the assignment of a different ConnectivityNodeContainer such as in Figure 2 below:

Figure 2: Vendor sample data



The question fielded was whether this Figure 2 example is valid.

In the Figure 1 example, it seems to initial make sense (i.e. tracing ConnectivityNode's ConnectivityNodeContainer and then on to the BaseVoltage), but Figure 2 it was not as clear.

Initial thoughts/response in view of what is in publications:

The containment of the Connectivity node is quite flexible - per the following constraint rule in the 452:

- C:452:EQ:ConnectivityNode:containment

  The association **ConnectivityNode.ConnectivityNodeContainer** is required however the type of EquipmentContainer the association shall point to is not specified. Therefore the association **ConnectivityNode.ConnectivityNodeContainer** shall point to any type of **EquipmentContainer** given by the connecting equipment (that is linked to the associated **Terminal**). Machine based validation is not performed. It is required that import and export shall not make any changes to this association.

Therefore, for Figure 2 it would not be wrong as the example **PowerTransformer** could also be in the **DCConverterUnit** - per this 452 rule:

- C:452:EQ:PowerTransformer:containment

  For **PowerTransformer** the association **Equipment.EquipmentContainer** is required and shall point to EquipmentContainer of type **Substation** or **DCConverterUnit**. For the case of a transformer that connects two substations, the terminal of one of the **PowerTransformerEnd**-s can be connected to a **ConnectivityNode** defined in another substation.

The BaseVoltage may be a little tricky if some tracing is required, but the following 452 EQ constraint rules could be helpful towards that:

- C:452:EQ:ACLineSegment.BaseVoltage:calculations

  All implementations shall use association to a **BaseVoltage** for the purpose of any per unit calculations and shall not rely on the voltages (neither nominal nor actual values obtained by previous or current solution) at the nodes, which the ACLineSegment connects to.

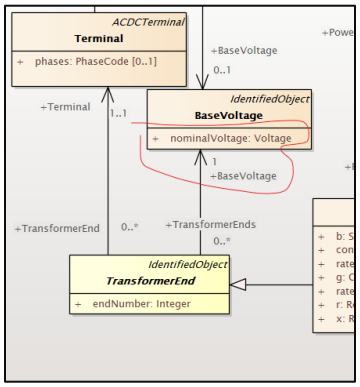
And…

- C:452:EQ:ConductingEquipment.BaseVoltage:whereRequired

  The **ConductingEquipment.BaseVoltage** association is required for the following ConductingEquipment: **ACLineSegment**, **EquivalentBranch** and **SeriesCompensator**.

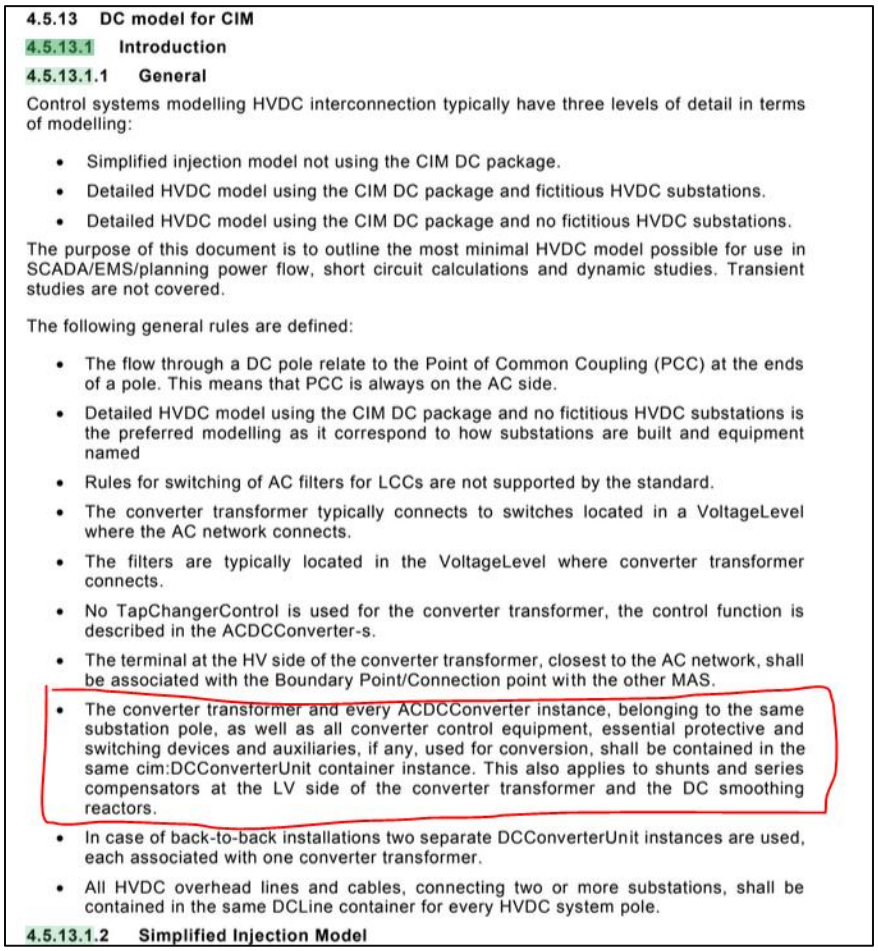
  For all other Equipment-s, not contained in a **VoltageLevel**, the association **ConductingEquipment.BaseVoltage** can be provided (as it is optional), however the association to BaseVoltage coming from the container or transformer ends takes precedence.

  For the transformer case the following required association in the 452 can be used:



This then led to discovery of the following which resulted in this Redmine issue:

We have two interpretations and therefore have ambiguity that should be resolved. Below is observed today **in IEC61970-301 Ed 7.1** which states bordered in red:



4.5.13 DC model for CIM

4.5.13.1 Introduction

4.5.13.1.1 General

Control systems modelling HVDC interconnection typically have three levels of detail in terms of modelling:

- Simplified injection model not using the CIM DC package.
- Detailed HVDC model using the CIM DC package and fictitious HVDC substations.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations.

The purpose of this document is to outline the most minimal HVDC model possible for use in SCADA/EMS/planning power flow, short circuit calculations and dynamic studies. Transient studies are not covered.

The following general rules are defined:

- The flow through a DC pole relate to the Point of Common Coupling (PCC) at the ends of a pole. This means that PCC is always on the AC side.
- Detailed HVDC model using the CIM DC package and no fictitious HVDC substations is the preferred modelling as it correspond to how substations are built and equipment named
- Rules for switching of AC filters for LCCs are not supported by the standard.
- The converter transformer typically connects to switches located in a VoltageLevel where the AC network connects.
- The filters are typically located in the VoltageLevel where converter transformer connects.
- No TapChangerControl is used for the converter transformer, the control function is described in the ACDCConverter-s.
- The terminal at the HV side of the converter transformer, closest to the AC network, shall be associated with the Boundary Point/Connection point with the other MAS.
- The converter transformer and every ACDCConverter instance, belonging to the same substation pole, as well as all converter control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion, shall be contained in the same cim:DCConverterUnit container instance. This also applies to shunts and series compensators at the LV side of the converter transformer and the DC smoothing reactors.
- In case of back-to-back installations two separate DCConverterUnit instances are used, each associated with one converter transformer.
- All HVDC overhead lines and cables, connecting two or more substations, shall be contained in the same DCLine container for every HVDC system pole.

4.5.13.1.2 Simplified Injection Model

These 301 statements invalidate the original **Figure 1** and its correctness (specifically the ConnectivityNode being pointed to having a ConnectivityNodeContainer of VoltageLevel is valid). Per this paragraph the **ConnectivityNode** being pointed to in Figure 1, should have as its **ConnectivityNodeContainer** the **DCConverterUnit**.

Discussion and decisions are needed as to how we may want to eliminate this ambiguity/conflicts via new (or updated) constraints for end-users.