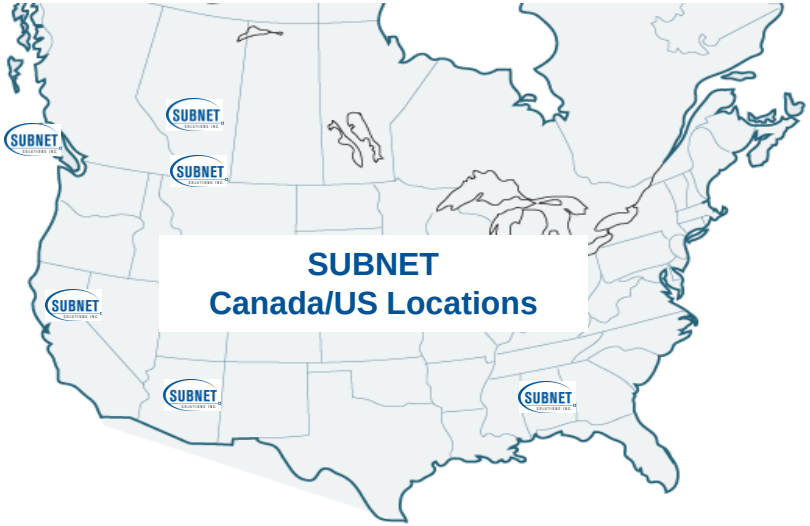
Unified Configuration & Documentation

Applying a unified configuration and documentation approach to the engineering and operation of multi-vendor multi-edition IEC 61850 systems

IEC 61850 Europe 2017

SUBNET Solution Inc. Overview

- Software Company focused on Electric Utilities
- Headquarters: Calgary, Alberta
- In Business for over 25 Years
- Core Expertise
  - SCADA Protocol Data Communications, Security and Substation Integration and Automation
- Private Held
- Large Electric Utility Client Base
  - 300+ Electric Utilities, 50+ Vendors
- Products used in over 30 Countries Worldwide



SUBNET International Locations

Mexico

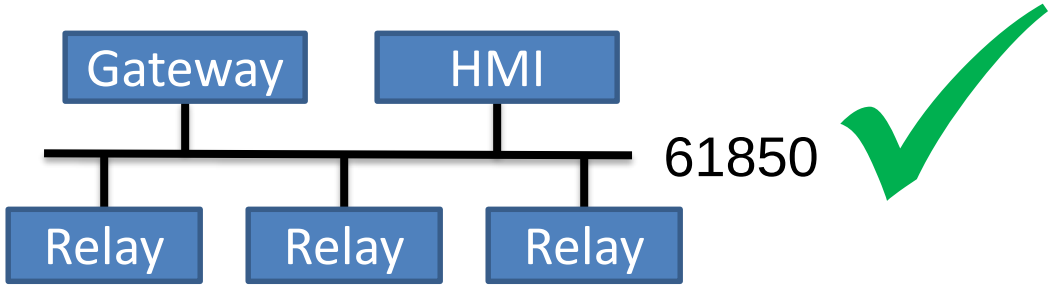
South Africa

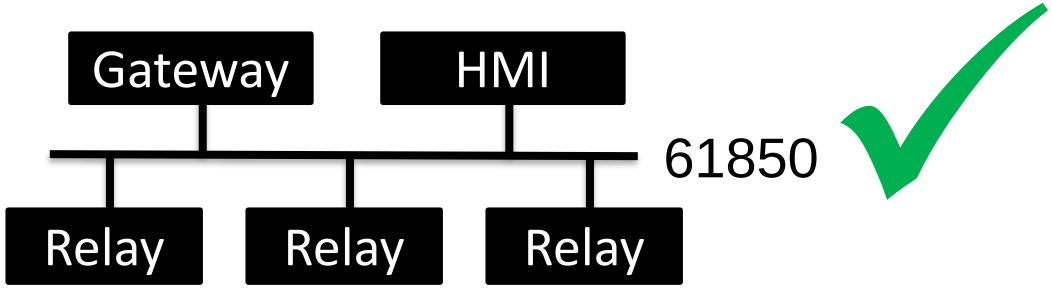
Australia

SUBNET IEC 61850 Projects Worldwide

The complexity of multi-vendor multi-edition systems

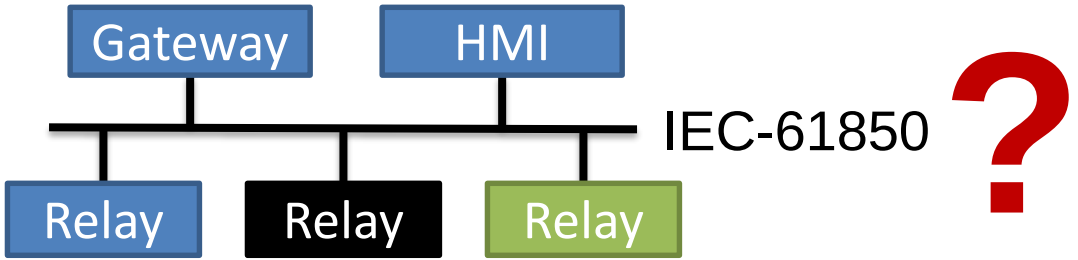
Single Vendor IEC 61580 Interoperability = OK





The complexity of multi-vendor multi-edition systems

What about Multi-Vendor IEC-61580 Interoperability



Recent IEC 61850 Interoperability Panels/Demonstrations

- UCA: IEC 61850 IOP in April 2011
- UCA: IEC 61850 IOP in October 2013
- Cigre: IEC 61850 IOP in 2014
- UCA: IEC 61850 IOP in October 2015
- UCA: Scheduled IEC 61850 IOP in October 2017

IEC 61850 Interoperability 2011

- Report: IEC 61850 IOP, Paris, France UCAIug-63-111Rv1.pdf
  - Issues found between vendor files
    - Incorrect initialized values
    - Issues found between vendor implementations
      - Support of Integer 128 issues
        - » Inability “to map/support such a value in the implementations memory/application”
    - “Vendor A attempted to import an SCD file exported by Vendor B. A problem occurred.”
      - Diagnosed to be an unsupported XML Namespace issue

IEC 61850 Interoperability 2013

- Report: http://www.ucaiug.org/Meetings/CIGRE_2014/USB%20Promo%20Content/UCAIug/UCA%20Users%20Group%2061850%20IOP%20Report%2028012014f.pdf
  - "Engineering efforts required to implement the standard in a substation are huge"
  - "Grid operators are forced to use specific vendor tools that are not optimal in a multi-vendor environment and train staff to use a wide range of tools to configure the system"
  - "A clear move by the market to a top-down approach using standardized third-party tools is needed"

IEC 61850 IOP 2013

- 61850 Standard Issues from the report:
  - SCL
    - “ED.1/ED.2 co-existence in a single SCD file”
    - “Client reporting subscription”
    - “GOOSE subscription”
    - “SV subscription”
  - Networking
    - “VLAN Tag 0 support in switches”

Incorrect SCD/CID File Formats

- CIGRE 2014:
  - Issues with Major Relay Vendor CID files
    - Problem: Vendor tools create incorrect CID file formats
      - Issue: Found several instances of missing DOType, DAType, ENUM, and ConnectedAP definitions
      - Issue: Point IDs created to be too long and incompatible with certain 61850 server driver implementations

        <DOType cdc="ACD" id="**SIPROTEC5_DOType_ACD_NonPhsSel_Without_DirRouting_V05.00.07_V02.00.00**“>
    - Solution: Vendor enhancement requests

Observations from IOP Results

- IOPs focus on newly-introduced features
- Communication interoperability has improved over time: Fewer problems observed
- SCL compatibility / interoperability seen is a major remaining area for improvement

Observation

- IEC 61850 specifies or uses several protocols
  - MMS
    - Client/Server “Vertical” communication
  - GOOSE & SV
    - Peer-to-peer “Horizontal” communication
  - SCL
    - Data sharing between tools

Based on Standards

IEC-61850 Defines a Standards-Based Approach to Configurations with SCL

SED System Exchange Description

SSD System Specification Description

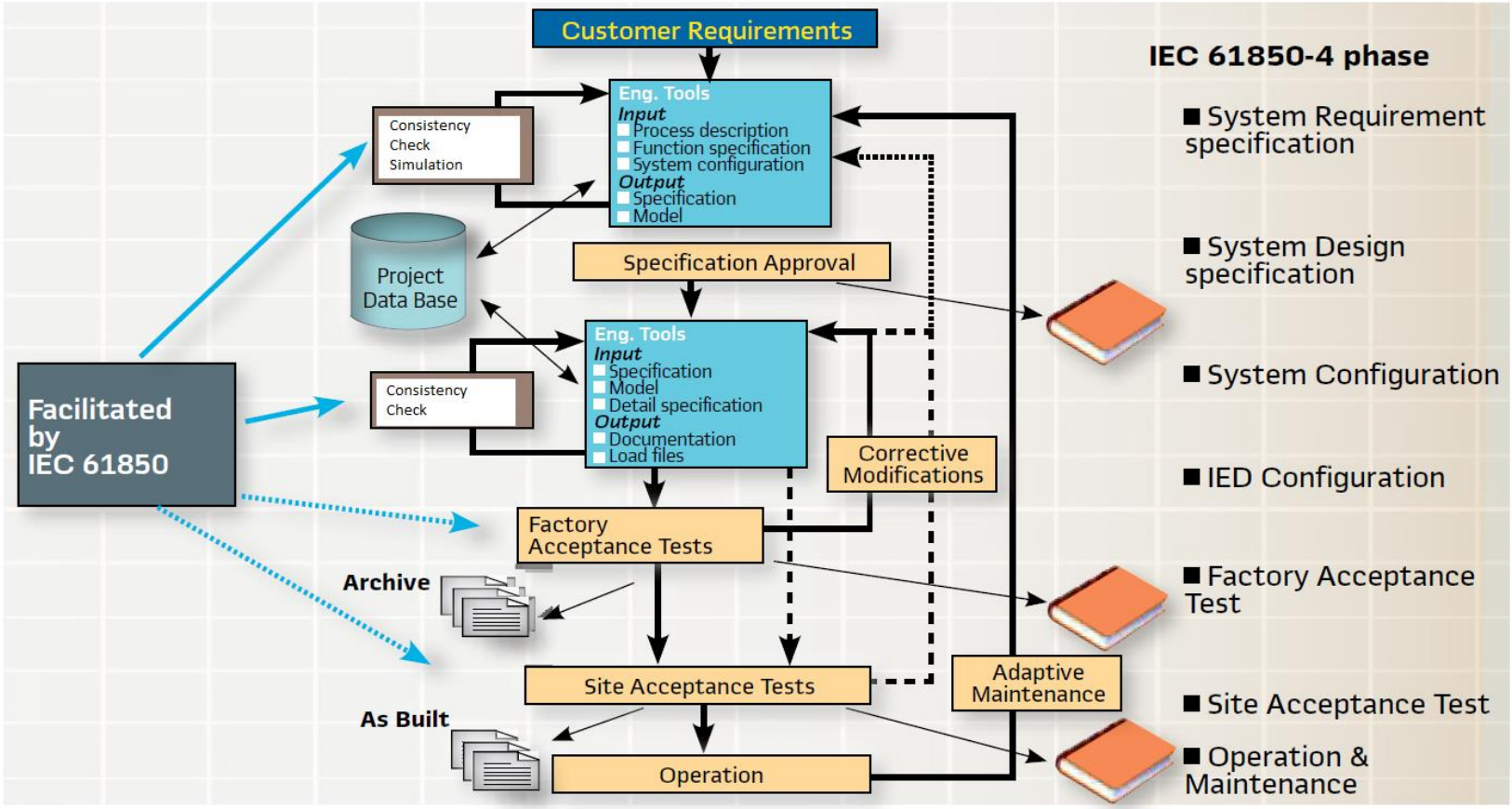
SCD Substation Configuration Description

ICD IED Capability Description

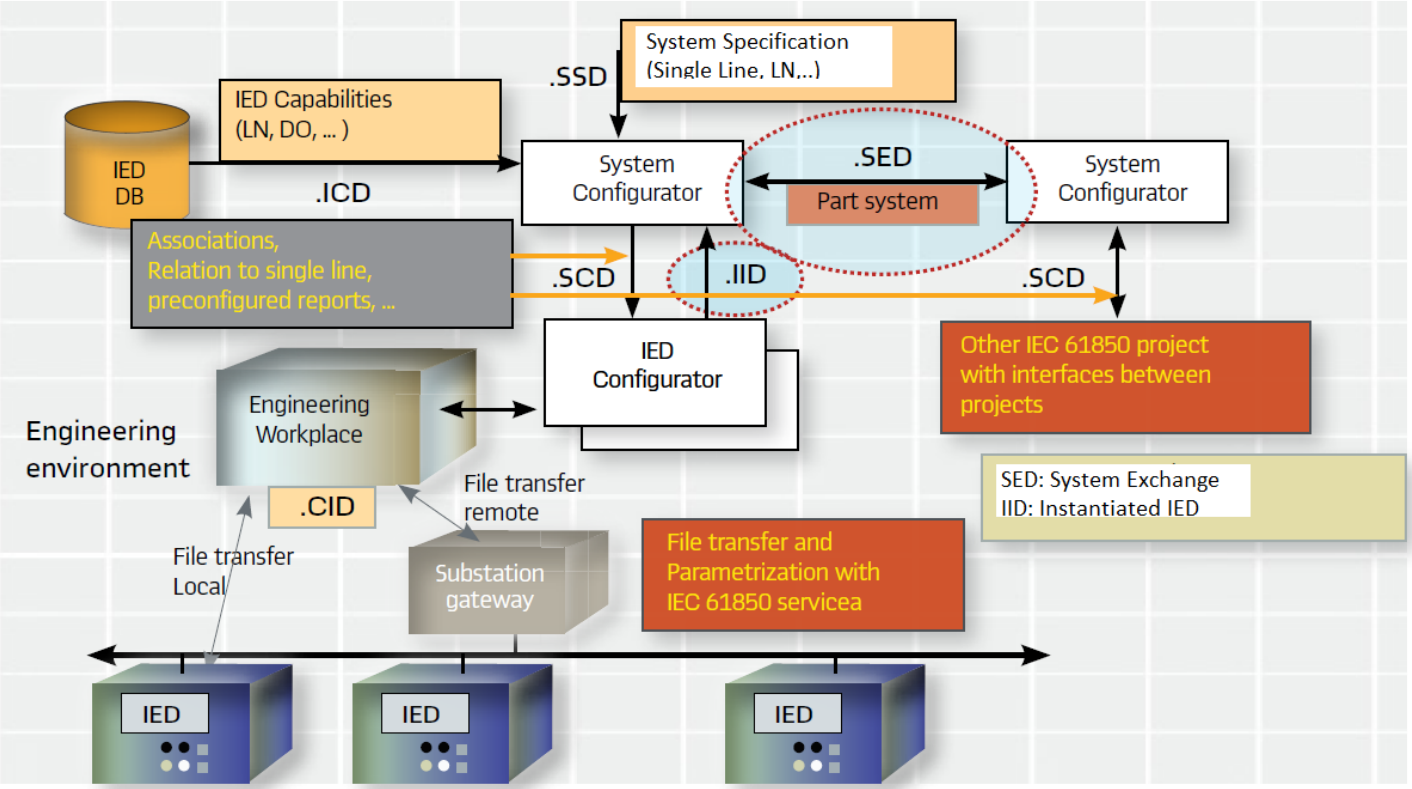
CID Configured IED Description

IID Instantiated IED Description

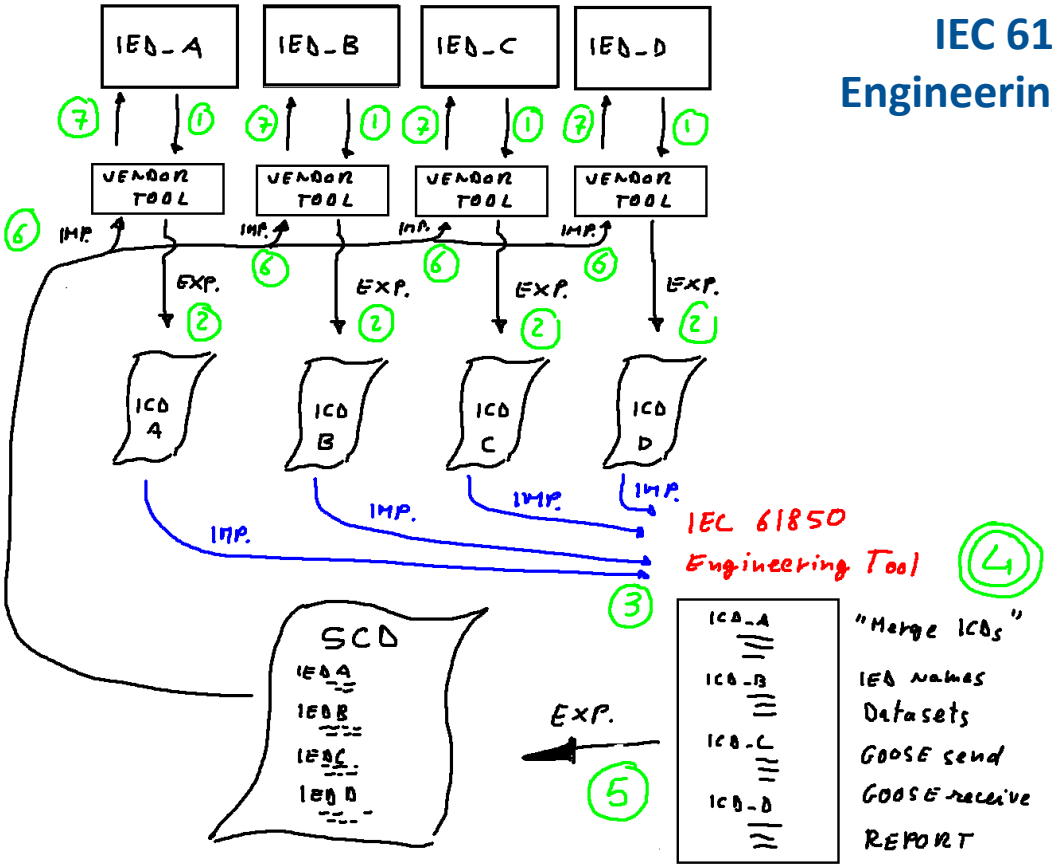
Overall engineering process according to part 4



Determining the optimal application of unified configuration and documentation tools

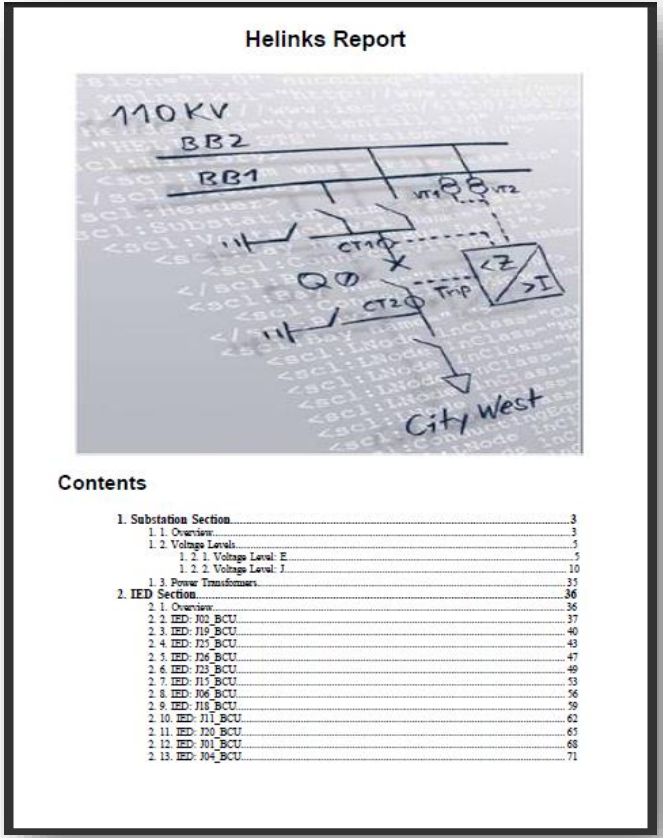


IEC 61850: Engineering Process



IEC 61850: Engineering Tools

- Documentation
  - The SCD file describes the substation in IEC 61850 SCL
  - Tools can convert this information to present it in human readable format



IEC 61850: Engineering Tools

pdf.pdf - Adobe Reader

File Edit View Document Tools Window Help

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Bookmarks

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  - 1. 2. Voltage Levels
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      - 1. 2. 1. 1. Overview
      - 1. 2. 1. 2. Bay: 01
      - 1. 2. 1. 3. Bay: 04
      - 1. 2. 1. 4. Bay: 02
      - 1. 2. 1. 5. Bay: 03
      - 1. 2. 1. 6. Bay: 05
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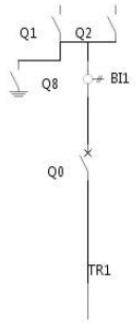


Figure 44: Single Line Diagram

Figure 45: Function Diagram

Conducting Equipment

Name	Type	IED	Logical Device	Logical Node	Description
Q8	DIS				
		-	-	-	-
BI1	CTR				

Configuration management as a natural extension of remote engineering access and password management

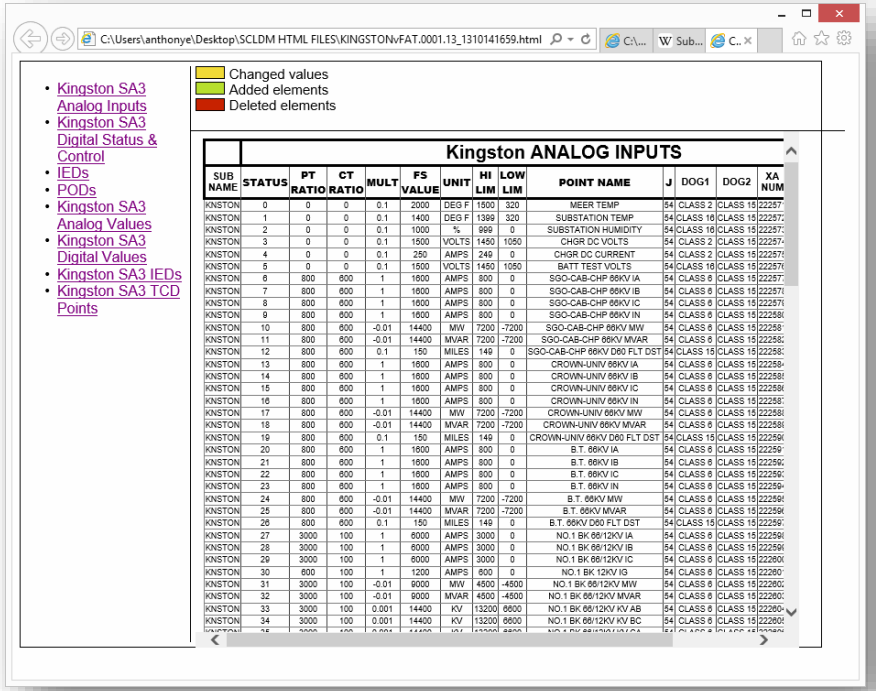
Configuration Management (CIP-010)

What functions are we looking for?

- Version-control
- Permission policies
- Approval processes and workflow
- Change Notifications

SCL Files are XML

- A vast array of tooling and technology can be leveraged for working with the information



SCL Files are Extensible

```
<ConnectedAP iedName="PLC" apName="AP1" eid:ref="_b444c2a5-67 ... bcd28cf0">
  <Private type="SUB_Protocol">
    <eSUB:Protocol xmlns:eSUB="http://www.SUB.com/SEMT/61850/ ... L">MODBUS</eS ... :Protocol>
    <eSUB:Base id="Status" type="4" off="0" bits="1" xmlns:eS ... UB.com/SEMT/61850/SCL" />
    <eSUB:Base id="Status2" type="4" off="32" bits="1" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:Base id="DIN" type="4" off="264" bits="2" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:DINChange type="4" idx="33" mask="0001" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:DINReset type="4" idx="37" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:Base id="DOT" type="0" off="0" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:Base id="AIN" type="4" off="0" bits="16" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
    <eSUB:Base id="AINStat" type="4" off="0" bits="1" xmlns:eSUB="http://www.SUB.com/SEMT/61850/SCL" />
  </Private>
```

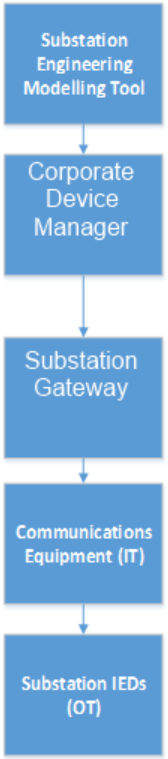
- The CID schema can be extended for defining non-IEC 61850 devices (Modbus, DNP3, etc.) within the context of IEC 61850
- The CID schema can be extended to support equipment such as routers and switches
- Standard extensions currently in development

Solving part of the problem

- IEC-61850 SCL helps with…
  - Considering all device configurations as one holistic substation configuration
  - Differencing two different configuration files
  - Ensuring compatibility with non-IEC 61850 devices
  - Handle IT devices (routers, switches, and radios) in the same manner as OT devices
  - Leveraging open standards

Solving the other part of the problem

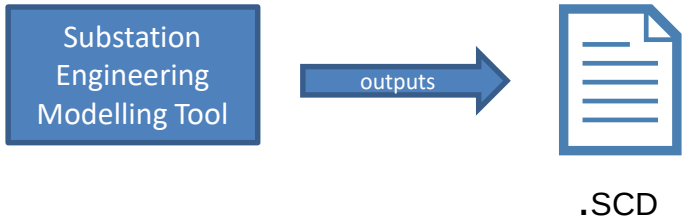
- Synchronization between the corporate environment and the substation
- Actively monitoring the devices in the substation
- Automatically extracting changed configurations from devices

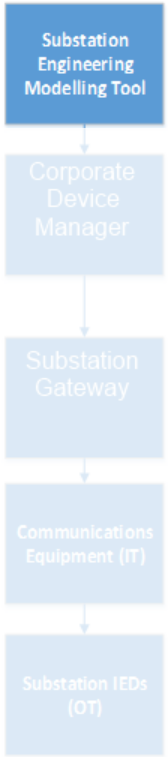


1. SCD File Configuration

The Substation Configuration Description file (.SCD) by a Substation Engineering Modelling Tool

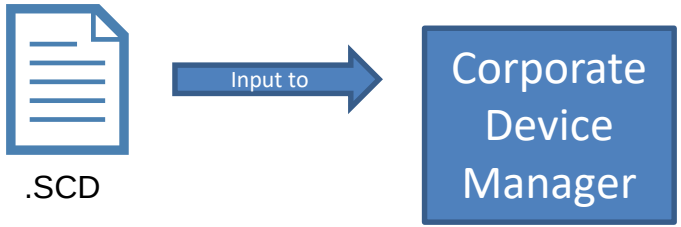
The SCD describes the entire substation configuration, including every IED, HMI, network switch, and router

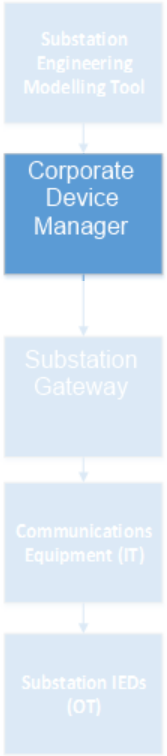




2. The SCD File is Loaded into the Corporate Device Manager

Because the SCD File is XML, the Corporate Device Manager has an opportunity to configure itself based on the SCD file

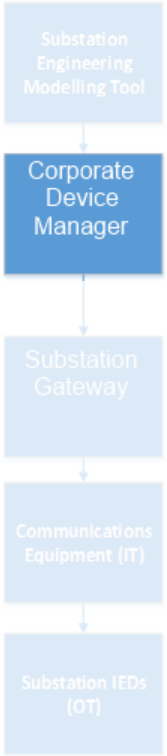




2. The SCD File is Loaded into the Corporate Device Manager

Device Manger can:

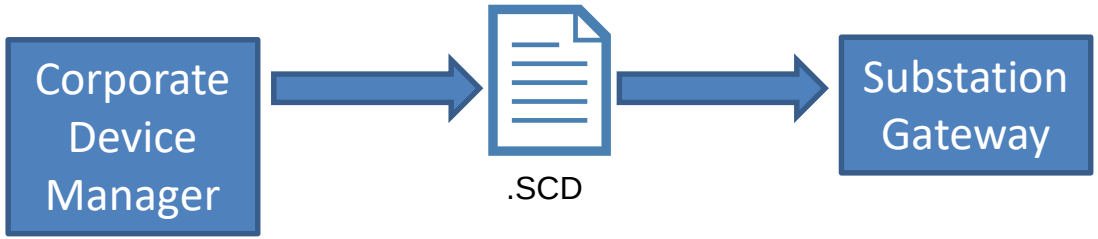
- Automatically create a substation instance
- Place the SCD file under document control
- Automatically create all substation devices
- Automatically create substation and device meta-data tags
- Extract per-device CID configuration files
- Place all CID files under document control
- Synchronize with other systems such as certificate/key managers, historians, etc.

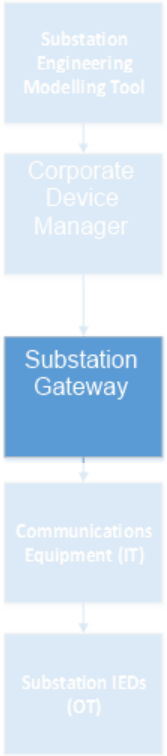


3. Transfer of SCD File to Substation Gateway

Electronic transfer ensures:

- SCD updates are always accessible at the substation
- The **right** configuration file is at the substation

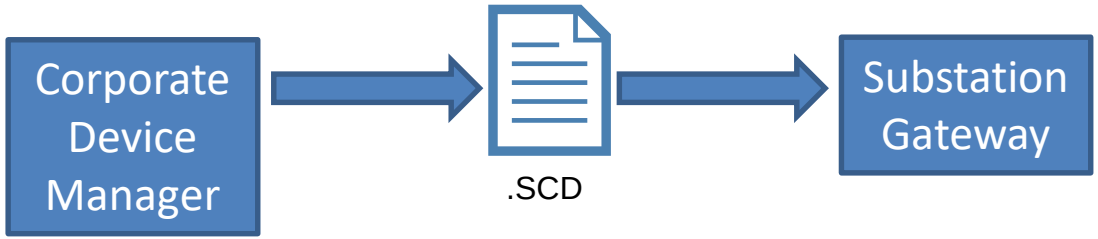


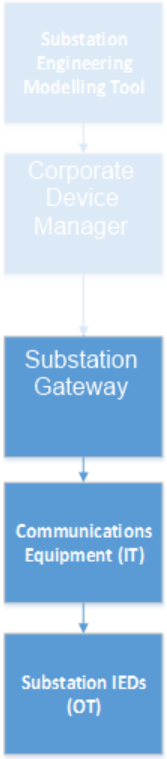


3. Transfer of SCD File to Substation Gateway

Electronic transfer ensures:

- SCD updates are always accessible at the substation
- The **right** configuration file is at the substation
- The substation gateway can auto-configure itself
- The substation gateway can auto-configure the other equipment in the substation

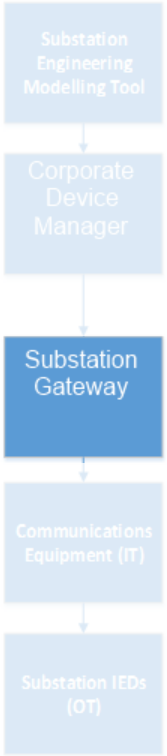




3. Transfer of SCD File to Substation Gateway

Configuring the substation gateway:

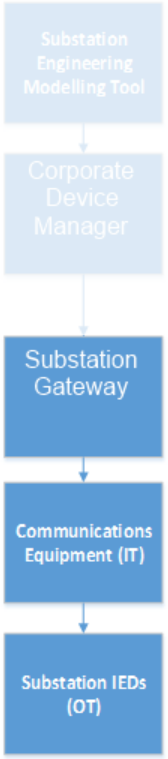
- Automatically create all substation devices
- Automatically build point references
- Establish which end devices have configurations ready to be deployed



3. Transfer of SCD File to Substation Gateway

Configuring the substation gateway:

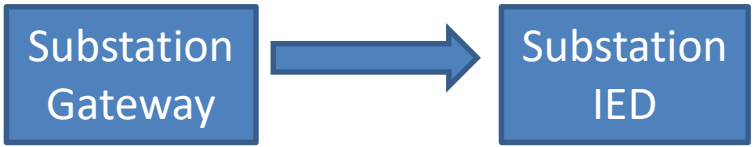
- Automatically create all substation devices
- Automatically build point references
- Establish which end devices have configurations ready to be deployed
- Automatically deploy those end device configurations

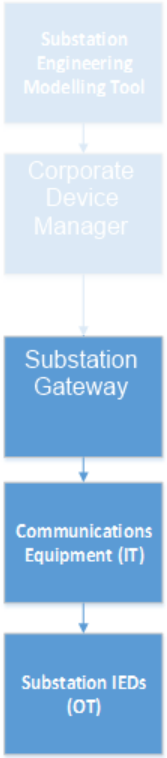


4. Active Configuration Monitoring

The Substation Gateway can actively poll and monitor the devices in the substation for out-of-band configuration changes

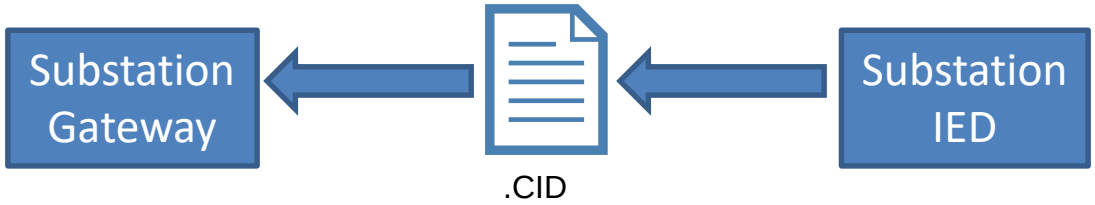
1. Front faceplate changes
2. Users accessing devices with vendor configuration software

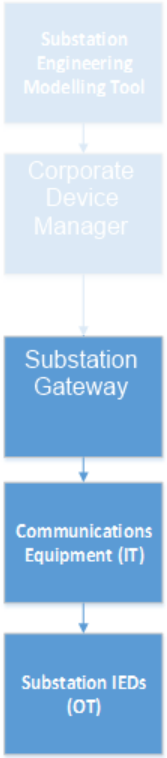




4. Active Configuration Monitoring

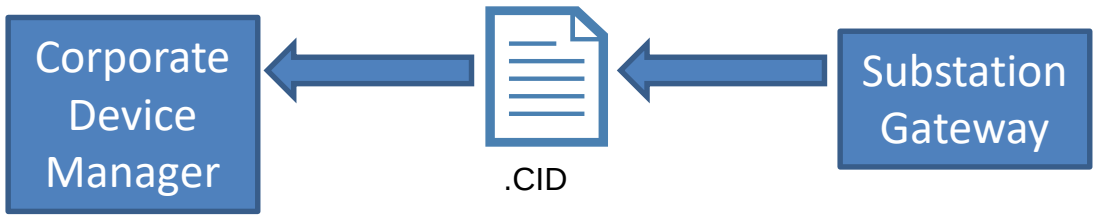
If a change is detected, the Substation Gateway can extract the configuration from the device

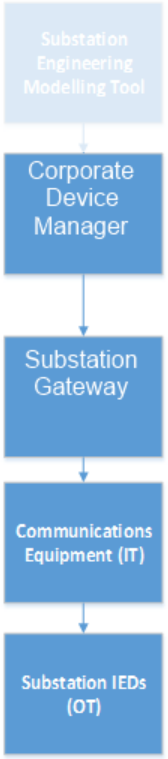




4. Active Configuration Monitoring

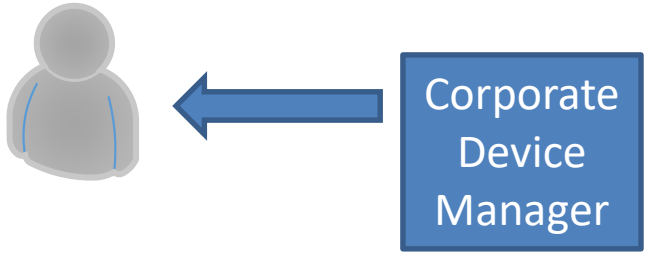
The Substation Gateway can automatically transfer the file to the Corporate Device Manager for archive

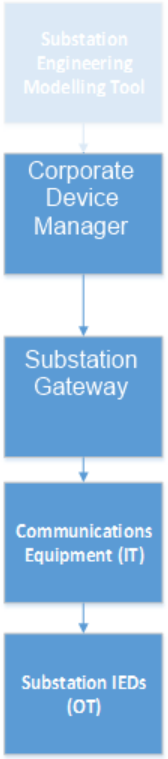




4. Active Configuration Monitoring

The Corporate Device Manager can notify users that an out-of-band change was detected





In summary…

- Effective IEC 61850 Multi-Vendor and Multi-Edition Integration is possible
- The SCL platform can be used as a common data management platform
  - Extensible for non-IEC 61850 devices
  - Readily managed to provide additional services

Q&A / Contact Details

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