Prednosti i nedostaci primjene norme IEC 61850 u elektroenergetskim postrojenjima

Predavač:

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CIRED HRVATSKI OGRANAK

IEC 61850 – Osnovne prednosti i problemi

- Glavne prednosti
  - Brža i jeftinija integracija sustava
  - Jednostavnije konfiguriranje uređaja i aplikacija
- Glavni nedostatci
  - Sloboda u određivanju konfiguracije
  - Nepotpuna sukladnost uređaja i aplikacija
- Rješavanje probleme
  - Poznavanje IEC 61850 standarda
  - Poznavanje načela rada sa SCL datotekama

IEC 61850-6 – SCL

- XML (eXtensible Markup Language) -> Notacija
- IED (Intelligent Electronic Device) -> Relej, upravljački uređaj
- SCL (System Configuration description Language) -> Jezik
  - SSD (System Specification Description) -> Sučelja opreme
  - ICD (IED Capability Description) -> Mogućnosti uređaja
  - IID (Instantiated IED Description) -> Trenutna konfiguracija
  - CID (Configured IED Description) -> Konačna konfiguracija
  - SCD (System Configuration Description) -> Konačna konfiguracija
  - SED (System Exchange Description) -> Sučelja za proširenja

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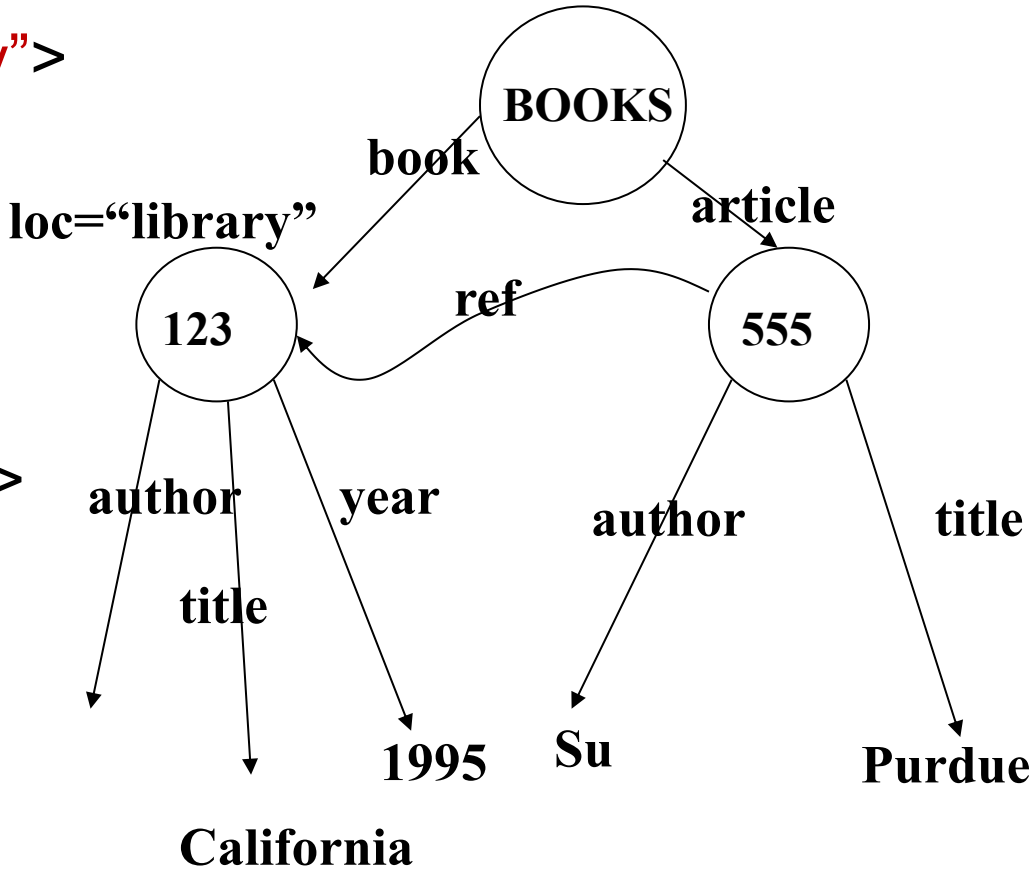
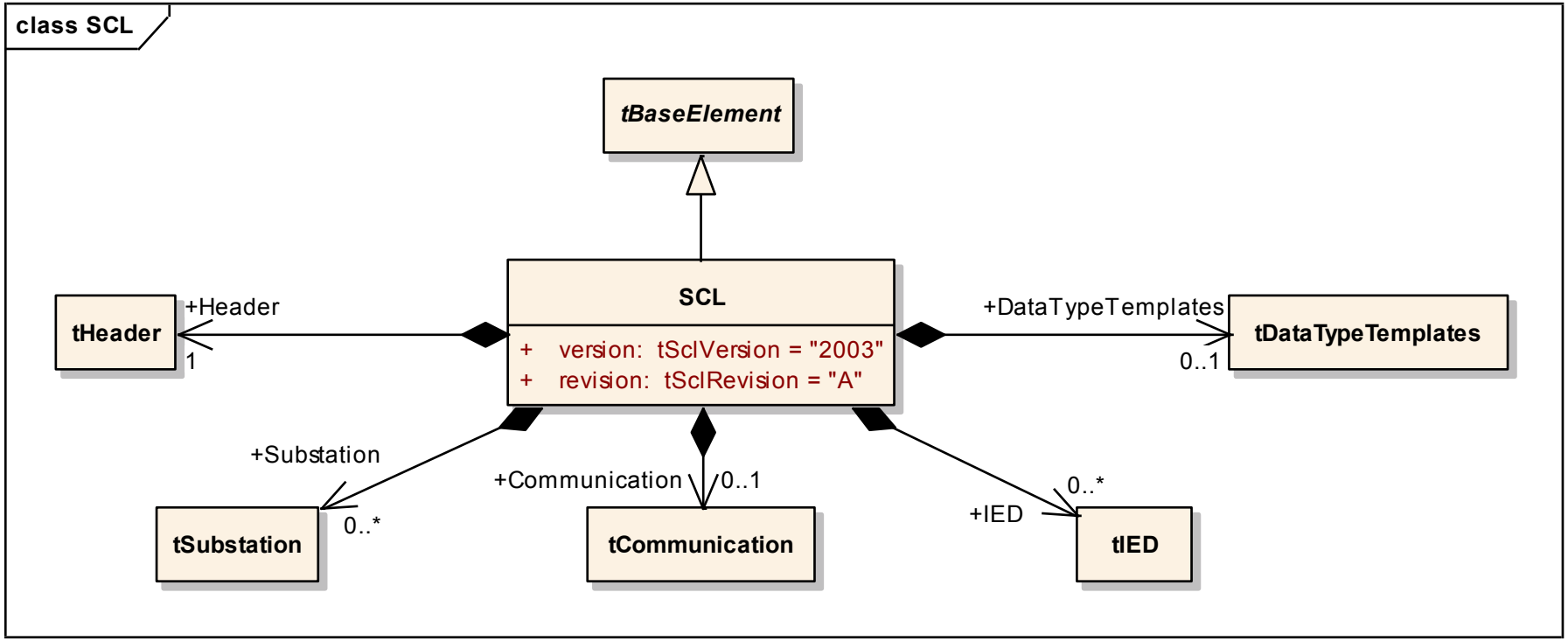
```
<BOOKS>
<book id="123" loc="library">
   <author>Hull</author>
   <title>California</title>
   <year> 1995 </year>
</book>
<article id="555" ref="123">
   <author>Su</author>
   <title> Purdue</title>
</article>
</BOOKS>
```



IEC 61850-6 – SCL struktura



IEC 61850-6 – XSD

- XDS - XML Schema Description

File name	Description
SCL_Enums.xsd	The used XML schema enumerations
SCL_BaseSimpleTypes.xsd	The basic simple types used by the other parts
SCL_BaseTypes.xsd	The basic complex type definitions used by the other parts
SCL_Substation.xsd	The Substation related syntax definitions
SCL_Communication.xsd	The Communication related syntax definitions
SCL_IED.xsd	The IED related syntax definitions
SCL_DataTypeTemplates.xsd	The data type template related syntax definitions
SCL.xsd	The main SCL schema syntax definition, which defines the root element of each SCL file

IEC 61850-6 – Primjer (Jednopolna shema)

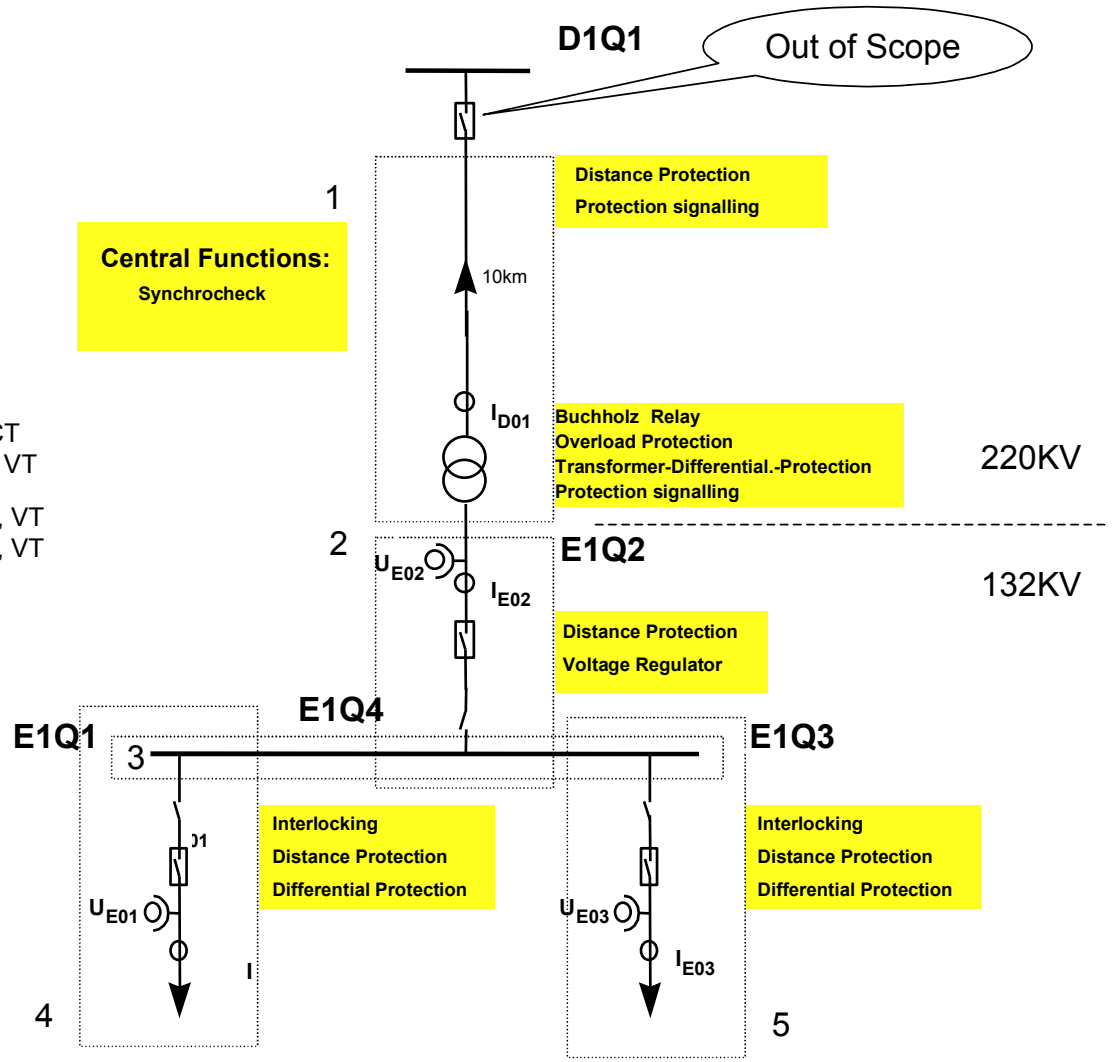
Example T 1-1

2 Voltage Levels

D1 – 220 kV
E1 – 132 kV

5 Bays

1 – D1Q1 Feeder with Transformer, CT
2 – E1Q2 Feeder with DIS, CBR, CT, VT
3 – E1Q4 Static Busbar
4 – E1Q1 Feeder with DIS, CBR , CT, VT
5 – E1Q3 Feeder with DIS, CBR , CT, VT



IEC 61850-6 – Primjer SCL (Jednopolna shema)

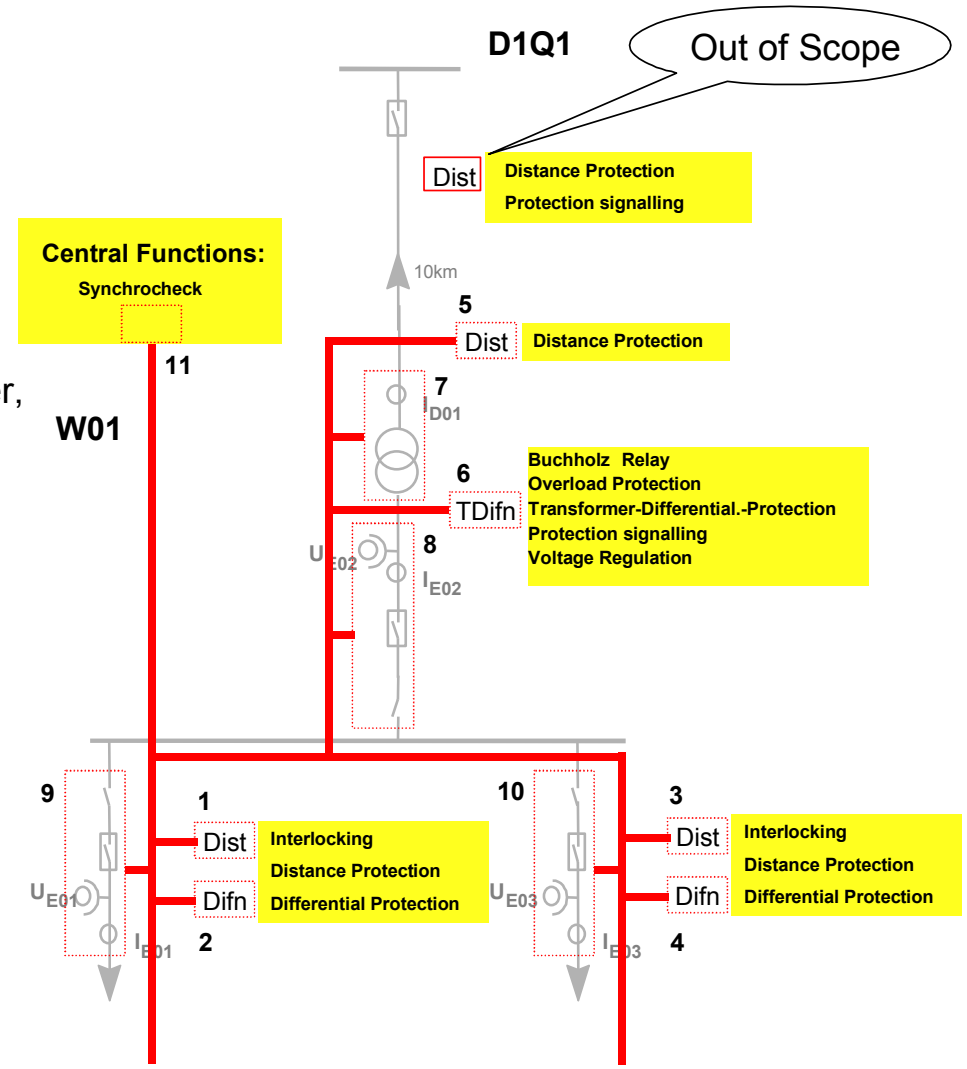
```
<Substation name="S12" desc="Baden">
  <PowerTransformer name="T1" type="PTR">
    <LNode lnInst="1" lnClass="PDIF" ldInst="F1" iedName="D1Q1BP2" />
    <LNode lnInst="1" lnClass="YLTC" ldInst="S12D1T1" iedName="None" />
    <TransformerWinding name="W1" type="PTW">
      <Terminal connectivityNode="S12/D1/Q1/L1" substationName="S12" voltageLevelName="D1" bayName="Q1" cNodeName="L1" />
    </TransformerWinding>
</PowerTransformer>
  <VoltageLevel name="D1">
    <Voltage multiplier="k" unit="V">220</Voltage>
    <Bay name="Q1">
      <LNode iedName="None" ldInst="S12D1Q1" lnClass="PDIS" lnInst="1" />
      <ConductingEquipment name="I1" type="CTR">
        <Terminal connectivityNode="S12/D1/Q1/L1" substationName="S12" voltageLevelName="D1" bayName="Q1" cNodeName="L1" />
        <SubEquipment name="R" phase="A">
          <LNode iedName="D1Q1BP2" ldInst="F1" lnClass="TCTR" lnInst="1" />
        </SubEquipment>
        <SubEquipment name="S" phase="B">
          <LNode iedName="D1Q1BP2" ldInst="F1" lnClass="TCTR" lnInst="2" />
        </SubEquipment>
        <SubEquipment name="T" phase="C">
          <LNode iedName="D1Q1BP2" ldInst="F1" lnClass="TCTR" lnInst="3" />
        </SubEquipment>
      </ConductingEquipment>
      <ConnectivityNode name="L1" pathName="S12/D1/Q1/L1" />
    </Bay>
```

Example T 1-1

Single communication bus

IEDs for:
Transformer.
Combined Bay Unit (Circuit Breaker, Disconnector, CT and VT).
Each Protection.
Central Functions.

No.	Name	ID
1	Dist	E1Q1BP3 (PDIS)
2	Difn	E1Q1BP2 (PDIF)
3	Dist	E1Q3BP3 (PDIS)
4	Difn	E1Q3BP2 (PDIF)
5	Dist	D1Q1BP3 (PDIS)
6	TDifn	D1Q1BP2 (PDIF)
7	Trafo	D1Q1SB1
8	LV Bay1	E1Q2SB1
9	LV Bay2	E1Q1SB1
10	LV Bay3	E1Q3SB1
11	Central	D1Q1SB4 (CILO, RSYN)



IEC 61850-6 – Primjer SCL (Komunikacija)

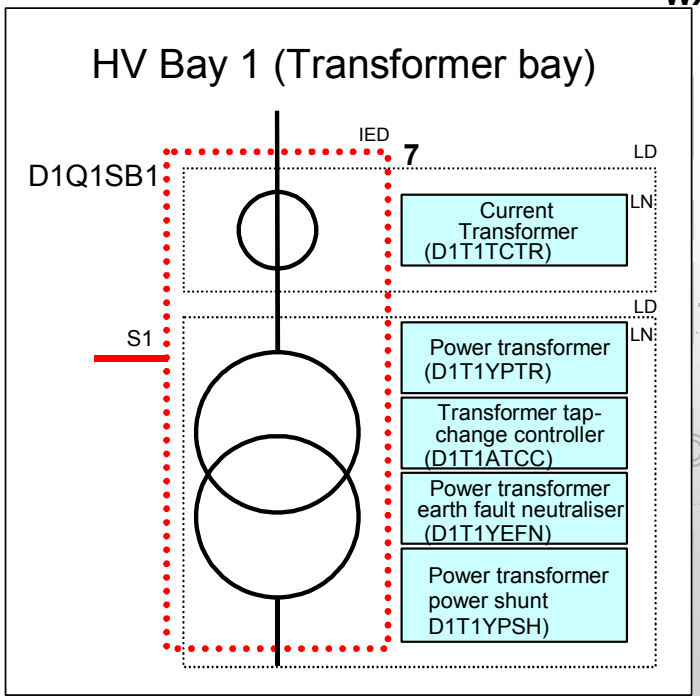
```
<Communication>
    <SubNetwork name="W01" type="8-MMS">
        <Text>Station bus</Text>
        <BitRate unit="b/s">10</BitRate>
        <ConnectedAP iedName="D1Q1SB4" apName="S1">
            <Address>
                <P type="IP">10.0.0.11</P>
                <P type="IP-SUBNET">255.255.255.0</P>
                <P type="IP-GATEWAY">10.0.0.101</P>
                <P type="OSI-TSEL">00000001</P>
                <P type="OSI-PSEL">01</P>
                <P type="OSI-SSEL">01</P>
            </Address>
            <PhysConn type="Connection">
                <P type="Type">FOC</P>
                <P type="Plug">ST</P>
            </PhysConn>
            <SMV ldInst="C1" cbName="Volt">
                <Address>
                    <P type="MAC-Address">01-0C-CD-04-00-01</P>
                    <P type="APPID">4000</P>
                    <P type="VLAN-ID">123</P>
                    <P type="VLAN-PRIORITY">4</P>
                </Address>
            </SMV>
        </ConnectedAP>
        </Communication>
```

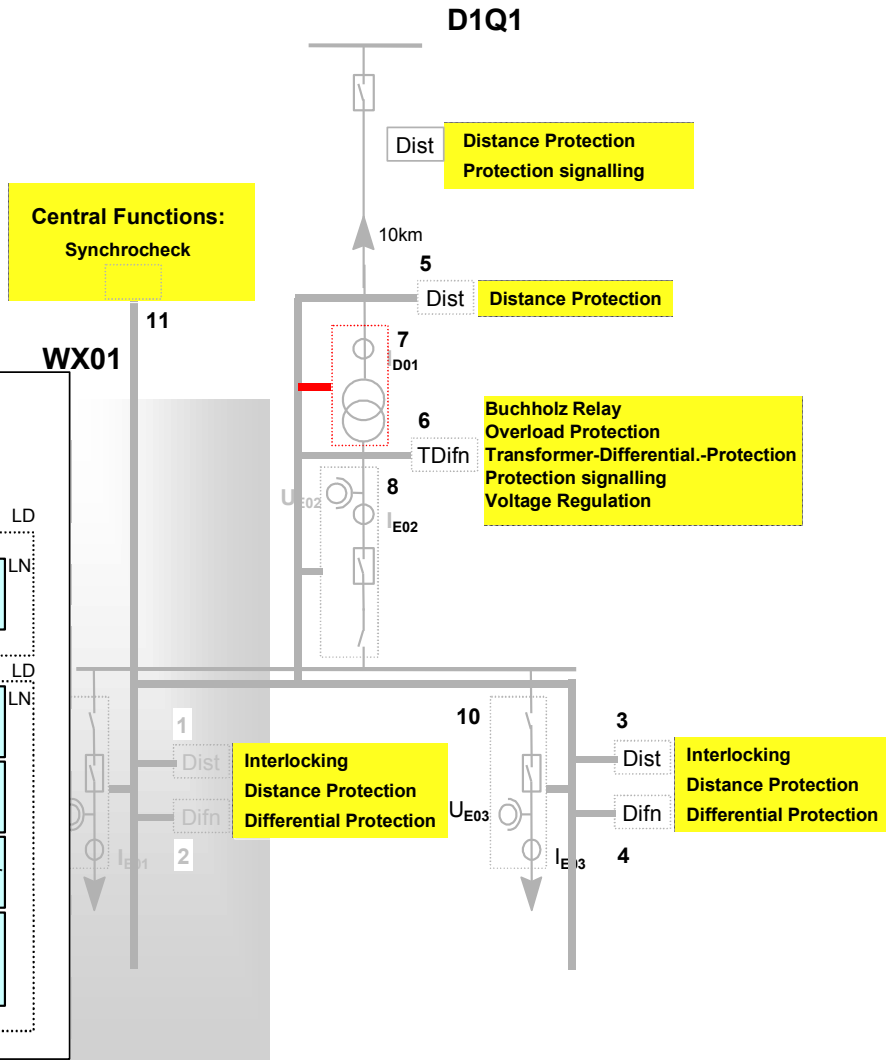
Example T 1-1

Single communications bus

IED for: Transformer bay.

No.	Name	ID
7	Trafo Bay1	D1Q1SB1





- Podržani servisi

```
<IED name="E1Q1SB1">
  <Services>
    <ClientServices goose="true" sv="true" />
    <DynAssociation />
    <GetDirectory />
    <GetDataObjectDefinition />
    <GetDataSetValue />
    <DataSetDirectory />
    <ConfDataSet max="4" maxAttributes="50" />
    <ReadWrite />
    <ConfReportControl max="12" />
    <GetCBValues />
    <ConfLogControl max="1" />
    <ReportSettings cbName="Conf" datSet="Conf" rptID="Dyn" optFields="Conf" bufTime="Dyn" intgPd="Dyn" />
    <GSESettings cbName="Conf" datSet="Conf" appID="Conf" />
    <GOOSE max="2" />
    <SMVSettings cbName="Conf" datSet="Conf" optFields="Fix" smpRate="Conf" svID="Conf">
                <SmpRate>80</SmpRate>
                <SmpRate>240</SmpRate>
        </SMVSettings>
    <FileHandling />
    <ConfLNs fixLnInst="true" />
  </Services>
```

IEC 61850-6 – Primjer SCL (Uređaj)

- Postavke servisa:

```
<AccessPoint name="S1">
  <Server>
    <Authentication none="true" />
    <LDevice inst="C1">
      <LN0 inst="" lnClass="LLN0" lnType="LN0">
        <DataSet name="Positions">
          <FCDA ldInst="C1" prefix="" lnClass="CSWI" lnInst="1" doName="Pos" fc="ST" />
          <FCDA ldInst="C1" prefix="" lnClass="CSWI" lnInst="2" doName="Pos" fc="ST" />
        </DataSet>
        <DataSet name="Measurands">
          <FCDA ldInst="C1" prefix="" lnClass="MMXN" lnInst="1" doName="Amp" fc="MX" />
          <FCDA ldInst="C1" prefix="" lnClass="MMXN" lnInst="1" doName="Volt" fc="MX" />
        </DataSet>
        <DataSet name="smv">
          <FCDA ldInst="C1" prefix="" lnClass="TVTR" lnInst="1" doName="Vol" daName="instMag" fc="MX" />
        </DataSet>
        <ReportControl name="PosReport" rptID="E1Q1Switches" datSet="Positions" confRev="1">
          <TrgOps dchg="true" qchg="true" />
          <OptFields />
          <RptEnabled max="5">
            <ClientLN iedName="A1KA1" ldInst="none" lnInst="1" lnClass="IHMI" />
          </RptEnabled>
        </ReportControl>
```

IEC 61850-6 – Primjer SCL (Podaci)

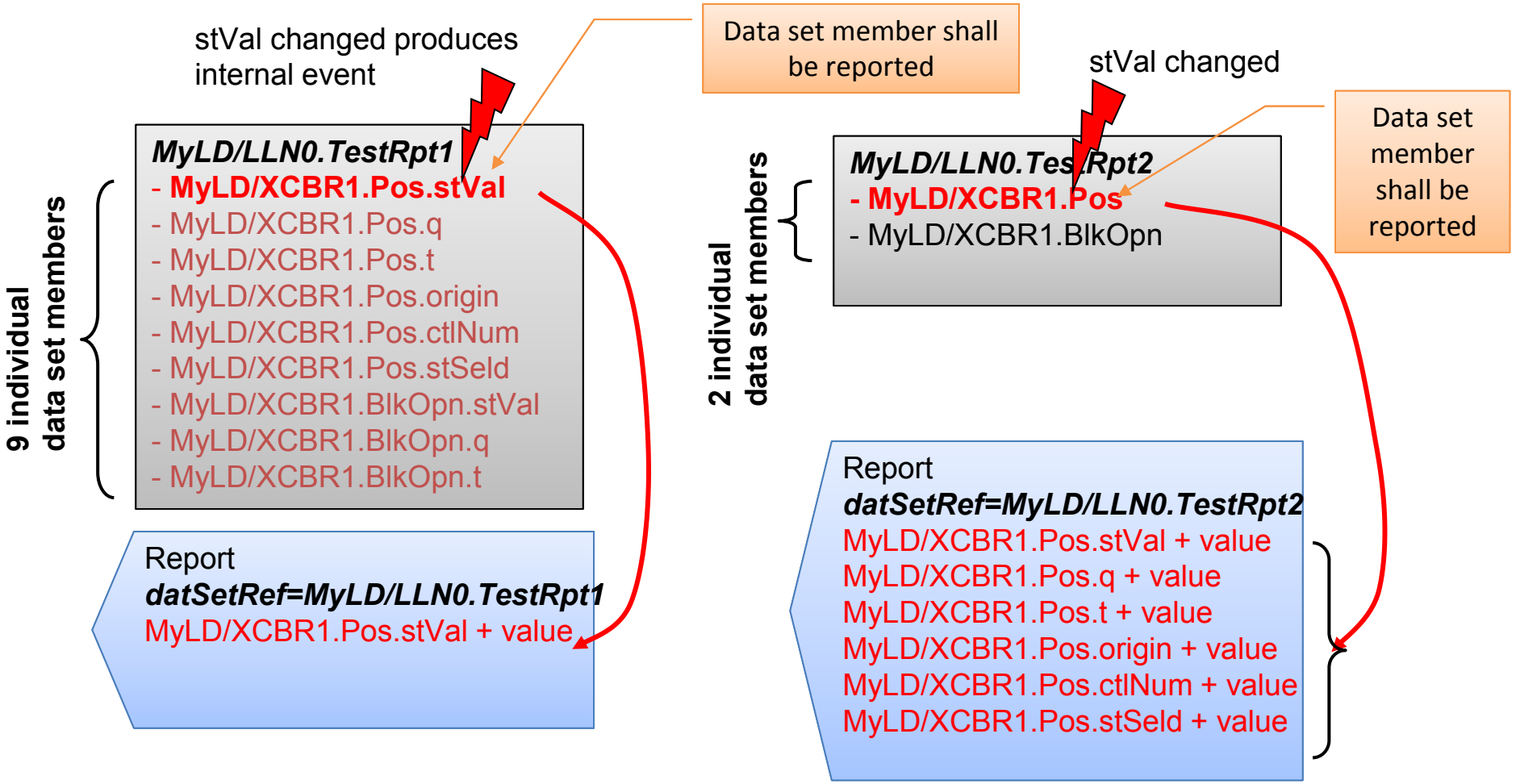
- Tipovi podataka:

```
<DataTypeTemplates>
  <LNodeType id="LN0" lnClass="LLN0">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myBeh" />
    <DO name="Health" type="myHealth" />
    <DO name="NamPlt" type="myLN0LPL" />
  </LNodeType>
  <LNodeType id="LPHDa" lnClass="LPHD">
    <DO name="PhyNam" type="myDPL" />
    <DO name="PhyHealth" type="myINS" />
    <DO name="Proxy" type="mySPS" />
  </LNodeType>
  <LNodeType id="CSWIa" lnClass="CSWI">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myBeh" />
    <DO name="Health" type="myHealth" />
    <DO name="NamPlt" type="myLPL" />
    <DO name="Pos" type="myPos" />
  </LNodeType>
  <LNodeType id="MMXNa" lnClass="MMXN">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myHealth" />
    <DO name="Health" type="myBeh" />
```

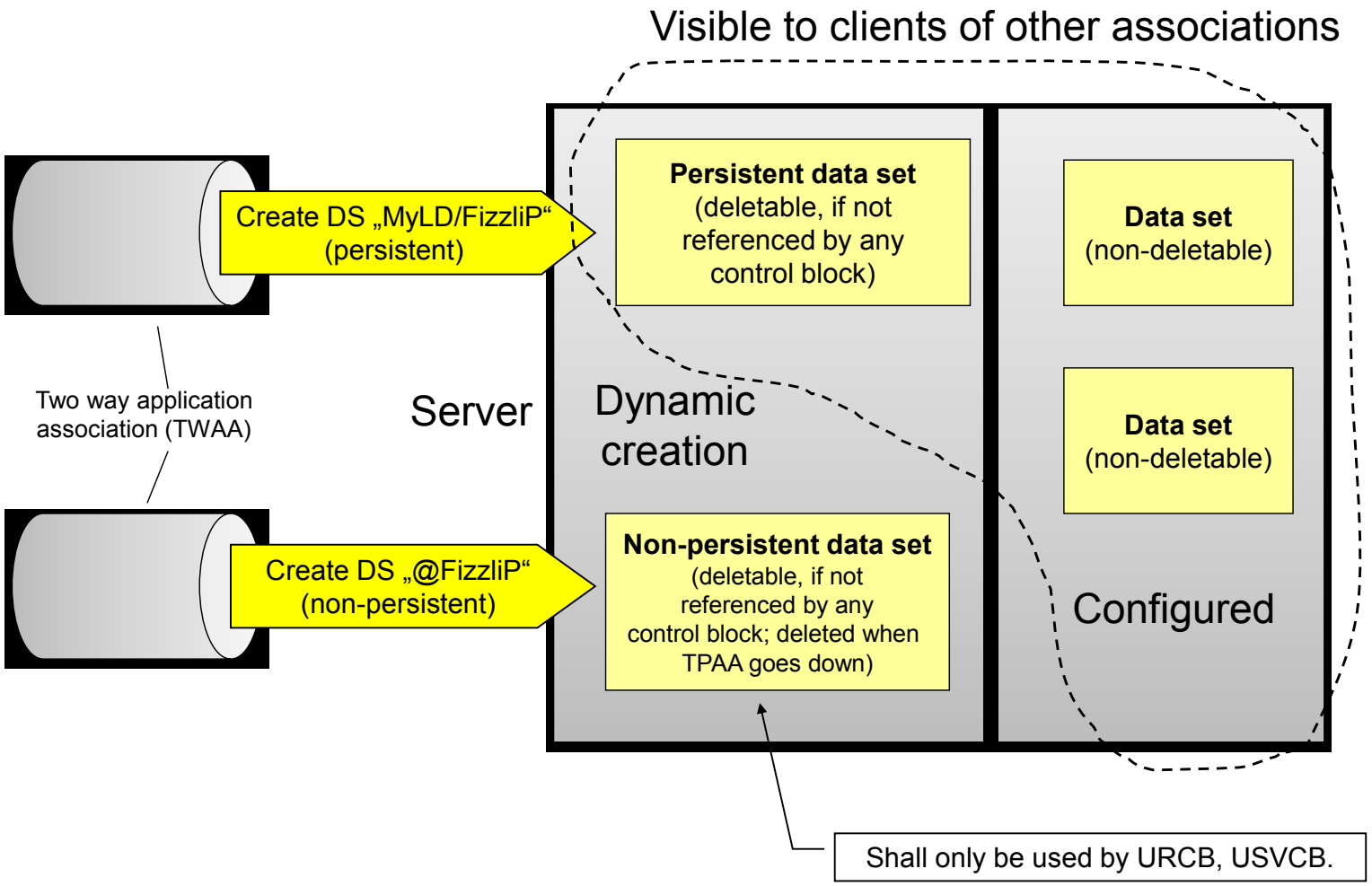
- Enumeratori:

```
<EnumType id="SIUnit">
        <EnumVal ord="1"/>
        <EnumVal ord="2">m</EnumVal>
        <EnumVal ord="3">kg</EnumVal>
        <EnumVal ord="4">s</EnumVal>
        <EnumVal ord="5">A</EnumVal>
        <EnumVal ord="6">K</EnumVal>
        <EnumVal ord="7">mol</EnumVal>
        <EnumVal ord="8">cd</EnumVal>
        <EnumVal ord="9">deg</EnumVal>
        <EnumVal ord="10">rad</EnumVal>
        <EnumVal ord="11">sr</EnumVal>
        <EnumVal ord="21">Gy</EnumVal>
        <EnumVal ord="22">q</EnumVal>
        <EnumVal ord="23">°C</EnumVal>
        <EnumVal ord="24">Sv</EnumVal>
        <EnumVal ord="25">F</EnumVal>
        <EnumVal ord="26">C</EnumVal>
        <EnumVal ord="27">S</EnumVal>
        <EnumVal ord="28">H</EnumVal>
        <EnumVal ord="29">V</EnumVal>
        <EnumVal ord="30">ohm</EnumVal>
        <EnumVal ord="31">J</EnumVal>
        <EnumVal ord="32">N</EnumVal>
        <EnumVal ord="33">Hz</EnumVal>
        <EnumVal ord="34">lx</EnumVal>
        <EnumVal ord="35">Lm</EnumVal>
        <EnumVal ord="36">Wb</EnumVal>
```

IEC 61850 – Dataset



IEC 61850 – Dataset



Postavke i testiranje horizontalne komunikacije

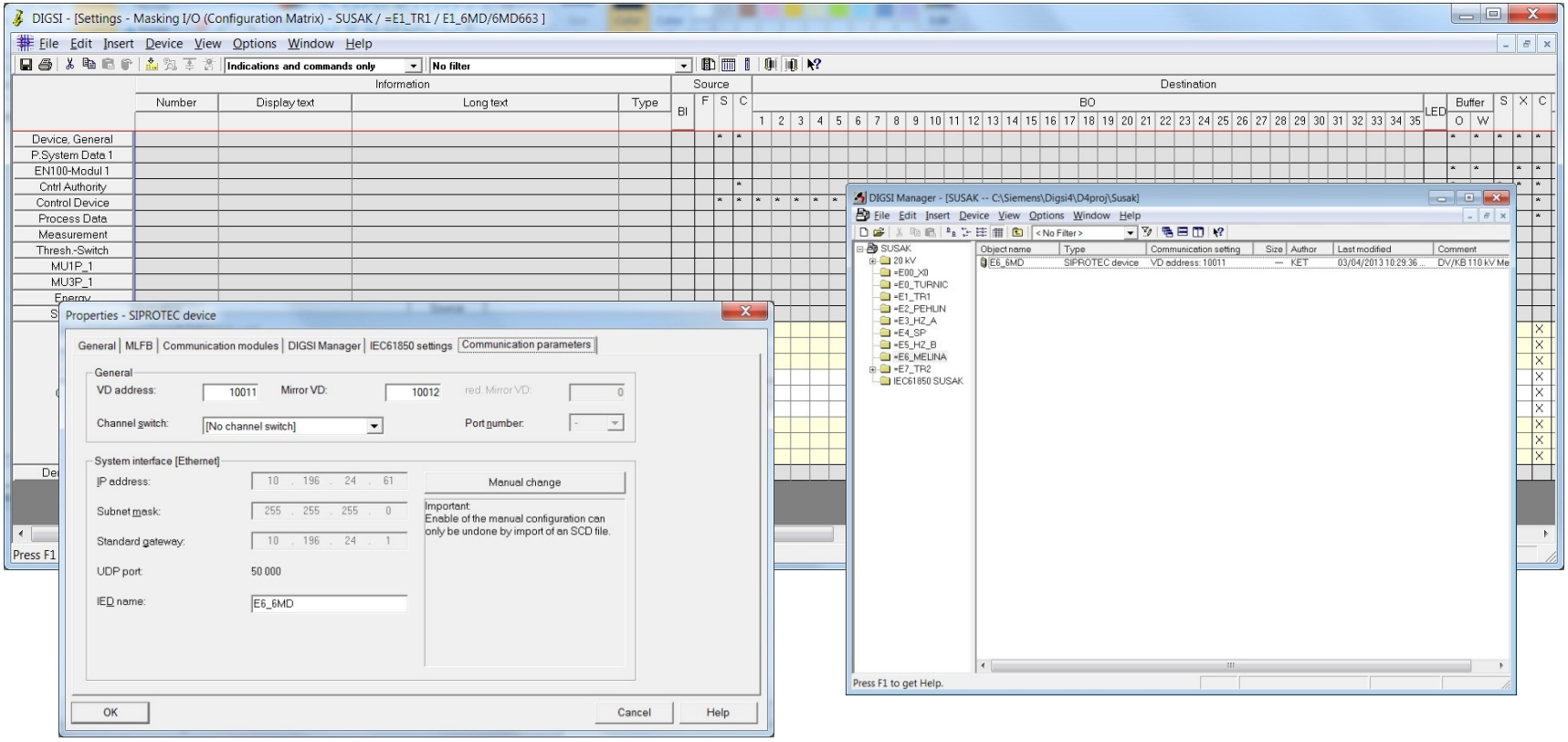
- GOOSE poruke - osnovne primjene:
  - Blokade (eng. *interlocking*)
  - Slanje sklopnih naredbi (eng. *trips*)
  - Zaštita zatajenja prekidača
  - Mjerenja (u svrhu vizualizacije)
  - Međustanična komunikacija (prijenos kriterija distantne zaštite)

Postavke i testiranje horizontalne komunikacije

- Velik broj proizvođača opreme
- Različiti konfiguracijski alati
- Interpretacije standarda
- Vlasnička proširenja konfiguracije
- Primjer za 3 velika proizvođača IEC 61850 uređaja
  - ABB
  - Siemens
  - GE

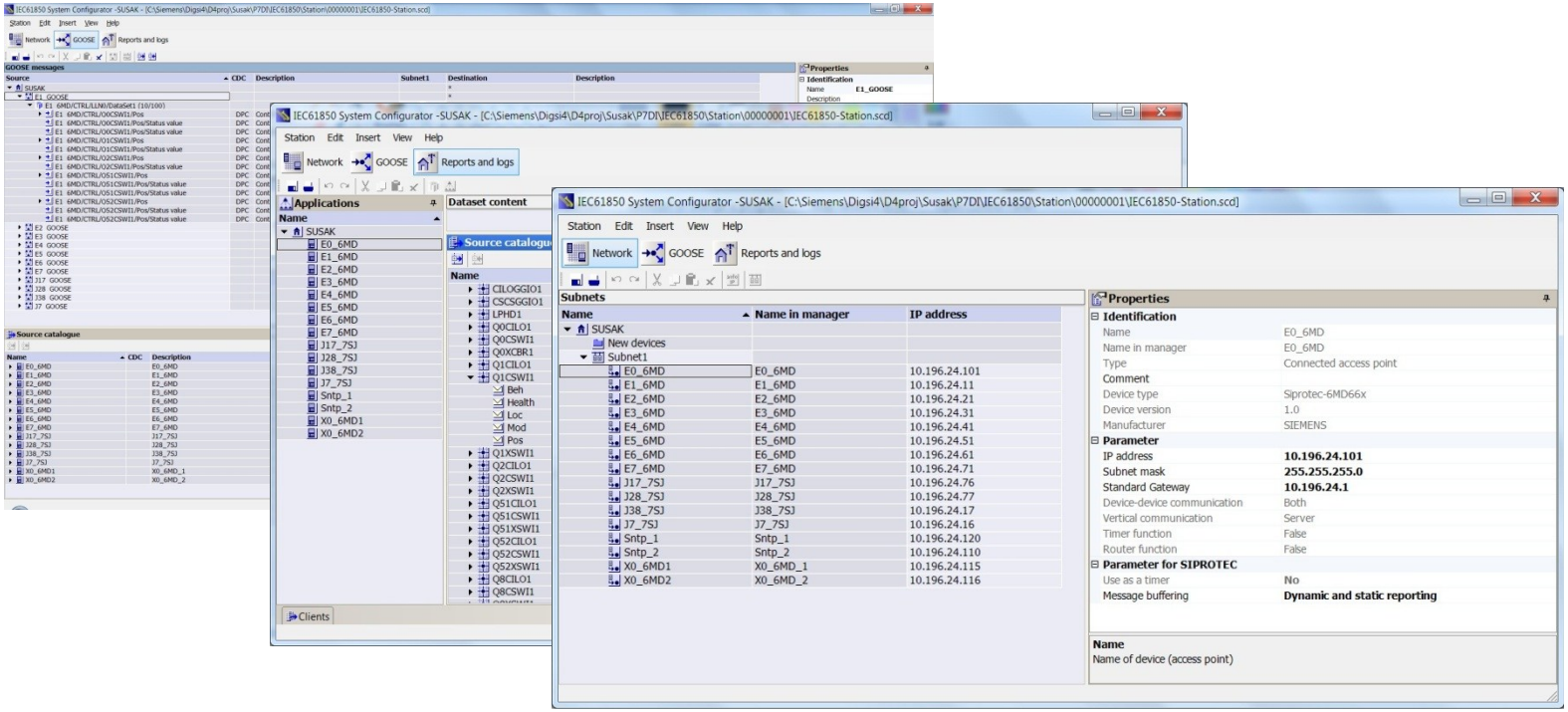
Postavke i testiranje horizontalne komunikacije

- Siemens
  - DIGSI Manager -> Konfiguracija uređaja



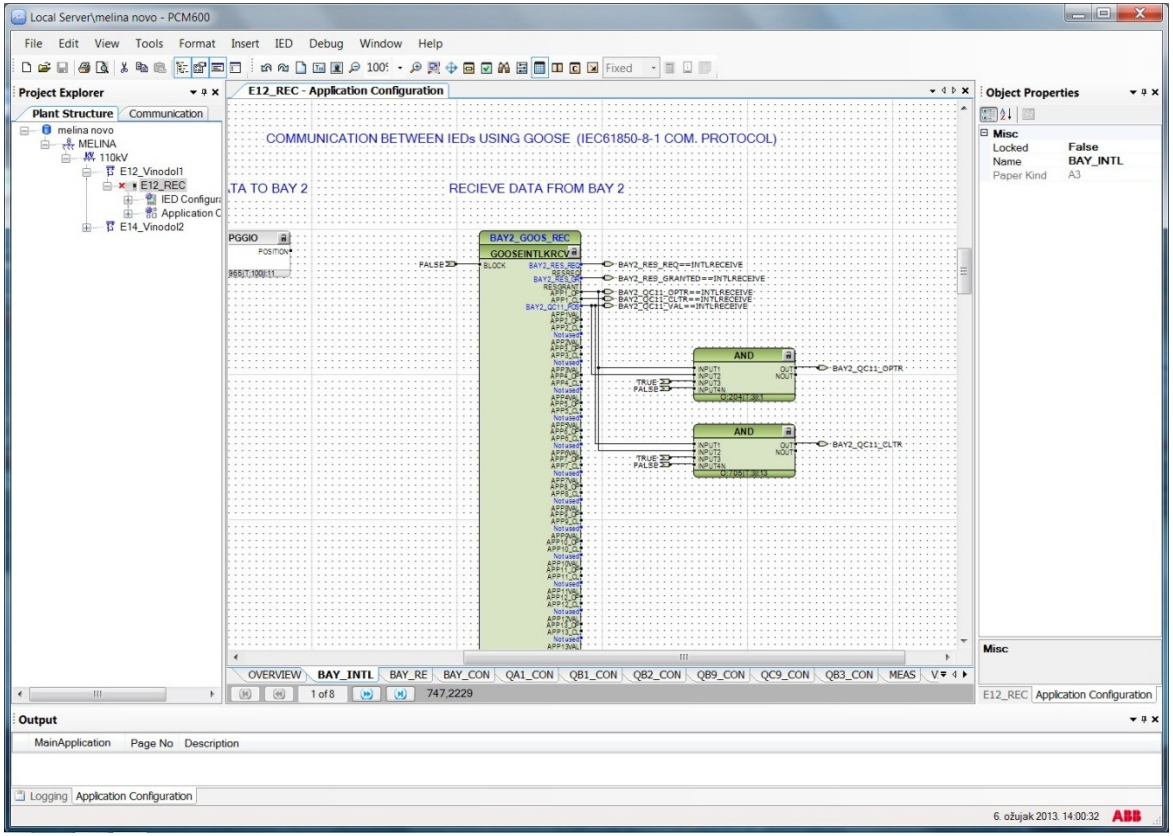
Postavke i testiranje horizontalne komunikacije

- Siemens
  - DIGSI Manager -> Konfiguracija uređaja
  - IEC 61850 System Configurator -> Konfiguracija IEC 61850 postavki



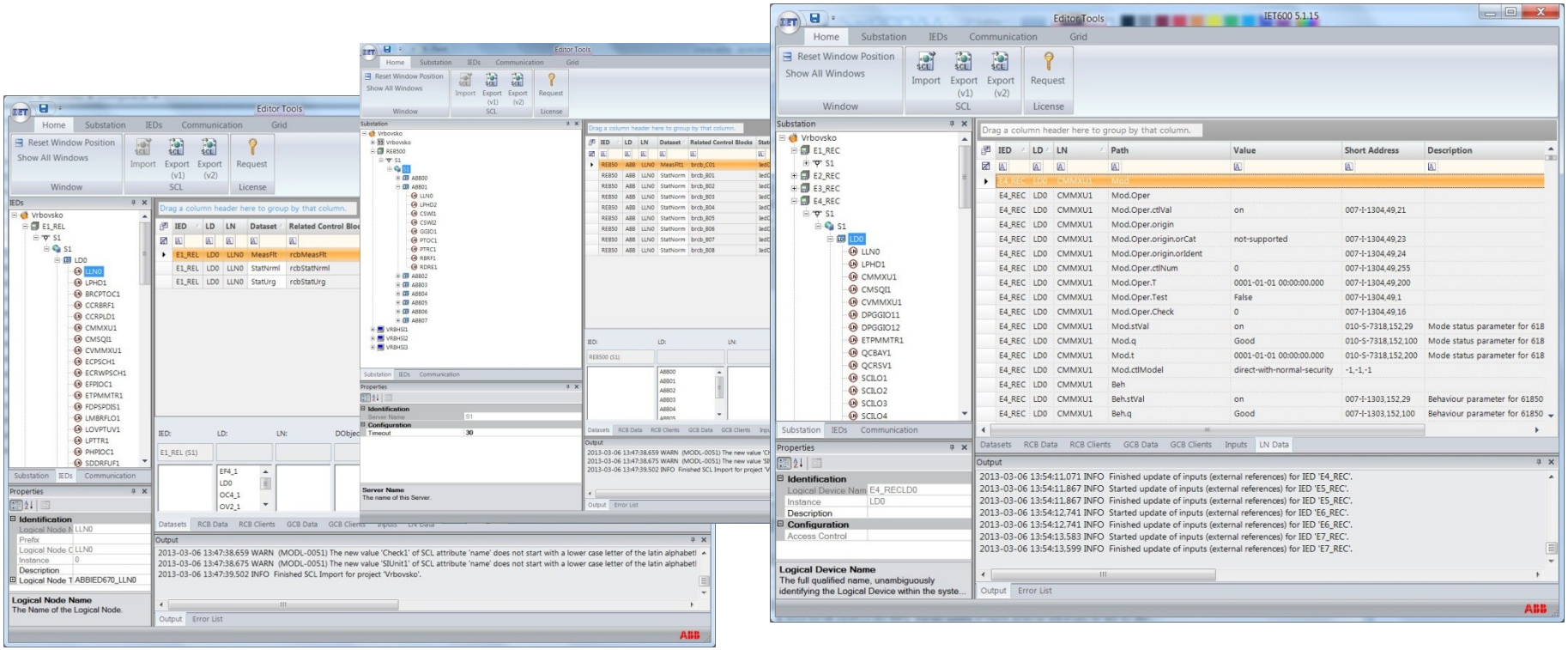
Postavke i testiranje horizontalne komunikacije

- ABB
  - PCM 600 -> Konfiguracija uređaja



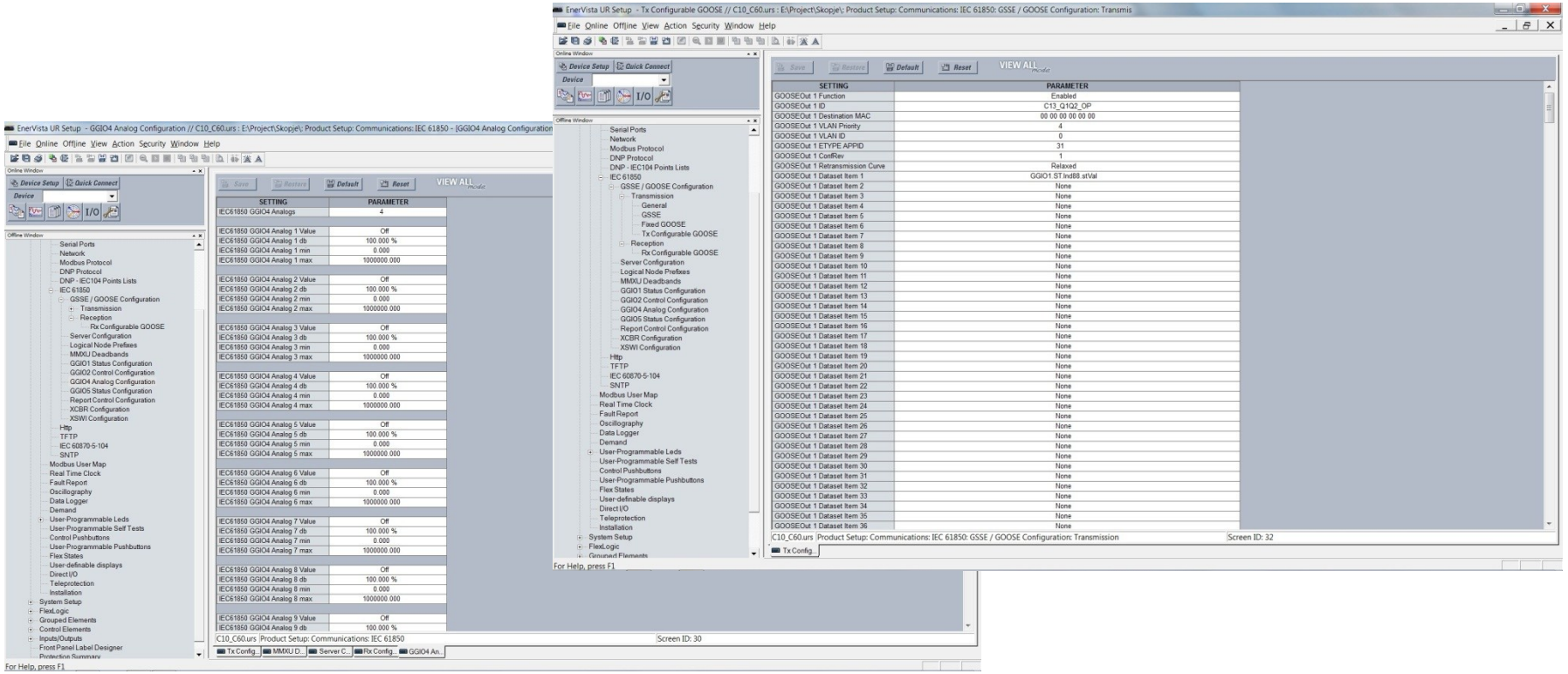
Postavke i testiranje horizontalne komunikacije

- ABB
  - PCM 600 -> Konfiguracija uređaja
  - IET 600 -> Konfiguracija IEC 61850 postavki



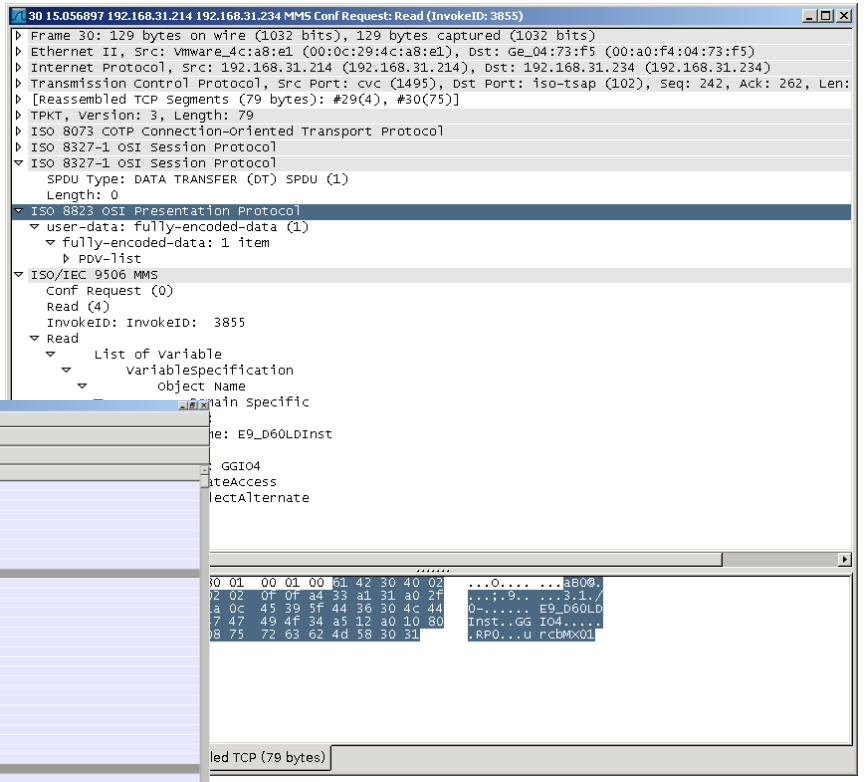
Postavke i testiranje horizontalne komunikacije

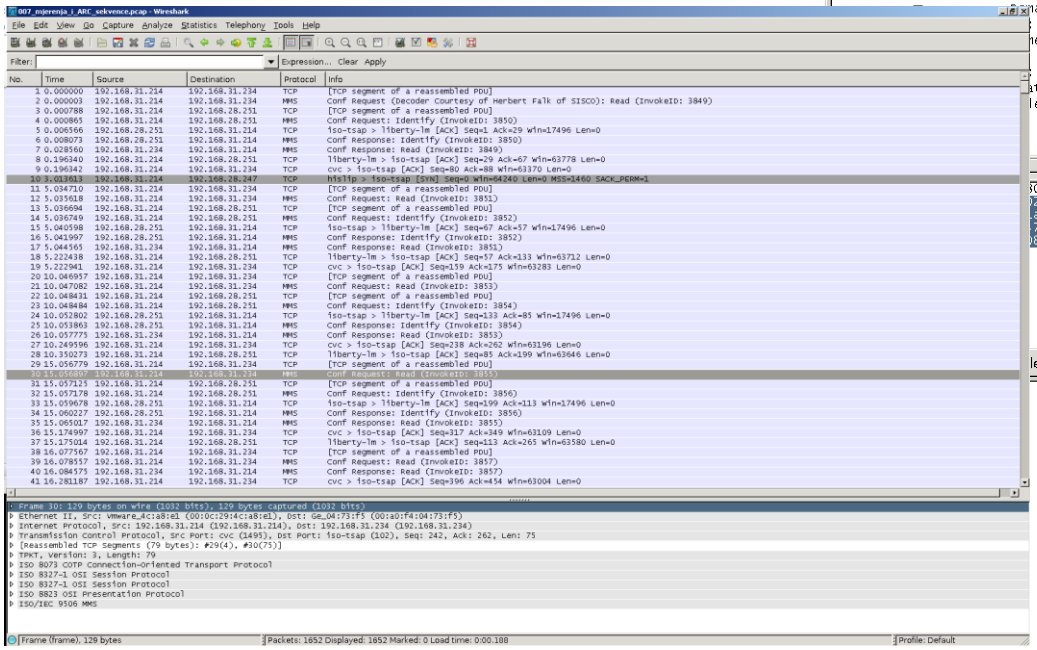
- GE
  - EnerVista-> Konfiguracija uređaja i IEC 61850 postavki



Analiza IEC 61850 komunikacije

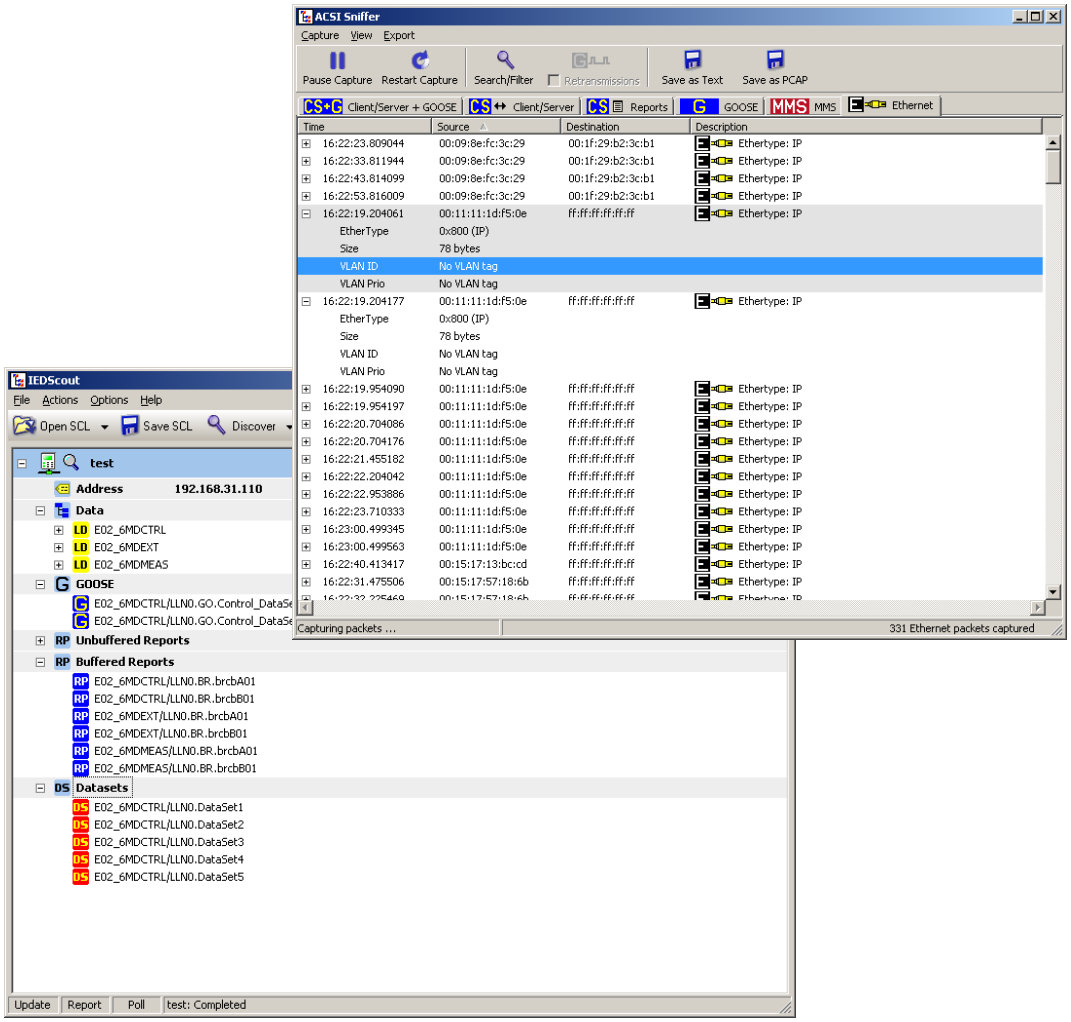
- Analizatori mrežnog prometa
  - Wireshark (Open source)
  - UniCA Analyzer (KEMA)



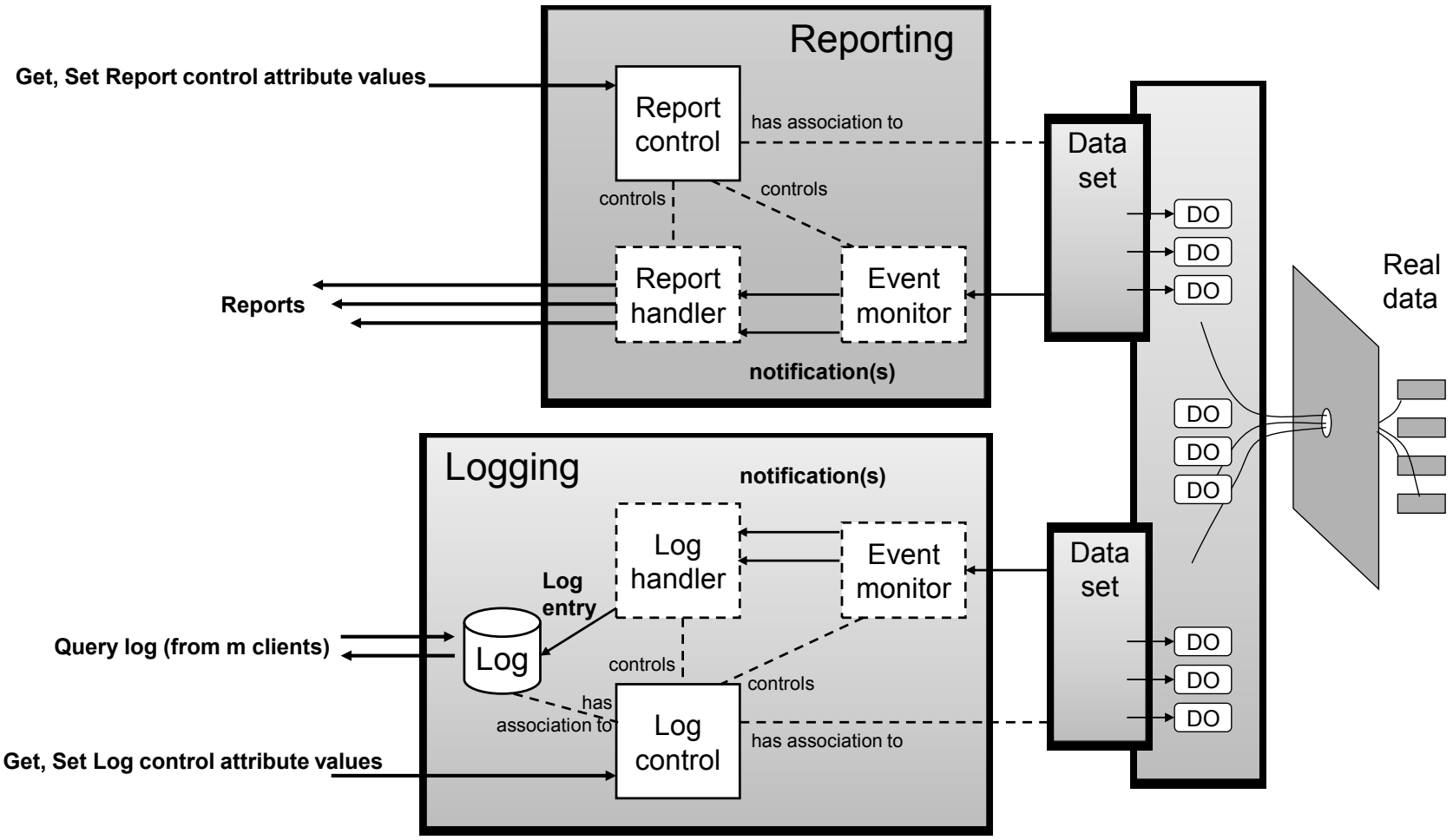


Postavke i testiranje vertiklane komunikacije

- SCADA sustavi
  - MicroSCADA (ABB)
  - SICAM PAS (Siemens)
  - Zenon (COPA-DATA)
  - PROZA NET (Končar)
- Pomoćni alati
  - IED Scout (Omicron)
  - ITT600 (ABB)
  - ACSI Tools (Končar)

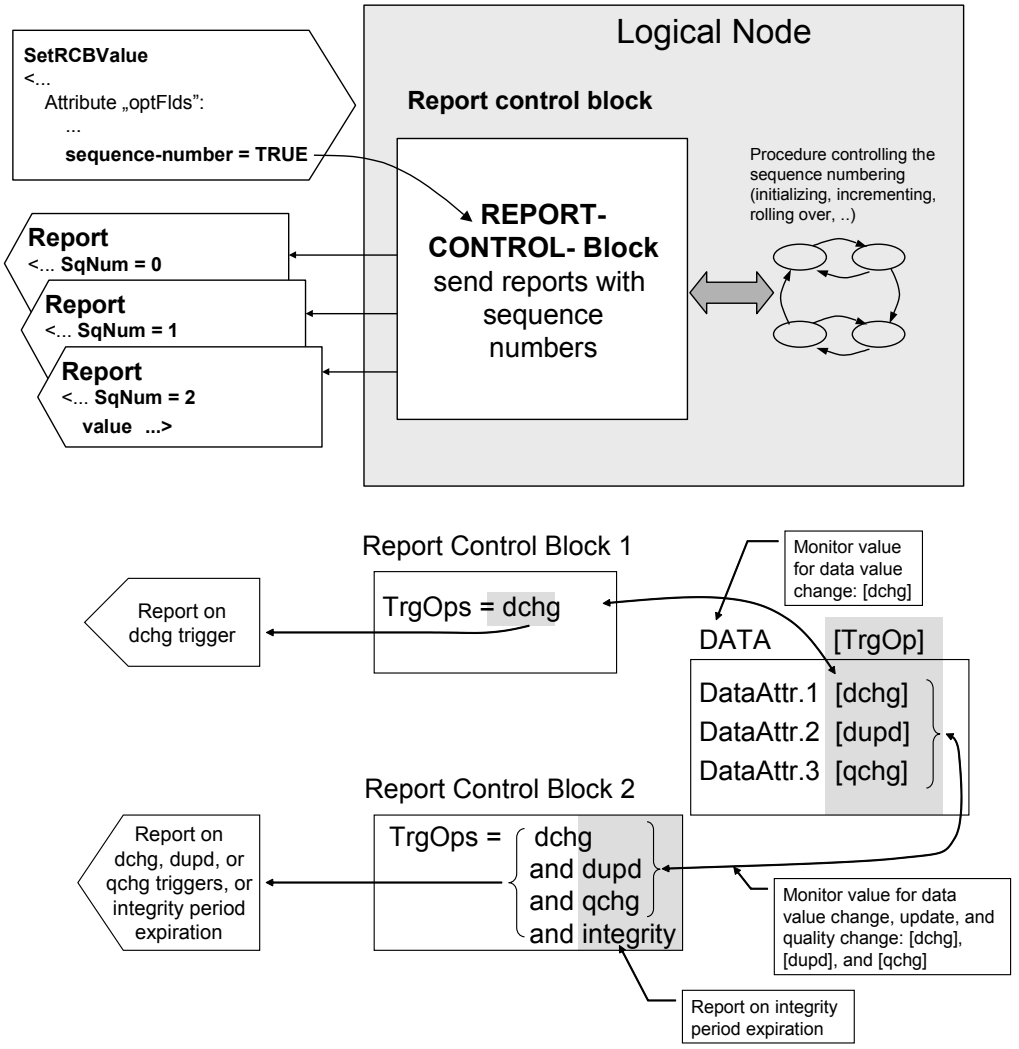


IEC 61850 – Reporting (načela)



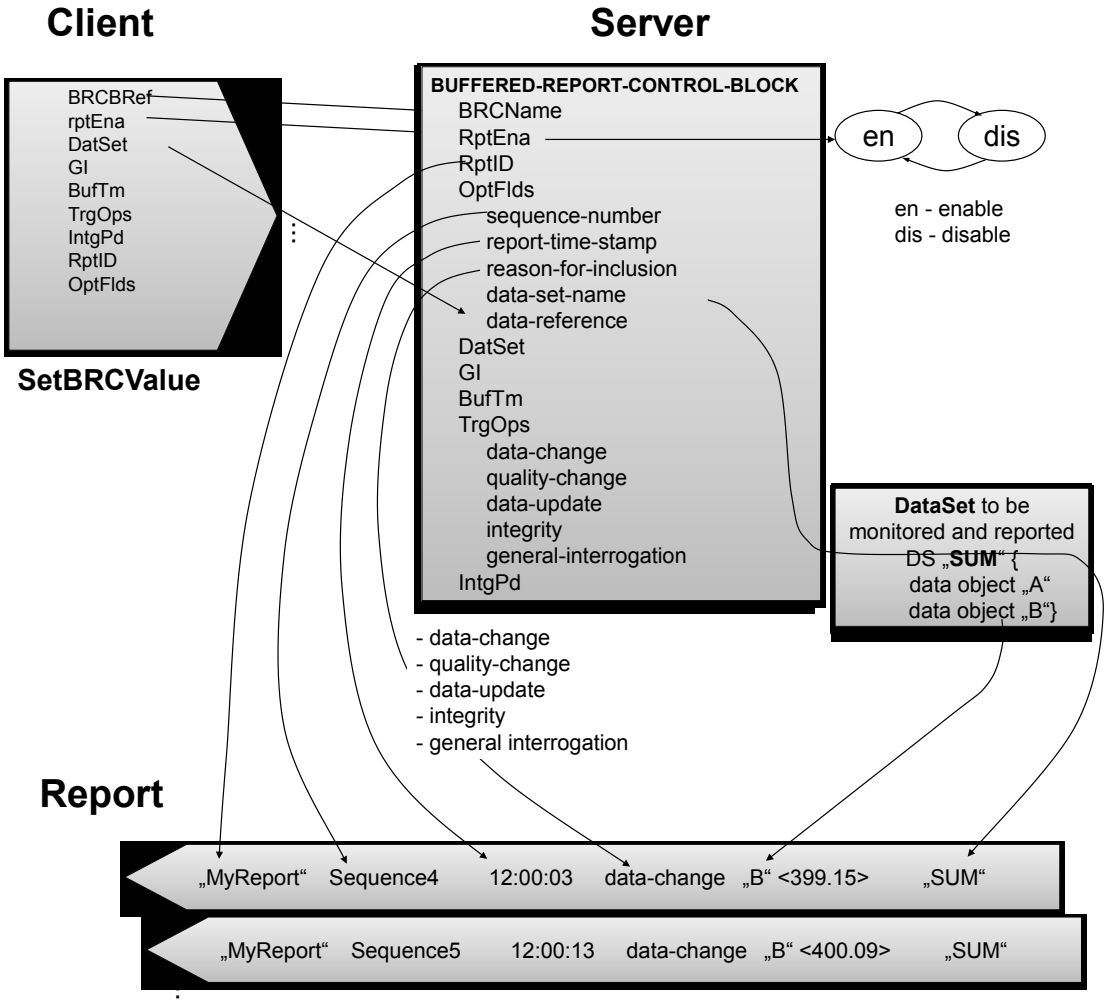
IEC 61850 – Reporting

- Načela dostave
- Slijed akcija
- Uvjeti okidanja
- Dataset postavke
- DA rezolucija
- DO rezolucija



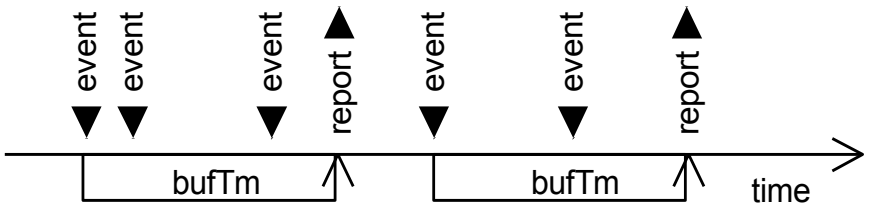
IEC 61850 – Reporting (načela)

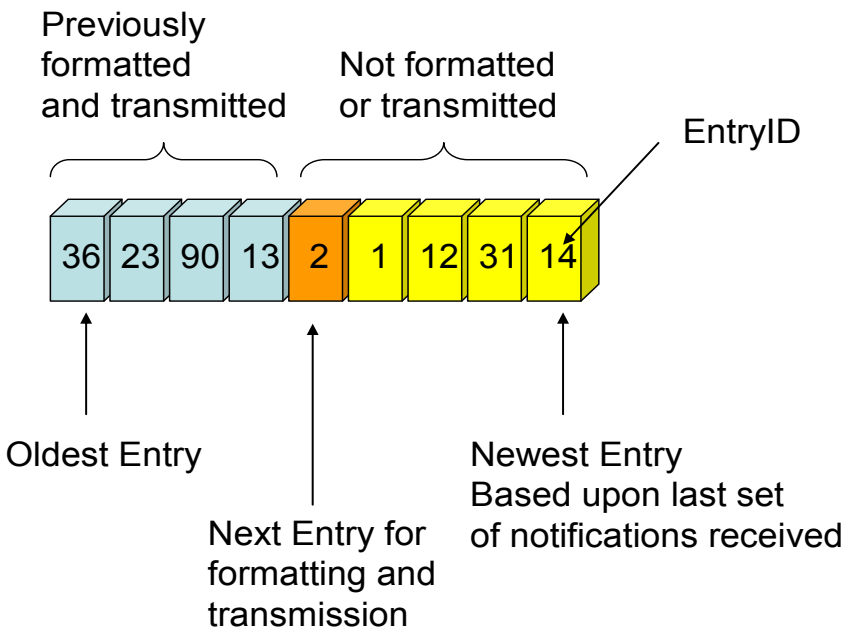
- Načela stvaranja IEC 61850 reporta
- Prilagođavanje postavki



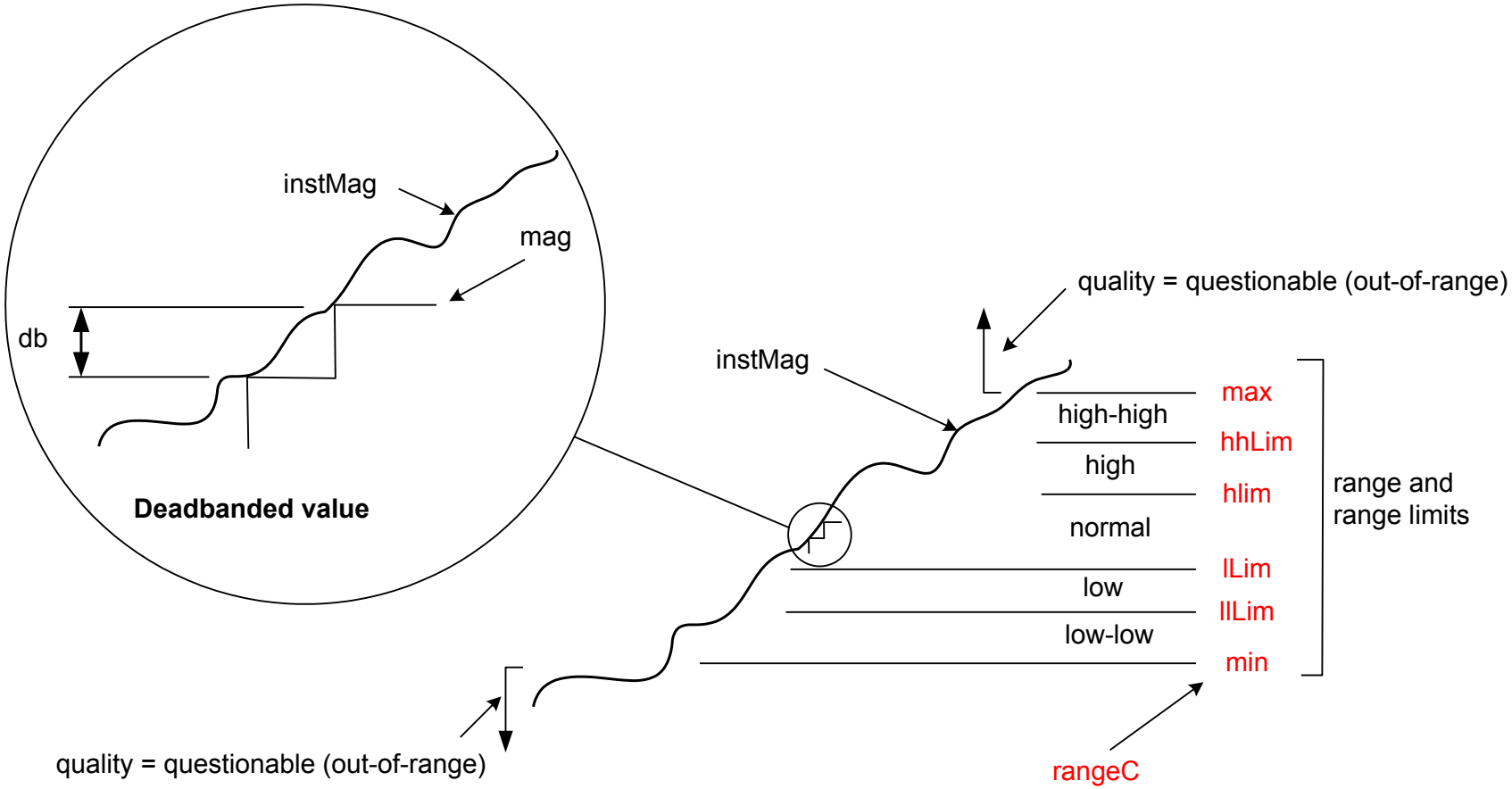
IEC 61850 – Reporting (BRCB vs. URCB)

- (X)RCB
- Međuspemnik (buffer)
- Rad sa spremnikom
- BufTime
- EntryID
- Mjerenja vs. Signali



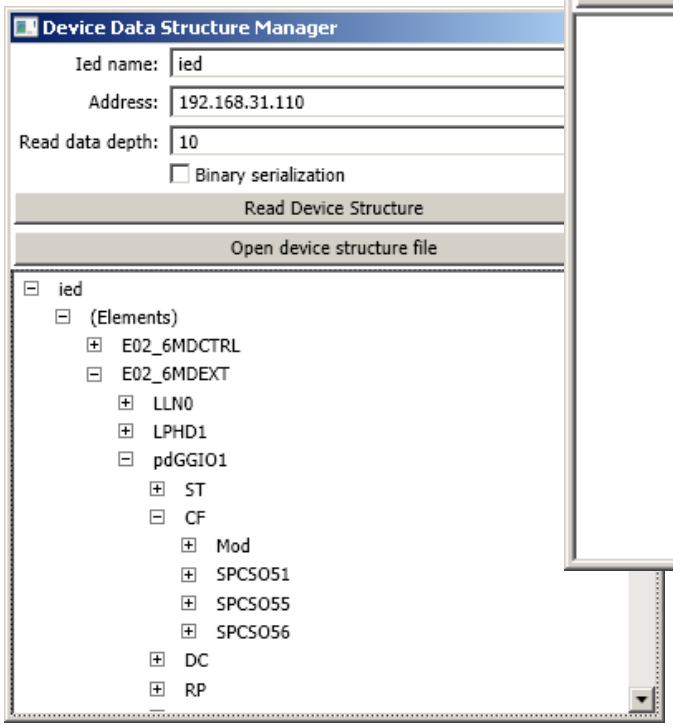


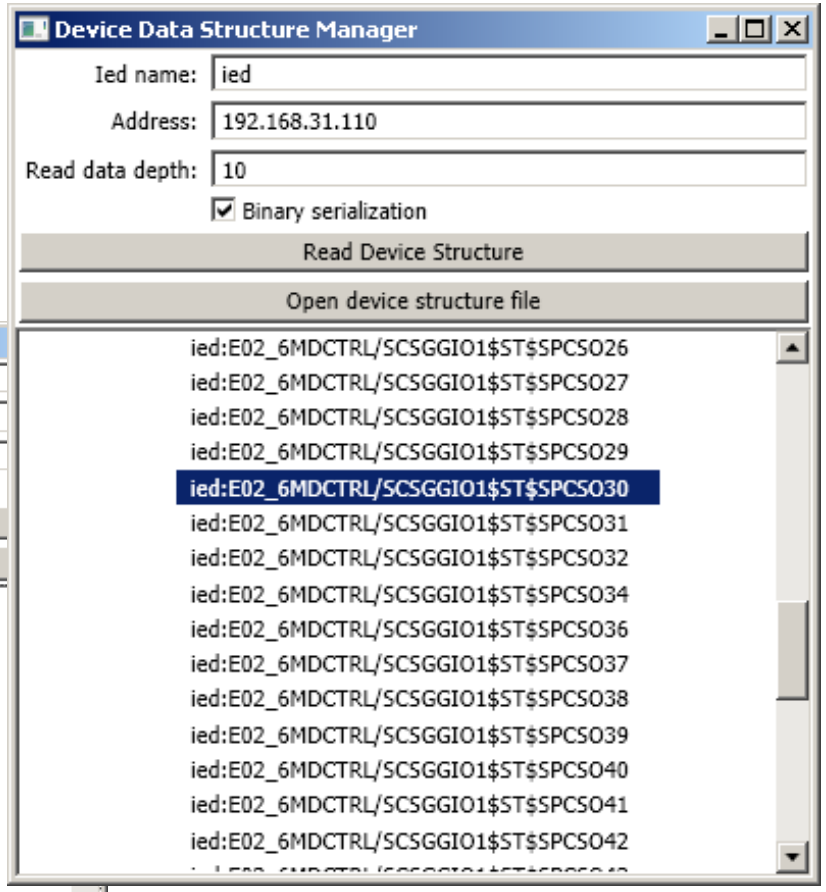
IEC 61850 – Reporting (analogne vrijednosti)



ACSI Tools - IEC 61850 pomoćni alati

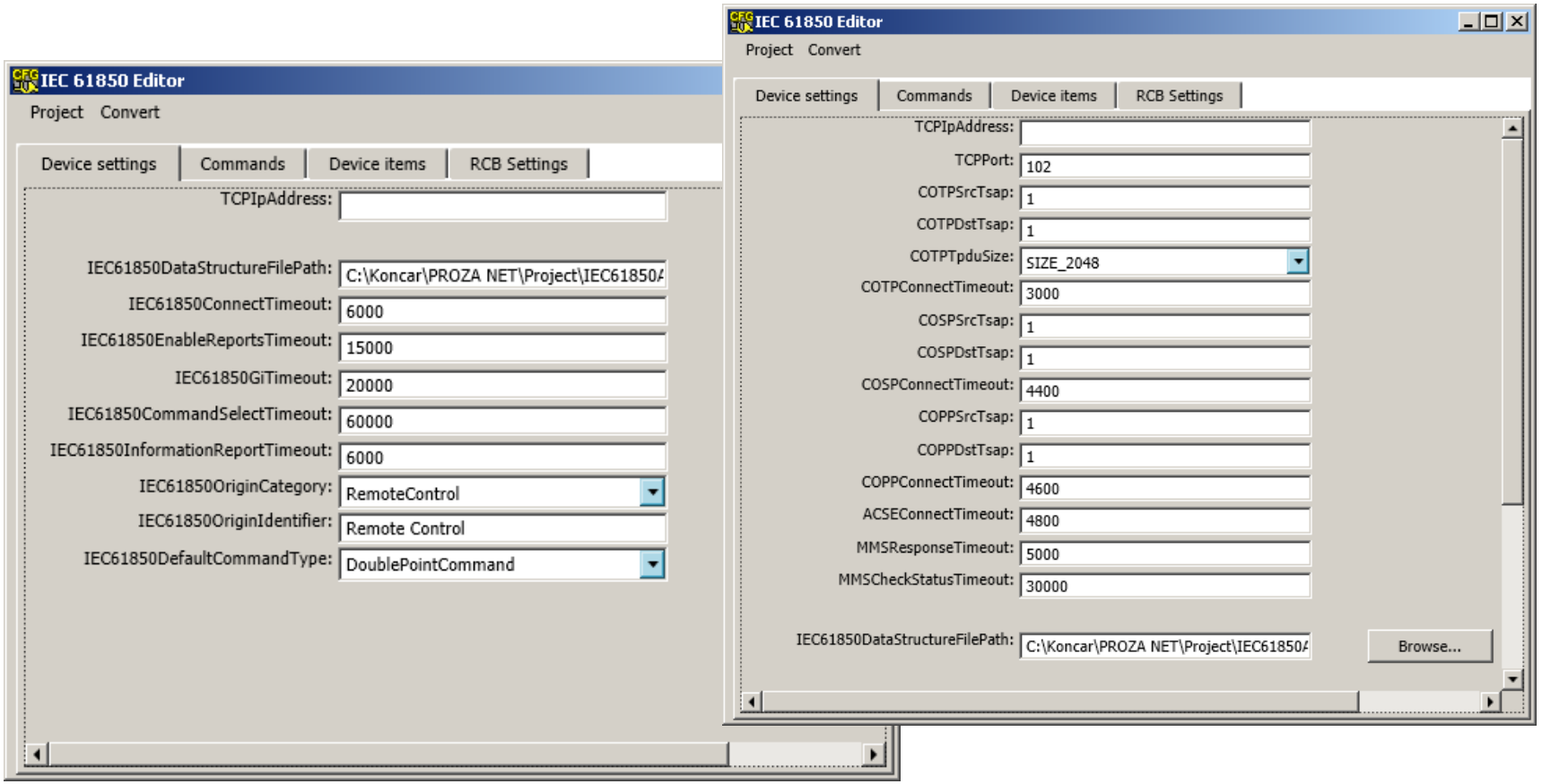
- Device Structure Manager
  - Prikupljanje strukture uređaja
  - Usklađeni format datoteke





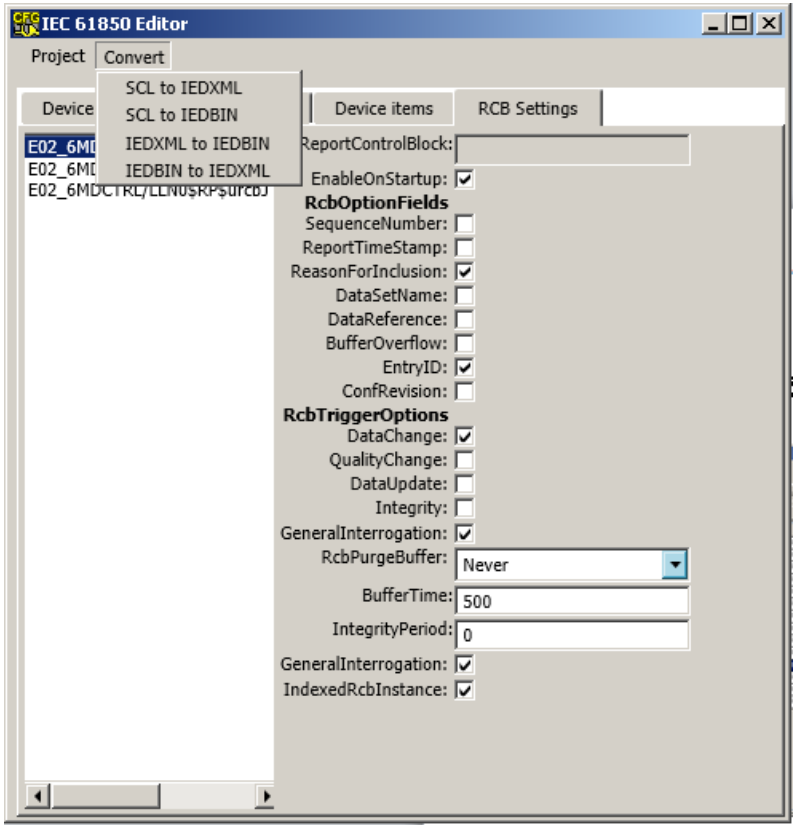
ACSI Tools - IEC 61850 pomoćni alati

- IEC 61850 Editor
  - Uređivanje komunikacijski postavki



ACSI Tools - IEC 61850 pomoćni alati

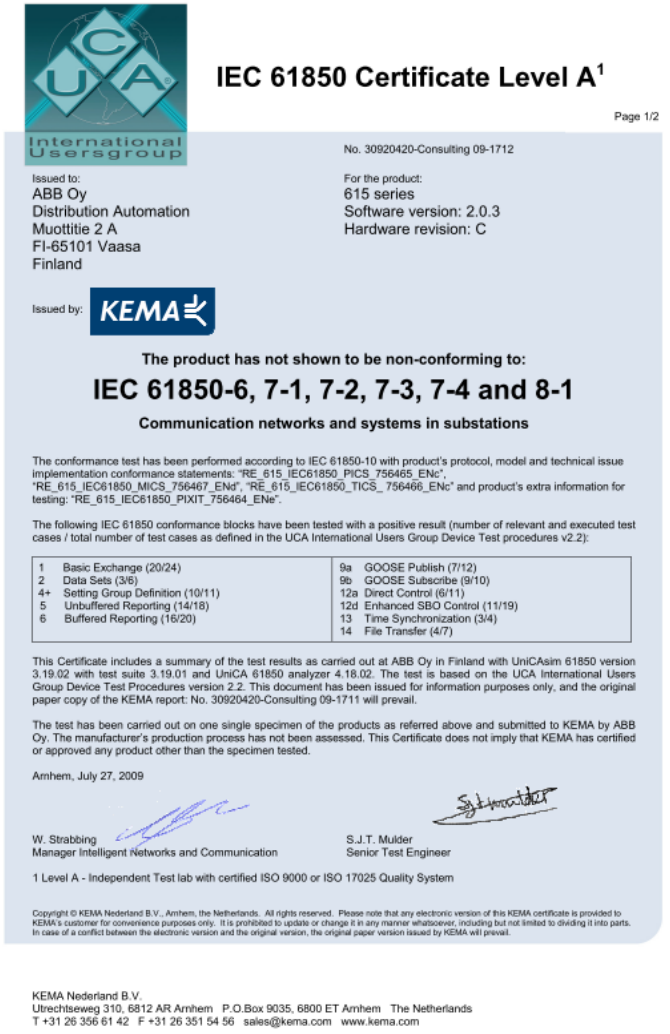
- IEC 61850 Editor
  - Prilagodba i analiza SCL datoteka
  - Analiza <Private> tag-ova
  - Usporedba sa .XSD shemama
  - Stvaranje SCL datoteka sukladnih sa standardnom shemom



Naručivanje opreme

- Certifikati
  - Razine
  - Interpretacija
  - PICS/MICS/PIXIT

1	Basic Exchange (20/24)	9a	GOOSE Publish (7/12)
2	Data Sets (3/6)	9b	GOOSE Subscribe (9/10)
4+	Setting Group Definition (10/11)	12a	Direct Control (6/11)
5	Unbuffered Reporting (14/18)	12d	Enhanced SBO Control (11/19)
6	Buffered Reporting (16/20)	13	Time Synchronization (3/4)
		14	File Transfer (4/7)



IEC 61850 Certificate Level A[1]

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No. 30920420-Consulting 09-1712

Issued to:
ABB Oy
Distribution Automation
Muottitie 2 A
FI-65101 Vaasa
Finland

For the product:
615 series
Software version: 2.0.3
Hardware revision: C

Issued by: KEMA

The product has not shown to be non-conforming to:

IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 with product's protocol, model and technical issue implementation conformance statements: "RE_615_IEC61850_PICS_756465_ENc", "RE_615_IEC61850_MICS_756467_ENd", "RE_615_IEC61850_TICS_756466_ENc" and product's extra information for testing: "RE_615_IEC61850_PIXIT_756464_ENe".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases as defined in the UCA International Users Group Device Test procedures v2.2):

1	Basic Exchange (20/24)	9a	GOOSE Publish (7/12)
2	Data Sets (3/6)	9b	GOOSE Subscribe (9/10)
4+	Setting Group Definition (10/11)	12a	Direct Control (6/11)
5	Unbuffered Reporting (14/18)	12d	Enhanced SBO Control (11/19)
6	Buffered Reporting (16/20)	13	Time Synchronization (3/4)
		14	File Transfer (4/7)

This Certificate includes a summary of the test results as carried out at ABB Oy in Finland with UniCAsim 61850 version 3.19.02 with test suite 3.19.01 and UniCA 61850 analyzer 4.18.02. The test is based on the UCA International Users Group Device Test Procedures version 2.2. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 30920420-Consulting 09-1711 will prevail.

The test has been carried out on one single specimen of the products as referred above and submitted to KEMA by ABB Oy. The manufacturer's production process has not been assessed. This Certificate does not imply that KEMA has certified or approved any product other than the specimen tested.

Arnhem, July 27, 2009

W. Strabbing
Manager Intelligent Networks and Communication

S.J.T. Mulder
Senior Test Engineer

1 Level A - Independent Test lab with certified ISO 9000 or ISO 17025 Quality System

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Naručivanje opreme

depicted in Annex A.

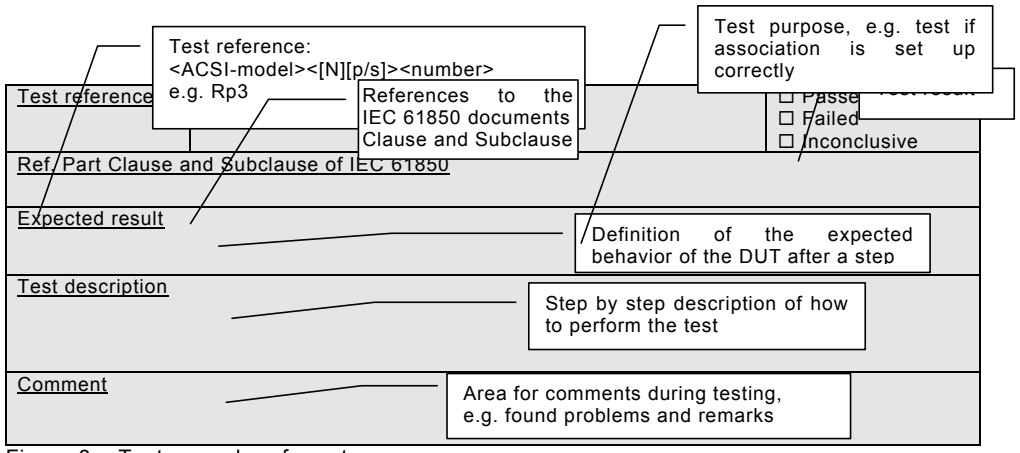

Figure 3 – Test procedure format

IEC 600/05

Applicable Test Procedures from the UCA International Users Group Device Test Procedures version 2.2

Conformance Block	Mandatory	Conditional
1: Basic Exchange	Ass1, Ass2, Ass3, AssN2, AssN3, AssN4, AssN5 Srv1, Srv2, Srv3, Srv4, Srv5, SrvN1abcd, SrvN4	Srv6, Srv7, Srv8, SrvN1e, SrvN2, SrvN3
2: Data Sets	Dset1, Dset10a, DsetN1ae	
4+: Setting Group Definition	Sg1, Sg2, Sg3a, Sg3b, Sg4 SgN1a, SgN1b, SgN2, SgN3, SgN4	
5: Unbuffered Reporting	Rp1, Rp2, Rp3, Rp4, Rp7, Rp10 RpN1, RpN2, RpN3, RpN4	Rp5, Rp8, RpN5, RpN6
6: Buffered Reporting	Br1, Br2, Br3, Br4, Br7, Br8, Br9, Br12 BrN1, BrN2, BrN3, BrN4, BrN5	Br5, Br10, BrN6
9a: GOOSE publish	Gop2, Gop3, Gop4, Gop7	Gop1, Gop6, GopN1
9b: GOOSE subscribe	Gos1a, Gos2, Gos3, GosN1, GosN2, GosN3, GosN4, GosN5, GosN6	
12a: Direct control	CltN3, CtlN8, DOns1, DOns3	Ctl2, CtlN11
12d: Enhanced SBO control	Ctl3, CtlN1, CtlN2, CtlN3, CtlN4, CtlN9 SBOes1, SBOes2, SBOes3	Ctl2, CtlN11
13: Time sync	Tm1, Tm2, TmN1	
14: File transfer	Ft1, Ft2ab, FtN1ab, Ft4	Ft2c, FtN1c

The conformance test was executed with following 615 series IED variants using the same software version and hardware revision.

REF615, RED615, RET615 and REM615

Zaključak

- IEC 61850 ed1.0 -> ed2.0
- Usklađivanje proizvođača
- Pomoćni alati kao integralni dio sustava
- Nove metodologije konfiguriranja uređaja i aplikacija
- „*Plug-and-play*” načela integracije
- Jedinstveni pristup u automatizaciji budućih postrojenja EES-a