

# IEC Protocol

IEC - The International Electrotechnical Commission (IEC) .

- **international standards for all electrical, electronic and related technologies**

# Different IEC Protocols

- ❑ IEC 60870 part 5, known as **Transmission protocols**
- ❑ **IEC 60870-5-101 Transmission Protocols** - companion standards especially for basic telecontrol tasks
  - Edition 1 published in 1995
- ❑ **IEC 60870-5-103 Transmission Protocols** - Companion standard for the informative interface of protection equipment
  - Published in 1995
- ❑ **IEC 60870-5-104 Transmission Protocols** - Network access for IEC 60870-5-101 using standard transport profiles
  - Edition 2 published in 2000
- ❑ **IEC 61850** - An international standard defining communication protocols for intelligent electronic devices at electrical substations.
  - Published in 2003.
  - The standard has been defined primarily for substation automation.

# IEC 60870 -5

Edition 1 – 101

Edition 2 – 104

IEC 60870 -5 Overview

Stacks Layers

ASDUs

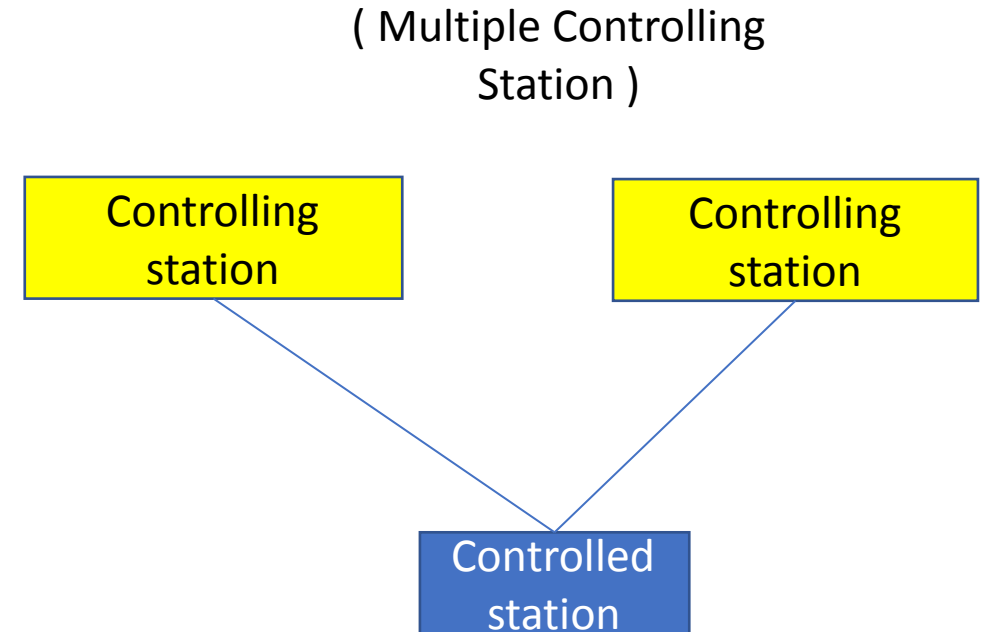
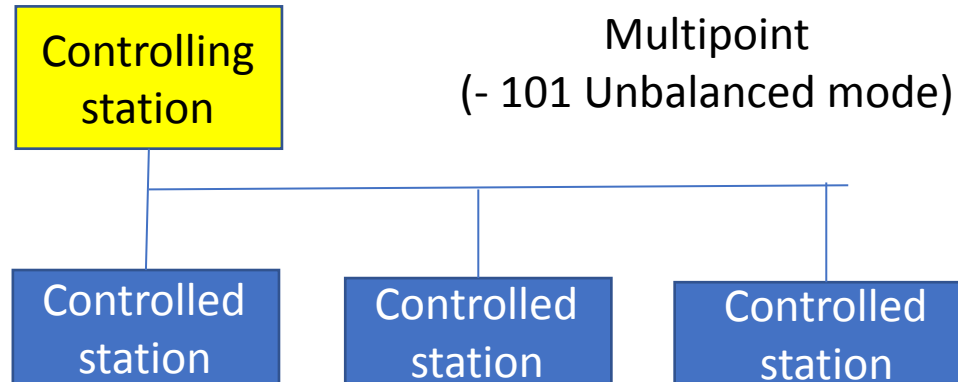
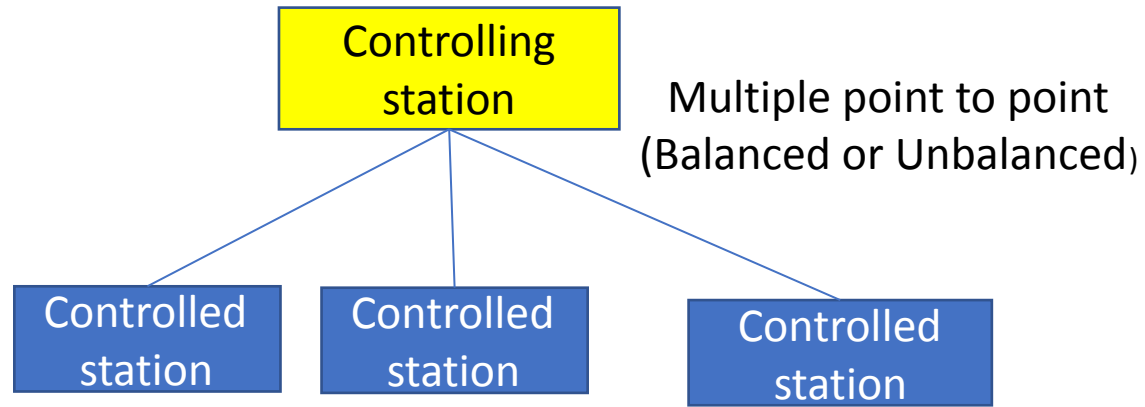
Application layer

Link ,Transport & Physical Layer

- **Polling**
- **Controls**
- **Link layer**

Security & Conclusion

# Supported Topology



**Balanced mode :** In balanced mode Master and slave both can initiate message.(Full Duplex)

Supported by IEC 60870 – 5- 101 & 104

**Unbalanced mode :** In Unbalance mode only, Master can initiate message.(half duplex)

Supported by IEC 60870-5-101 only.

# Stack Layers :IEC 60870-5-101

❑ Three layer protocol based on Enhanced Performance Architecture (EPA)

## ❑ Application

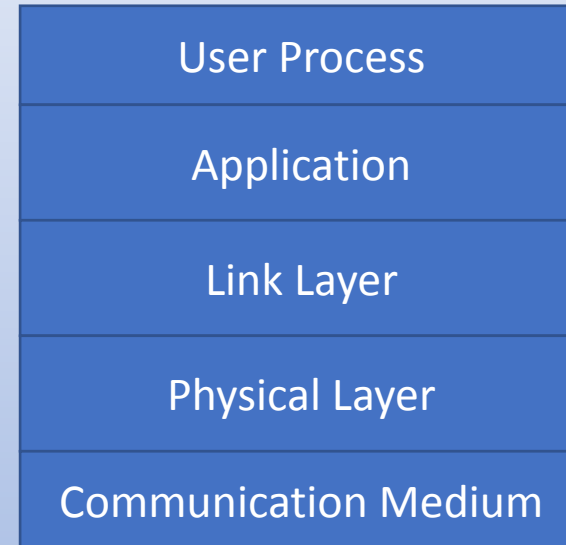
- Data objects
- buffers
- polling
- commands
- Events
- time stamp & synch

## ❑ Link Layer

- Handles of link control
- addressing
- frame checksum
- link confirms.

## ❑ Physical Layer

- serial
- Supports serial Radio.



# Stack Layers :IEC 60870-5-104

It adds up TCP/IP layer to -101

- ❑ Application layer
  - Most of the same ASDUs
  - 104 Link layer (TCP Interface)
- ❑ TCP/IP Protocol suit
- ❑ Physical
  - IEEE 802.3 Ethernet

User Process
Application
Transport - TCP
Network IP
Data Link
Physical
Communication Medium

# ASDU : Application Service Data Unit

- ❑ Link address and ASDU (**Application Service Data Unit**) addresses are provided for classifying the end station and different segments under the same.
- ❑ Application service data unit (ASDU) contain
  - Data Type
  - No of data object
  - Address for data object
  - Why data is being sent
  - Data object
- ❑ Mostly ASDU are the same between -101 and -104
  - Mostly difference with Time tag.

# ASDU Structure

## ASDU

### ☐ Data Unit Identifier

Type Identification –Identify structure type and format of data.

Variable structure qualifier –Number of information object or element

Cause of transmission - why ASDU sent

Common address of ASDUs – address of station or each logical sector

### ☐ Information object

Structure set by Type ID Includes

- Information object address
- Information element
- Time tag ( If present)

### ☐ Information Object

- same

### ☐ Information Object

- same



# ASDU type identification

ASDU

VSQ

COT

COMMON ADDRESS

INFO OBJECT #1

INFO OBJECT #2

INFO OBJECT #3



Identifies the Data or Command in the ASDU

- Status and measured value (1 - 40)
- Command for control (45 - 51 , 58 - 64 )
- System monitoring (70)
- Security (41 , 81 - 87, 90 - 95)
- Command for monitoring (100 – 107)
- Command for measured value (110 – 113)
- File transfer (120 – 127)

## Examples of Type Identification

Type Identification	Definition
<1>	Single-point
<2>	Single-point with time tag
<3>	Double-point
<4>	Double-point with time tag
<13>	Measured value – short floating point
<17>	Event of protection equipment with time
<45>	Single command
<46>	Double command
<100>	Interrogation command
<102>	Read command
<103>	Clock synchronization command

# Examples of Cause of Transmission

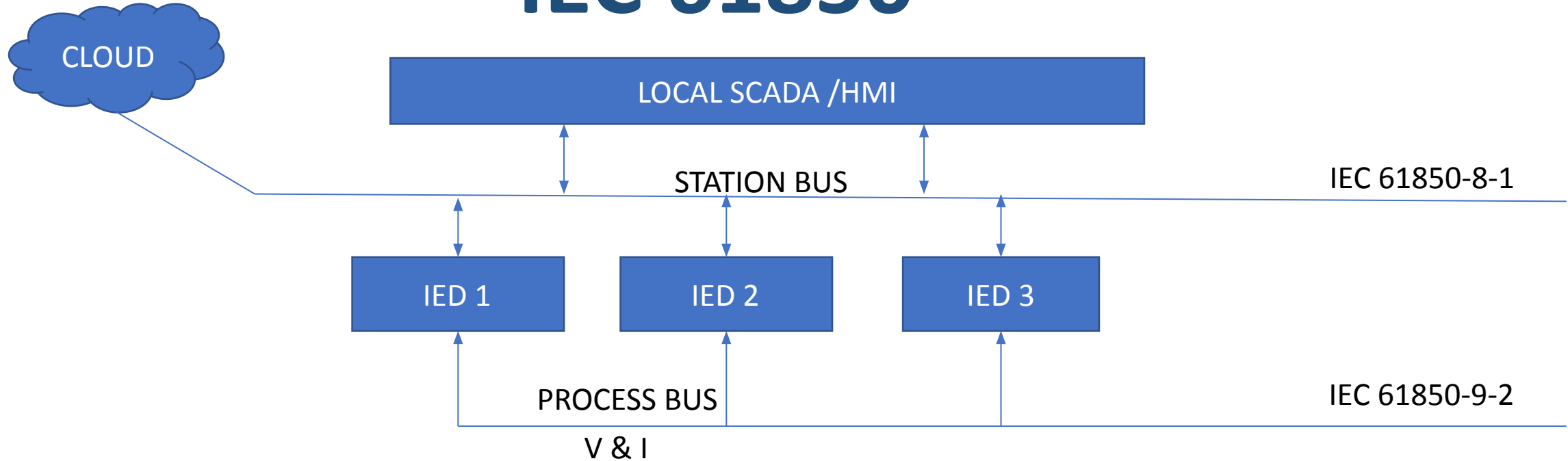
COT : Cause  
of  
transmission

Cause	
<1>	Periodic/cyclic
<2>	Background Scan
<3>	Spontaneous (events)
<5>	Request
<6>	Activation
<7>	Activation Confirmation
<10>	Activation Termination
<44>	Unknown Type Identification
<46>	Unknown Common Address of ASDU
<47>	Unknown Information Object Address

# IEC 60870 -5-104 : Transport Interface

- -104 adds a header to – 101 ASDU
- Replaces – 101 link layer header
- APDU (Application protocol Data Unit)
  - APCI header + ASDU = APDU
- APCI has control field with sequence no and start /stop transmission control .
- Added protection against lost or duplicated message.

# IEC 61850

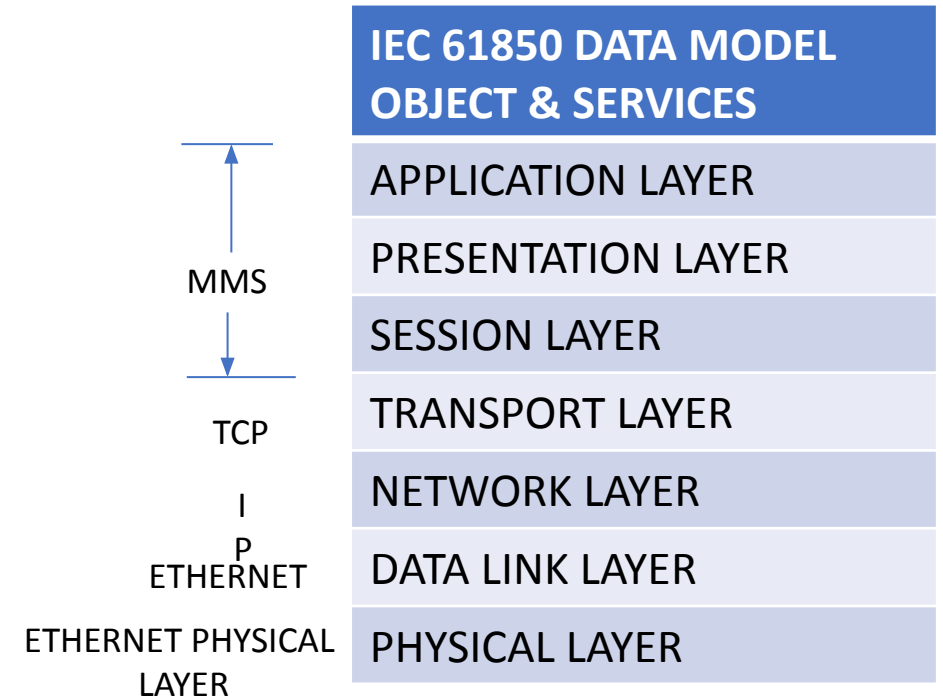


- ❑ IEC 61850 -8- 1 : Edition 1 , It uses Hard wire cu- wire
- ❑ IEC 61850 -9-2 : Edition 2, It uses sampled data Non – conventional instrument, e.g optical CT

# IEC 61850 stack overview

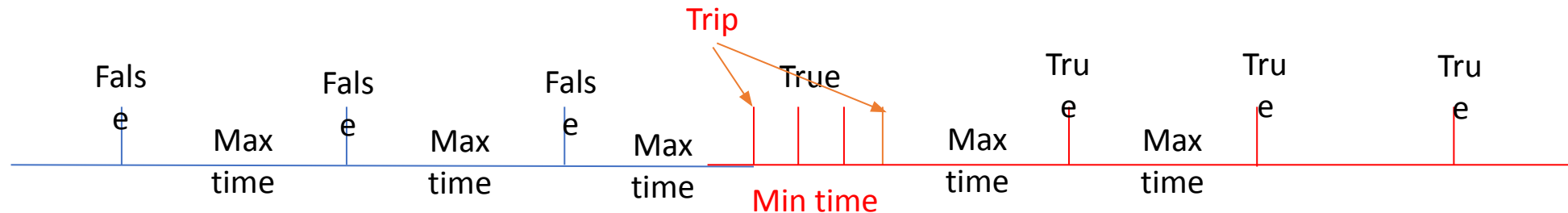
IEC 61850 has two different communication topology.

- **Horizontal Communication (GOOSE)** : It has ability of horizontal communication between different IED called Interoperability.
- **Vertical Communication (MMS)** : It has ability of vertical communication between IED to Remote SCADA/HMI (SERVER/CLIENT )

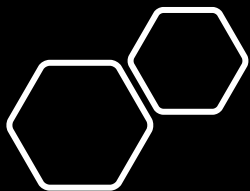


# GOOSE : General object oriented system event

- ❑ It is an unacknowledged multicast message that is repeated with certain strategy allowing the supervision of the horizontal communication .
- ❑ The GOOSE Sending relay ( Publisher) continuously publish information over network to Receiver (Subscriber) . It is an unacknowledged communication .
- ❑ All IED has whole information of other IED that described in GOOSE control block. any change in previous state can also acknowledged by other IED in the network.
- ❑ Publisher will multicast after certain interval of time , In the event of any change it will send message continuously within short duration to get ensure that the Subscriber has received the information of change in event.



- ❑ GOOSE Protection is much faster than conventional contact protection .



## Communication

App ID :

MAC Address :

Max Time :

Min Time :

VLAN ID :

VLAN Priority :

# GOOSE object Properties

# MMS : Manufacturing Message Specification

- ❑ It is client / server-based protocol for communications between IEDs (IED – Intelligent Electronic Device) and higher-level entities (such as RTUs and SCADAs) over Ethernet that is part of the IEC 61850 standard for communication technology in substations.
- ❑ It provides a range of functions that allows the client to obtain the data model of the server, read or modify individual values, delete entries as well as transfer files.
- ❑ When an action is performed, the client sends a request to the server, which processes the request and responds to the client, also stating whether the request was processed successfully.
- ❑ The MMS protocol is not only used by IEC 61850 for communication in substations here are several more areas of application for the MMS protocol in smart grids, as for example. **IEC 60870–6 (ICCP: Inter-Control Centre Communications Protocol)** telecontrol protocol, often used for communication between control centers.



## Report Control Blocks

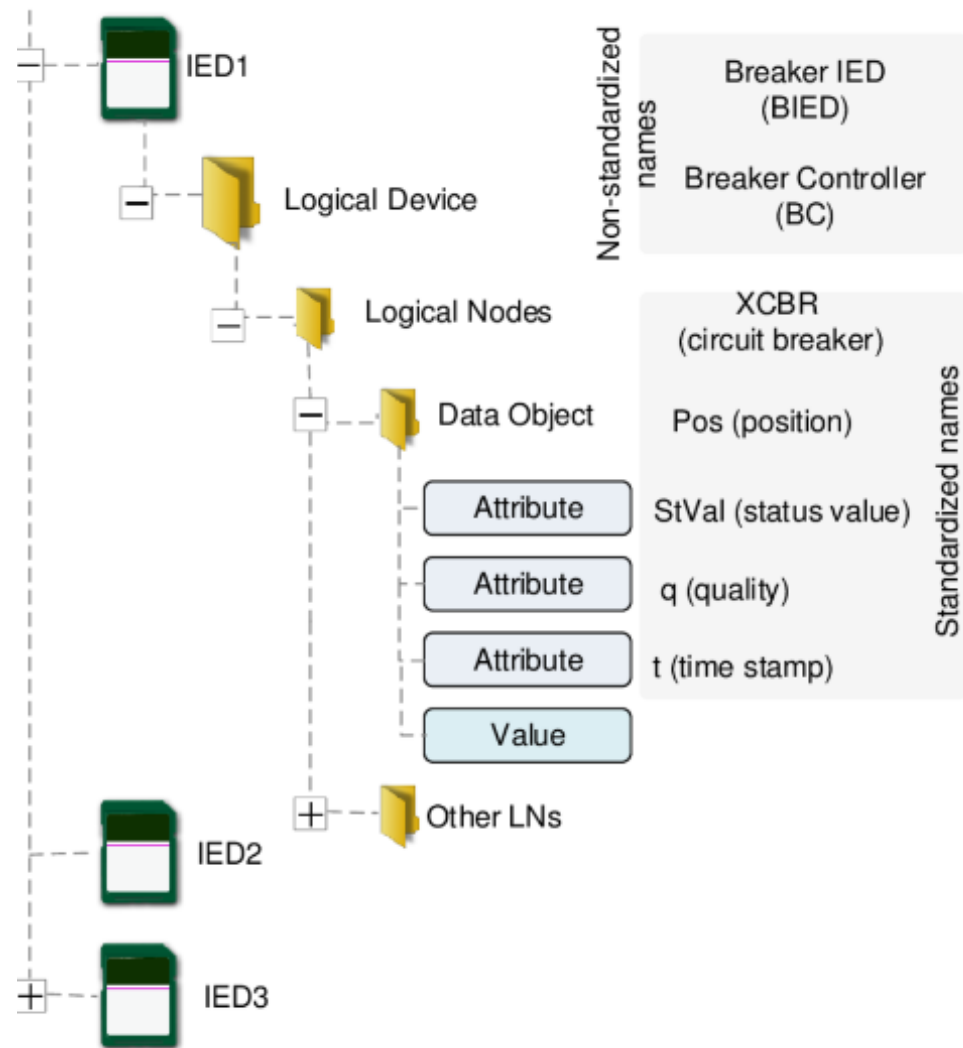
Control block must be configured to handle and specify how the event are transmitted to client. there are two type of report control block.

- **Buffered report control block (BRCB)** : BRCB store the event during communication interruption.
- **Unbuffered report control block (URCB)** : while URCB sent upon data change and not stored during communication interruption.

## Trigger Option

There are five trigger option

- **dchg = data – change** : whenever value change either binary or measured ,transmission takes place.
- **qchg = quality – change** : any change in quality description will be transmittable.
- **dupd = data value – update** : transmission will be done on a condition which can be controlled by Application.
- **Integrity** = This trigger the transmission of all process values defined in the data set when timer values (integrity period) expire.
- **General interrogation** = This trigger is forced by client ,normally GI is asked when client and server start or restart session.



# Data Model of IEC 61850

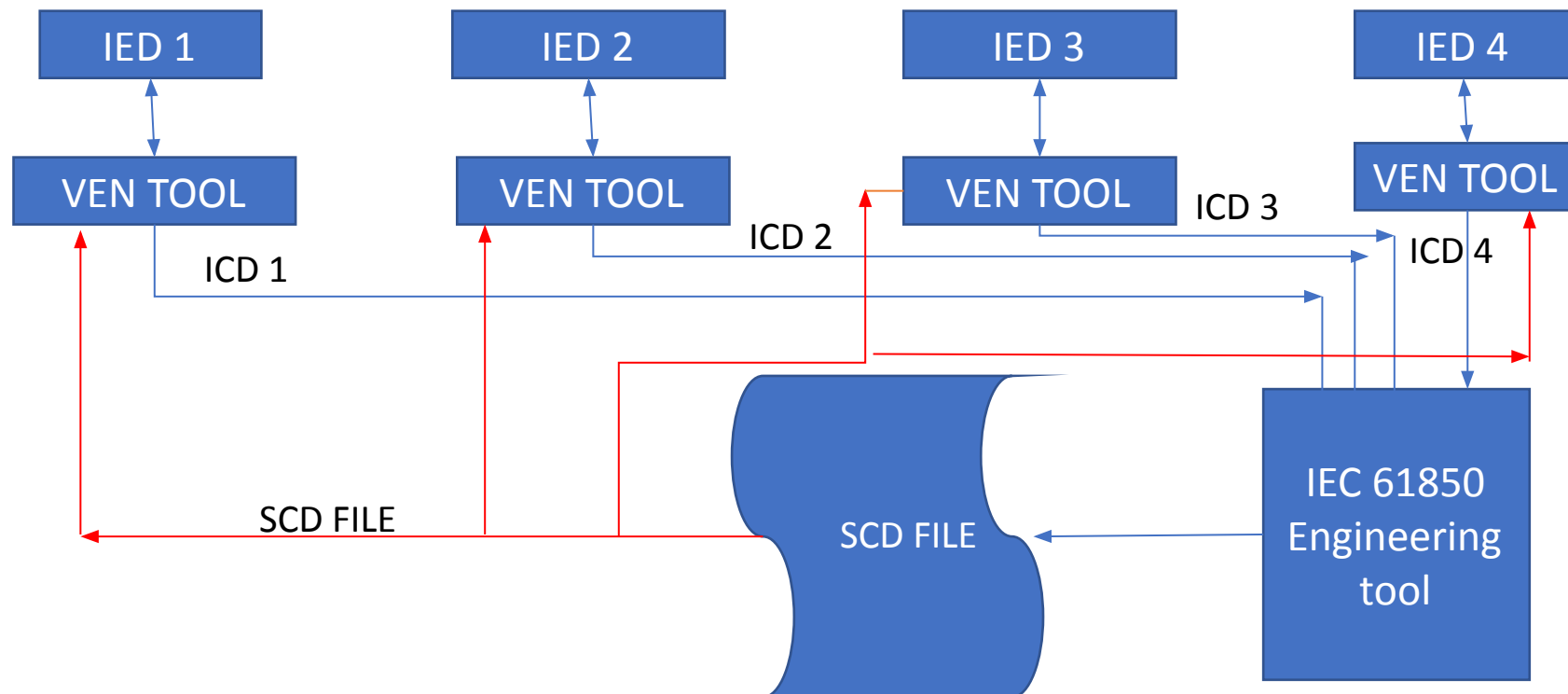
## IEC 61850 : Different SCL files

There are three different SCL files.

ICD : IED capability description.

CID : Configured IED description.

SCD : Substation configuration description



THANK YOU