WG D2 57 : CIM (Common Information Model)

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cigre

For power system expertise

Agenda

1. CIM overview & Interoperability
2. CIM properties
3. Regulatory bodies of CIM
4. Existing CIM Standards
5. Practical use case of CIM
6. Updates on WG D2.57
7. Summary

Introduction

Job Title : Common Framework Specialist
Team : Innovation, VirtualES
Organisation : National Energy System Operator (NESO)

Area of Expertise

- ❑ Working as subject matter expert in the domain of CIM, power system modelling, data exchange interfaces as part of the Data sharing infrastructure (DSI) pilot program of VirtualES.
- ❑ Responsible for building a common framework including data & industry standards, strategy and policies, best practices guidelines based on socio-economic-technical key factors (People, Process, Data and Technology) for providing interoperability of digital twins for the virtual energy system program.
- ❑ Developed data exchange format such as CIM and Data Conversion tools for power system modelling & analysis software (IPSA) in the previous role.
- ❑ Significant years of experience developing software tools and scripts in the realms of power system in the domains of data integration, energy system integration, data, modelling and analysis modules.

Volunteering:

1. CIGRE UK NGN's Membership Team Lead & UK NGN International Representative.
2. D2-57 (CIM Working group – UK Regular Member)
3. WiN ERG Development Workstream Co-Lead
4. NGN Representative of SC D2

CIM Overview

20201218T1356Z_XX_YYY_SSH_.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Created with PowerFactory 20.0.4 (digcimdb.dll ServicePack 0) -->
<rdf:RDF xmlns:cim="http://iec.ch/TC57/2013/CIM-schema-cim16#" xmlns:entsoe="http://entsoe.eu/CIM/SchemaExtension/3/1#" xmlns:md="http://iec.ch/TC57/61970-552/ModelD
  <md:FullModel rdf:about="urn:uuid:2b774ef0-234b-4d62-9fa4-fecdf1634572">
    <md:Model.DependentOn rdf:resource="urn:uuid:aa4e1cde-ff06-4ede-92d7-4954464b9242" />
    <md:Model.created>2020-12-20T19:41:26Z</md:Model.created>
    <md:Model.modelingAuthoritySet>South Wales</md:Model.modelingAuthoritySet>
    <md:Model.profile>http://entsoe.eu/CIM/SteadyStateHypothesis/1/1</md:Model.profile>
    <md:Model.scenarioTime>2020-12-18T13:56:46Z</md:Model.scenarioTime>
  </md:FullModel>
  <cim:Terminal rdf:about="#_b67e1e4a-7dc2-57ea-fcfb-510bfae70953">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_8b30393f-4a33-436c-1f4f-469e29e80c2f">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_b5d6c2d9-4c2a-8da9-0390-16097e618207">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_8b7f4ba7-928b-30e7-d978-d90f61621c19">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_8bb8050e-0db5-36d7-9604-2b3a39d3aa42">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_b6a258d7-29a8-7e77-61f1-ff04ada948ac">
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  </cim:Terminal>
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    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_8bb0b3f3-0400-a1ed-4200-f591ad400aab">
    <cim:ACDCTerminal.connected>true</cim:ACDCTerminal.connected>
  </cim:Terminal>
  <cim:Terminal rdf:about="#_b5bd0111-d280-8d71-03c6-0b31af2e224b">
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  <cim:Terminal rdf:about="#_8bf19e0c-9952-9cf1-8f0a-5a76d23b8774">
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  </cim:Terminal>
  <cim:Terminal rdf:about="#_8b355444-6536-51c9-8f4d-a02c44e9d78e">
```

Source : NGED - National Grid - Common Information Model

Common Information Model (CIM)

- ✓ Universal set of engineering standards
- ✓ Governed – resource description framework (RDF)
- ✓ Output – eXtensible Markup Language(XML files)
- ✓ Created & authorised – International Electrotechnical Commission (IEC)

Common Information Model (CIM)

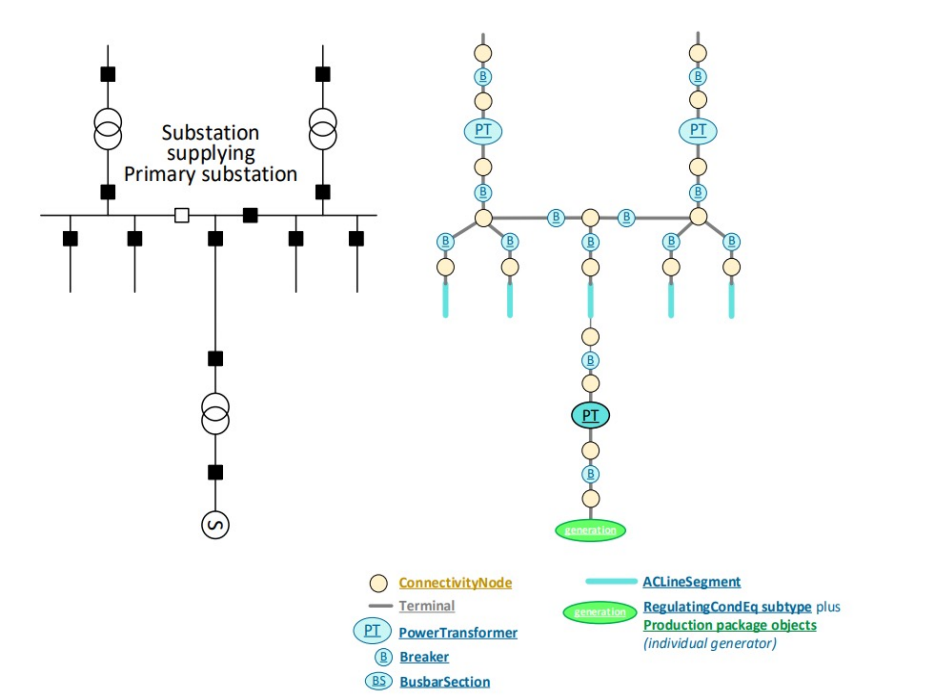
XML files contains:

1. Standard Data file format with lots of <XXX></XXX>”tags”
2. Self-defined files, open standard from W3C
3. Each <XXX></XXX> contains data fields or further groups of fields
4. mRID (Master Record Identifiers) – Linking profiles/equipment/attributes in object-oriented programming approach

Common Information Model (CIM)

PSA Tool <-> CIM Translation

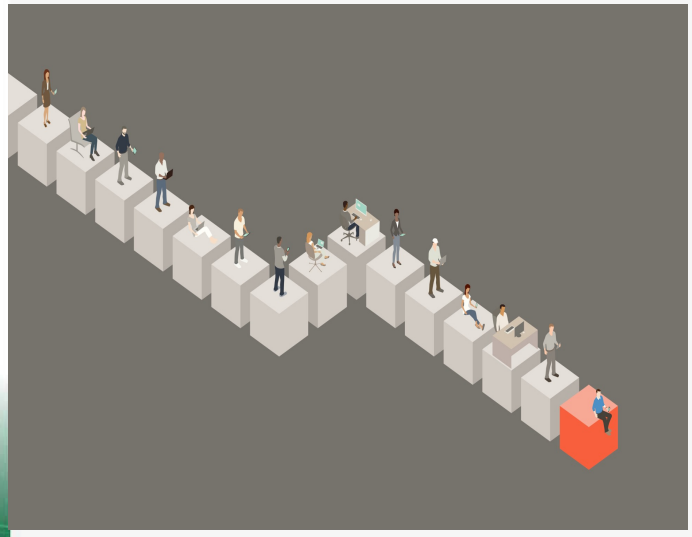
- ✓ Network topology captured
- ✓ Connectivity rendered
- ✓ Enables rendering Islanded network
- ✓ Captures slack busbar information



Source : Outputs from the Long Term Development Statement Reforms Working Group | Ofgem – LTDS Grid Modelling Guidelines

Common Information Model (CIM)

- ✓ Profile 
- ✓ Attributes 
- ✓ Topology 
- ✓ Objects 
- ✓ Header/Meta Data 



CIM Properties

Profiles

- Equipment (EQ)
- Topology (TP)
- Steady state hypothesis (SSH)
- Diagram Layout (DL)
- State Variable (SV)
- Dynamics (DY)
- Operational (OP)
- Equipment Boundary (EQ-BD)
- Topology Boundary (TP-BD)
- Geographical Layout (GL)
- Short Circuit (SC)

Profile Relationship

- **Equipment (EQ) Profile**: This forms the base profile, providing the skeleton information of the components in the electrical network.
- **EQ & DL Profile**: When merged, these profiles provide a single line diagram, which is a simplified graphical representation of the electrical power system.
- **EQ & SSH Profile**: Merging these profiles gives the initial conditions and status of the equipment in the electrical network.
- **Multiple EQs & EQ-BD Profile**: Combining these profiles helps identify the boundary or common points between different electrical network operators.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Created with PowerFactory 2022 SP2 (x64) (digcimdb.dll ServicePack 0) -->
<rdf:RDF xmlns:cim="http://iec.ch/TC57/2013/CIM-schema-cim16#" xmlns:entsoe="http://entsoe.eu/CIM/SchemaExtension/3/1#" xmlns:md="http://iec.ch/TC57/
  <md:FullModel rdf:about="urn:uuid:d52ceaf0-cf93-4c0f-abda-64307c3e8163">
    <md:Model.DependentOn rdf:resource="urn:uuid:ba12f107-7ca7-43eb-a8f5-f551c933edf4" />
    <md:Model.created>2023-03-16T15:51:30Z</md:Model.created>
    <md:Model.modelingAuthoritySet>South West</md:Model.modelingAuthoritySet>
    <md:Model.profile>http://entsoe.eu/CIM/SteadyStateHypothesis/1/1</md:Model.profile>
    <md:Model.scenarioTime>2023-01-18T08:57:24Z</md:Model.scenarioTime>
  </md:FullModel>
```

SSH Profile

```
<rdf:RDF xmlns:cim="http://iec.ch/TC57/2013/CIM-schema-cim16#" xmlns:entsoe="http://entsoe.eu/CIM/SchemaExtension/3/1#" xmlns:md="http://iec.ch/TC57/
  <md:FullModel rdf:about="urn:uuid:ba12f107-7ca7-43eb-a8f5-f551c933edf4">
    <md:Model.created>2023-03-16T15:51:30Z</md:Model.created>
    <md:Model.modelingAuthoritySet>South West</md:Model.modelingAuthoritySet>
    <md:Model.profile>http://entsoe.eu/CIM/EquipmentCore/3/1</md:Model.profile>
    <md:Model.profile>http://entsoe.eu/CIM/EquipmentOperation/3/1</md:Model.profile>
    <md:Model.scenarioTime>2023-01-18T08:57:24Z</md:Model.scenarioTime>
  </md:FullModel>
```

EQ Profile

Headers / Meta Data

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Created with PowerFactory 2022 SP2 (x64) (digcimdb dll ServicePack 0) -->
<rdf:RDF xmlns:cim="http://iec.ch/TC57/2013/CIM-schema-cim16#" xmlns:entsoe="http://entsoe.eu/CIM/SchemaExtension/3/1#" xmlns:md="http://iec.ch/TC5
  <md:FullModel rdf:about="urn:uuid:ba12f107-7ca7-43eb-a8f5-f551c933edf4">
    <md:Model.created>2023-03-16T15:51:30Z</md:Model.created>
    <md:Model.modelingAuthoritySet>South West</md:Model.modelingAuthoritySet>
    <md:Model.profile>http://entsoe.eu/CIM/EquipmentCore/3/1</md:Model.profile>
    <md:Model.profile>http://entsoe.eu/CIM/EquipmentOperation/3/1</md:Model.profile>
    <md:Model.scenarioTime>2023-01-18T08:57:24Z</md:Model.scenarioTime>
  </md:FullModel>
```

1. Version of CIM
2. Created data
3. Data owner
4. Schemas defined in CGMES 3.0
5. Scenario Time which is applicable
6. Custom Namespace extensions

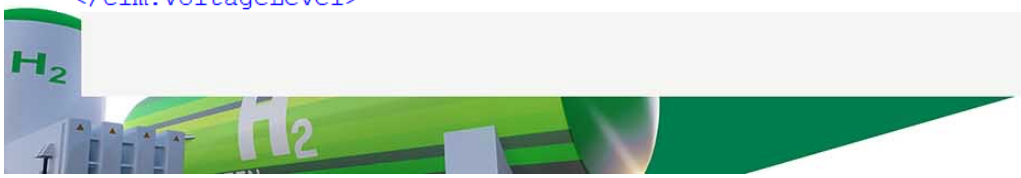
Attributes

```
<cim:ACLineSegment rdf:ID="_91175065-0609-407c-ace8-cbd57e2b9170">
  <cim:ACLineSegment.bch>0</cim:ACLineSegment.bch>
  <cim:ACLineSegment.gch>0</cim:ACLineSegment.gch>
  <cim:ACLineSegment.r>0.1</cim:ACLineSegment.r>
  <cim:ACLineSegment.x>0.1</cim:ACLineSegment.x>
  <cim:ConductingEquipment.BaseVoltage rdf:resource="#_f07bd084-fdd7-782c-90c2-1d2eca5b6d46" />
  <cim:Conductor.length>1</cim:Conductor.length>
  <cim:IdentifiedObject.name>Line</cim:IdentifiedObject.name>
</cim:ACLineSegment>
```

Objects

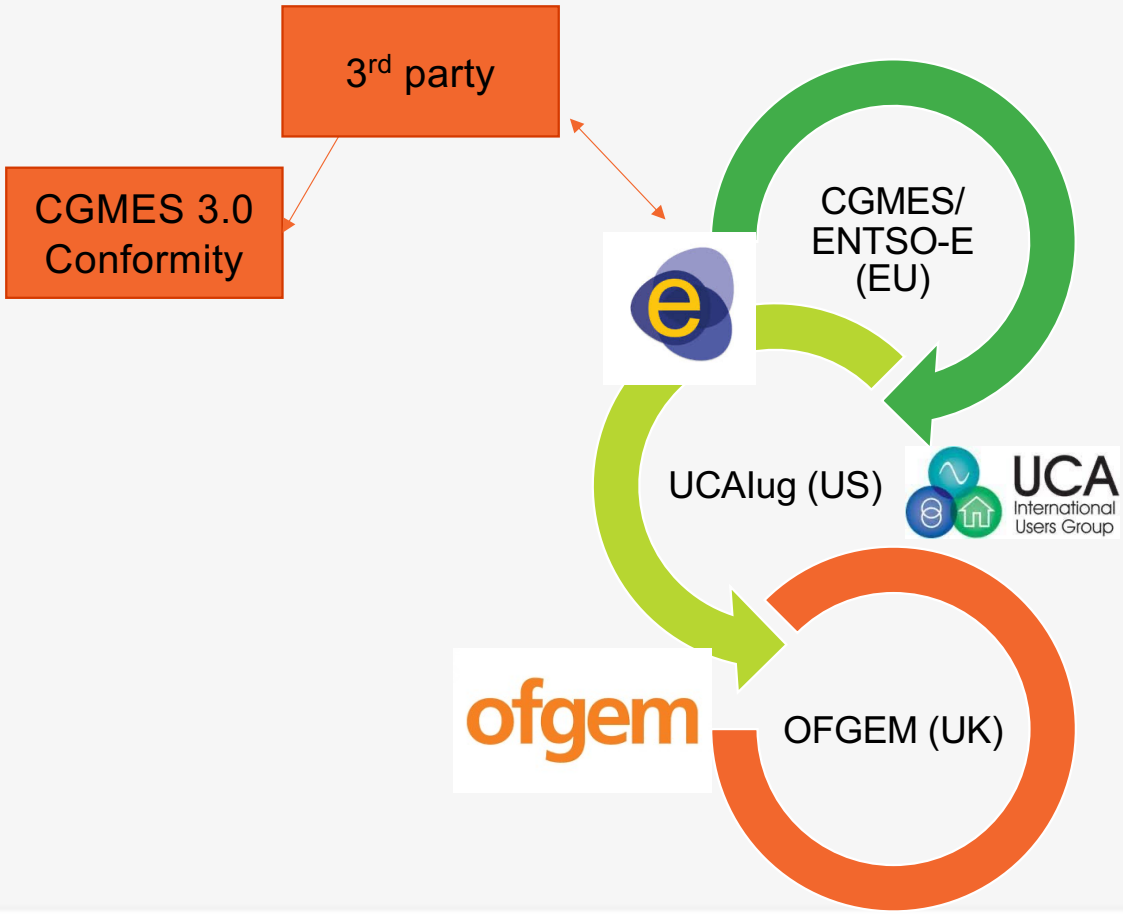
```
<cim:BaseVoltage rdf:ID="_f07bd084-fdd7-782c-90c2-1d2eca5b6d46">
  <cim:BaseVoltage.nominalVoltage>11</cim:BaseVoltage.nominalVoltage>
  <cim:IdentifiedObject.description>BaseVoltage 11.00 kV</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.name>11.00 kV</cim:IdentifiedObject.name>
  <entsoe:IdentifiedObject.shortName>11.00 kV</entsoe:IdentifiedObject.shortName>
</cim:BaseVoltage>
<cim:VoltageLevel rdf:ID="_925419db-fc1a-1552-740b-7504b9e41851">
  <cim:IdentifiedObject.name>Bus 2</cim:IdentifiedObject.name>
  <cim:VoltageLevel.BaseVoltage rdf:resource="#_f07bd084-fdd7-782c-90c2-1d2eca5b6d46" />
  <cim:VoltageLevel.Substation rdf:resource="#_f4668b59-875b-95f1-8a18-d35a60441a47" />
</cim:VoltageLevel>
```

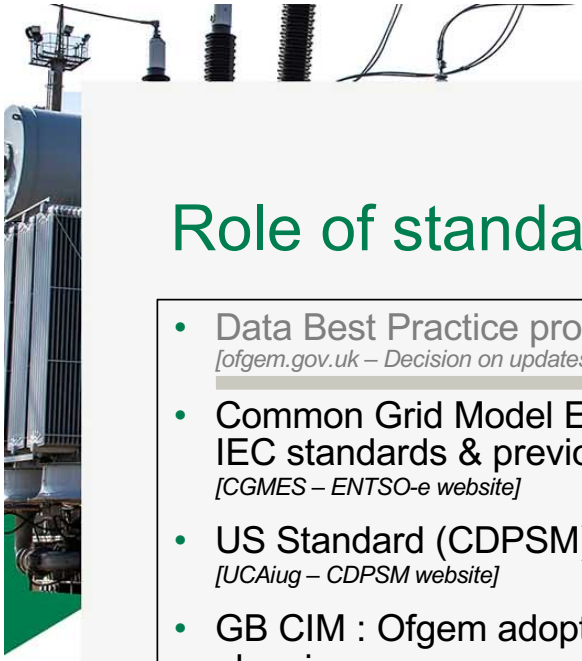
- Like Object Oriented Programming
- mRID or unique id is used to link between two objects & also between different profiles



Regulatory Bodies

Regulatory Bodies

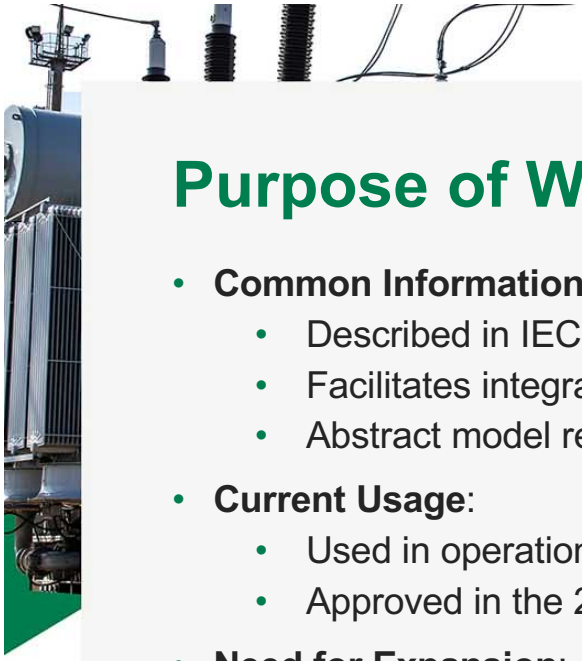




Role of standardisation, conformance & practical use case

- Data Best Practice promotes and requires pursuit of interoperability — **Conformance**
  [ofgem.gov.uk – Decision on updates to Data Best Practice Guidance – August 2023]
- Common Grid Model Exchange Standards (CGMES) 3.0 : Latest version of ENTSO-e's adoption of CIM 17 from IEC standards & previous version 2.4.15 & 2009 standard
  [CGMES – ENTSO-e website]
- US Standard (CDPSM) – Common Distribution power system model — **Standardisation**
  [UCAiug – CDPSM website]
- GB CIM : Ofgem adoption of CGMES 3.0 with extensions for consideration into distribution networks long term planning
  [ofgem.gov.uk – Outputs from the Long-Term Development Statement Reforms Working Group – July 2023]
- GC0139 : Enhanced planning data exchange to facilitate whole system planning
  [nationalenergysystemoperator.com – Industry Info – Codes – Grid Code – Grid Code Modifications]
- Data Sharing Infrastructure Pilot – VirtualES — **Practical Use Case**
  [nationalenergysystemoperator.com – VirtualEnergySysetm - NESO]
- Energy Digitalisation Taskforce recommended increasing use across electricity and a CIM-like implementation for gas networks
  [es.catapult.org.uk – Energy Digitalisation Taskforce]

WG D2 : 57 CIM Update



Purpose of Working Group D2.57

- **Common Information Model (CIM)**:
  - Described in IEC 61970, IEC 61968, IEC 62325 standards.
  - Facilitates integration between information systems and applications by defining API semantics.
  - Abstract model representing major objects in an electric utility.
- **Current Usage**:
  - Used in operational planning, long-term planning, asset management, electricity market, etc.
  - Approved in the 2000s, developed conservatively.
- **Need for Expansion**:
  - CIM standards contain flexible models for common tasks.
  - Some tasks require expansion (e.g., AC line model extensions discussed since the 2010s but not yet included in IEC standards).
- **Working Group (WG) Role**:
  - Analyse existing extensions of the standard model.
  - Propose unification or creation of new extensions to solve more tasks.
  - Extensions proposed by the WG will be free of any patent.
- **Proposed Activity**:
  - Like JWG N° D2/C2.48 but focused on CIM extensions and development.

12 countries

15 members:
8 representatives
5 specialists
2 secretaries

Timeline of WG

2022

- Working proposed
- Terms of reference prepared & published

2023

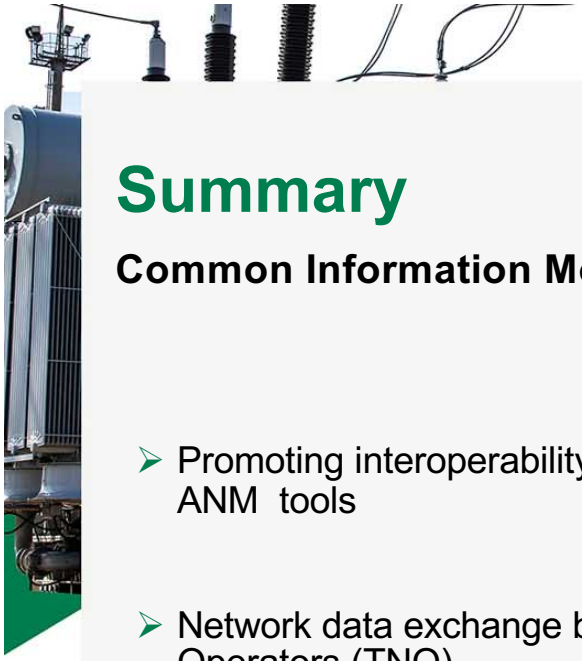
- Online meetings to discuss the scope & challenges
- Survey sent out to the vendors/TSO/ISO

2024

- First in person meeting
- Proposal to change the WG to use case driven approach rather than proposing changes to IEC

Future

- Each WG member to prepare use cases, discuss them among WG members, and then prepare proposals for CIM standard extensions.



Summary

Common Information Model (CIM)

- Promoting interoperability rather than one power system analysis(PSA) or active network management ANM tools
- Network data exchange between Distribution Network Operators (DNO)/ Transmission Network Operators (TNO)
- Reconcile & Manage multiple parallel isolated models of electrical networks

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Thank you ☺