

Training modules for public and in-house training courses

IEC 61850, IEC 61400-25, IEC 60870-5/-6, IEC 61968/70 CIM, DNP3, ...

The following list contains the most asked modules of our training services with regard to standards related to power system automation. Depending on the needs of our customers we select the modules to provide the most crucial information for the experts of the customers.

[S-00] – General

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| 00 | Welcome and opening | Welcome, opening, roll call of attendees, expectations of attendees, Title and scope of IEC 61850 (IEC TC 57), Power Delivery System, What does IEC 61850 provide?, Motivation for the new standards, IEC 61850 in brief, Re-use of IEC 61850, Tools and System Integration, Standardization and projects, General observations. |
| 01 | Summary | Summary and next steps |

[S-01] – Management and automation of the power system (basics)

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| 00 | Power system automation basics | Basics of power system information integration and automation covering control centers, substations, power generation; Elements of the power system: Substations, Power Generation, Transmission, Distribution, System architecture, Functions, Communications, System engineering, and device configuration |
| 01 | Standardization | IEC activities related to power system standardization, IEC TC 57 and TC 88, International organizations for the power industry, IEC organization and standardization work, IEC activities related to the power industry, CIGRE, IEEE, UCA Users Group, IEC 61400 User Group, activities related to the power industry; international fieldbus |
| 02 | System design and specification | Introduction Substation automation system specification, Product requirements for communication equipment from IEC 61850-4, product requirements from IEC 61850-3, substation automation system design |
| 03 | System migration aspects and role of system integrator | Stepwise migration from existing systems to solutions compliant to standards, project and migration planning, ...; roles of users, vendors and system integrators |
| 04 | Security | Secure communication (data on travel and data stored) (IEC 62351), IED security (IEEE 1686), IEC/TS 62443-1, NERC CIP (critical infrastructure protection), VDE Guideline |
| 05 | System management | Revision control and asset management with IEC 61850 |
| 06 | Testing devices and systems | Test coverage and steps towards system testing and simulation (from devices to systems) |
| 07 | Power Delivery System Basics | Brief Introduction to Power Delivery System and relations to standards from IEC TC 57 and TC 88; mainly intended to give an overview of the power delivery system and power system automation for non-utility experts. |

[S-02] – IEC 61850 (and IEC 61400-25) basics

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| 00 | IEC 61850 series – overview | Communication networks and systems for power system automation: general introduction on whole series.
Design objectives and scope IEC 61850, Content and structure of IEC 61850, Features of IEC 61850, Application modeling, Information exchange and communication services, the 16 parts of the standard |
| 01 | IEC 61850 Application modeling principles | Modeling protection, substation automation, other applications (Logical nodes, data and data attributes, function modeling, extension of the models, monitoring).
The elements of the data model, Acquisition of measured information, Controlling of switchgear equipment, Protection functions, Edition 2 updates, Example of a model. |
| 02 | IEC 61850-6 engineering process | Engineering process using the configuration language: from IEDs and single line diagram to configured substation automation system
Systems specification (Single line diagram and functions), IED specification (IED capability description), System engineering, IED engineering and configuration, Use of SCL (summary), Edition 2. |

03	Communication services of IEC 61850	Information exchange with the ACSI according to IEC 61850-7-2 Basics, Information flow through IEDs, ACSI in detail (IEC 61850-7-2), Server, Logical Device, Logical Node, Data, DataSet, Control Blocks (Reporting, Logging, GOOSE, SV), Control, Conformance statement, Recording (IEC 61850-7-4).
04	Implementation of IEC 61850 conformant devices and tools	Device models, design of advanced IEDs, software and hardware architectures, OEM software
05	Device conformance testing	Conformance testing of devices according to IEC 61850-10
06	Extension rules IEC 61850	The extension rules for Logical Nodes, Data, and Common Data Classes, the name space concept. Scope, Instantiation of existing information model classes, New information models, Name space concept.
07	Substation configuration language (SCL)	System configuration language: basics and details; Engineering process and SCL, SCL object model, SCL syntax (IEC 61850-6 (SCL)), SCL edition 2. The object model and content of the SCL files, Examples, Binding models to real world, inputs, and to outputs, the data flow engineering
08	Common Data Classes (Ed2)	What is new in part IEC 61850-7-3 Edition 2? New possibilities for information modelers.
50	Mapping of Common Data Classes (CDC) to IEC 60870-5-101/104 according to IEC 61850-80-1	Introduction and details of IEC 61850-80-1. The Technical Specification IEC 61850-80-1 gives a guideline on how to exchange information from a CDC based data model (IEC 61850) using IEC 60870-5-101 or IEC 60870-5-104 protocols between substation(s) and control center(s).

[S-03] – Substation automation and protection

00	IEC 61850 modeling details	Modeling of protection, switchgear, metering and power quality equipment and other substation automation applications. Basic principles, Protection functions, Protection related functions, Control, Example
01	Applying IEC 61850 for power system automation – use cases	Use cases from power system automation like measuring of current and voltage, protection, operating a switch, creation of a sequence of events, SCADA. Use case 1 – measuring current and voltage Use case 2 – operate switchgear
02	Product specifications for substation equipment	Implementation guideline IEC 61850-9-2 "LE", Product standard for switchgear with integrated IEC 61850 interface (IEC 62271-003)
03	Substation automation system architecture	Communication architecture and topology, device architecture, impact of new technologies; redundancy concepts for switched Ethernet network. Communication architecture, Device modeling, Availability considerations
04	Substation to substation communication for protection and control with IEC 61850	What does the standard IEC 61850-90-1 (Use of IEC 61850 for the communication between substations) provide? Introduction and current status of work. Interlocking between substations, Distance line protection, Current differential line protection, Out-of-step detection, etc.

[S-04] – Power generation

00	Wind power plants	Overview and introduction of the standard for Communications for monitoring and control of wind power plants – IEC 61400-25
01	Hydro power plants	Overview and introduction of the standard for Communications for monitoring and control of hydro power plants – IEC 61850-7-410
02	Distributed Energy Resources	Overview and introduction of the standard for Communications for monitoring and control of Distributed Energy Resources (DER) – IEC 61850-7-420
03	Application modeling for hydro power plants	Overview and introduction of the standard for IEC 61850-7-410 modeling details; New common data classes for hydro power plants

[S-05] – Communication between field devices and system level and at system level

00	Telecontrol protocols IEC 60870-5-101/-104 and DNP3	Fundamentals of Telecontrol standards IEC 60870-5-101, IEC 60870-5-104, and DNP3. What is the market relevance in the future (comprehensive set of slides available if information is needed for the attendees; several slides are added for the attendees convenience – to take home). Is IEC 61850 competing with Telecontrol Protocols? What are the use cases for Telecontrol Protocols and IEC 61850?
01	Telecontrol protocols details	Fundamentals of DNP3; comparison with IEC 60870-5-101/104
02	Substation to control center communication with IEC 61850	What will the standard IEC 61850-90-2 (Using IEC 61850 for the communication between substations and control centres) provide? Introduction and current status of work.
03	Inter control center communication (ICCP)	Fundamentals of the use of IEC 60870-6-TASE.2 (ICCP); a comprehensive stand-alone seminar is available as well, ask for details.
04	Webservices	Fundamentals of the definition of Webservices for IEC 61400-25-3 (and IEC 61850-7-2)

as specified in IEC 61400-25-4.

- 05 Comparison of protocols Detailed comparison of the protocol suites IEC 60870-5, DNP3, IEC 61850

[S-06] – Power system level applications

- 00 IEC 61970 / 61968 series Energy management system application program interface (EMS-API) / System interfaces for distribution management – introduction
- 01 IEC 61970-301 CIM Energy management system application program interface (EMS-API); focus on Part 301: Common Information Model (CIM) and harmonization with IEC 61850
- 02 Dynamic and static use of the CIM Model Component Interfaces for information exchange, use cases for the CIM: GID, EAI, Network models
- 03 Tooling for the Common Information Model CIM Available tools, platforms, experiences with power delivery systems
Overview of existing OS tools: CIMTool, Xpetal, CIMVT, CIMValidate, CIMSpy; Available commercial tools; Flaws and future tools
- 04 UML Modeling basics Introduction of the modeling basics required for CIM
- 05 UML demonstration of the CIM Using the free viewer of the Spax Enterprise Architect Modeling and Design Tool to visualize the current CIM (IEC 61970-301 Edition 2009). Free viewer will be provided for all attendees.
- 06 CIM Users Group Activities of the CIM Users Group
- 07 Application examples and projects Presentation of implemented and planned applications; projects
- 08 Harmonization CIM – IEC 61850 Present the current status and potential issues of the harmonization of the two models

[S-07] – Communication and SCADA aspects and protocol implementations

- 00 Extracting data from field devices General SCADA services – configuration of control blocks (IEC 61850-7-2).
Overview, Reporting, Logging, GOOSE, Sampled values
- 01 Monitoring for SCADA applications Fundamentals of special SCADA services (IEC 61850-7-2): model basics for monitoring, event reporting, event logging.
IEC 61850 aspects of monitoring, SCADA services, Alarm handling
- 02 Communication technologies Fundamentals of Industrial Ethernet used for substations and beyond
Industrial Ethernet features, Ethernet Requirements for IEC 61850, Shared Ethernet, Switched Ethernet, Ethernet frames, Ethertypes used in IEC 61850, Priority tagging, 802.1Q / 802.1p
- 03 Information presentation and encoding Fundamentals of UML, XML, ASN.1, ...
- 04 Protocol details Fundamentals of ISO 9506 (MMS), Webservices, IEC 60870-5, DNP3, IEC 61850
- 05 Protocol implementations and Mappings for IEC 61850-7-2 Details on how to implement protocols and information models? MMS, ASN.1 BER, Web services, ..., simple MMS clients; IEC 60870-5, IEC 61850, DNP3
- 06 Demonstration of compliant software Demonstration of IEC 61850 compliant client and server software.
Server (software-only, hardware version), API between existing data and „standard world“, Existing data, DER model, and mapping of existing data to the DER model, Clients (MS Internet Explorer, Tamarack test client, Tamarack Client), Demonstrate information exchange
- 07 MMS client and server implementation – the basis for IEC 61850 Comprehensive training on the implementation of MMS clients and servers for all basic services required by TC 57 standards: Association, NamedVariable, NamedVariableList, Read, Write, Information Report, ... This module usually requires a 2 day course
- 08 IEC 60870-6 TASE.2 Protocol Use of MMS for realizing the TASE.2 services
- 09 Network Engineering Guidelines (IEC 61850-11) Recovery protocols (RSTP, PRP, etc); different approaches to network topology, redundancy, time synchronization, etc.; status of standardization

[S-08] – Products and projects

- 00 Practical experience IEC 61850 devices, tools, and projects in reality; penetration of IEC 61850 (61400-25) in the global market.
Equipment, IEDs, Tools, Substations, Industrial applications
- 01 Tool support Tools for IEC 61850, SCL, IEC 61400-25, Ethernet, TCP/IP, MMS, ASN.1
MS Internet Explorer, XML, SCL browser from ABB, Use of SCL for automatic building IED data bases of servers, Validation of models of a server IEDs, Network analyzers (Ethereal, KEMA UNICA, ...)
- 02 User support UCA international users group, quality measures and TISSUE process, why to join the users group?
- 03 Current and future standardization Introduction of current and future application domains using and extending IEC 61850; Update on ongoing and planned standardization activities, Coordination and

		harmonization of information models, Maintenance of IEC 61850 base documents, Data and communication security, Power quality monitoring, Statistical and historical statistical data, Wind power plants, Hydro power plants, Decentralized energy resources, Substation to control center communication, Substation to substation communication, Product standards: switch gear and merging units, Monitoring, asset management, and maintenance (various groups), Condition monitoring.
04	SCL demo with compliant software	Use of SCL files for building data model in an IED, extension of model (new data); including live demonstration.
05	Products offered by major vendors	What is the situation on the market? What products are offered by the major vendors (ABB, Areva, GE, Siemens, ... Doble, Omicron, ... Beckhoff, Phoenix Contact, ... RuggedCom, Hirschmann, ...)
06	Multivendor projects and turn key projects of single vendor	Experiences after two years substation automation and protection with IEC 61850; turn key projects, ... User's view and requirements for the future. Are the users' expectations met?
07	IEC 61850 Network Analyzer and SCL	Presentation and demonstration of the use of SCL files for the interpretation of messages: Connect IED Scout to QNE Measurement IED, Generate SCL for QNE with IED Scout, KEMA UNICA trace without SCL, KEMA UNICA trace with SCL, Ethereal Trace and interpretation of ASN.1 BER
10	Tools for the engineering of IEC 61850 conformant systems	The engineering process of IEC 61850 requires several tools for the various aspects of engineering: system design, IED design, system engineering, IED configuration, testing, ... The presentation introduces the typical engineering process using tools. More details can be found in the hands-on training [H-0104]
11	Second edition of IEC 61850 and other extensions	The first edition of IEC 61850 had 14 parts and was published between 2002 to 2005. In the meantime many extensions have been defined and published as standards or draft standards. This presentations presents the many new definitions in information models, services, configuration, mappings, and applications.
50	Quality process and user group	The ICA international users group represents all major vendors, many utilities, system integrators and consultants to support the various standards. The crucial objective is the support of the quality assurance process for testing, certification and lab accreditations.

[S-09] – Real-time information exchange with GOOSE and Sampled Values

00	Network Infrastructure for Real-time information exchange NEW	Required Ethernet communication infrastructure (Ethertype, Multicasting, Multicast filtering, ... Redundancy). Non Ethernet communication solutions.
01	GOOSE (Generic Object Oriented System Event) NEW	GOOSE Control Blocks and dynamic behavior of GOOSE message exchange. Required Ethernet communication infrastructure (Ethertype, Multicasting, Multicast filtering, ...) . GOSSE message syntax. Configuration of GOOSE control using SCL. GOOSE application examples. Demonstration of GOOSE messaging and network traffic analysis.
02	Sampled Measured Values NEW	SMV Control Blocks and dynamic behavior of SMV message exchange. Required Ethernet communication infrastructure (Ethertype, Multicasting, Multicast filtering, ...). SMV message syntax. Configuration of SMV control using SCL. SMV application examples.

Special hands-on Training opportunities for IEC 61850

[H-00] – General IEC 61850 hands-on training for in-house courses

00	Extended modeling of non-standardized information	Build your own extended model. The use of the extension rules of IEC 61850 to model application information outside standards
01	Design and engineering of a substation	Engineering of substations, IEDs and other systems using SCL tools
02	Real models	Analysis of existing real models; design of the model for your application
03	IED communication	Hands-on training of the use of communication services (ACSI) using an IED Simulator and common IED Browsers. The communication comprises all ACSI services except Sampled Values; communication with real IEDs (if IEDs are available and accessible); Network infrastructure and PCs are required; one PC per two attendees; training software will be provided in advance
04	Analyzing the communication	Analyzing the communication according to IEC 61850: client-server, GOOSE, SV; communication testing

[H-01] – IEC 61850 IED and Engineering tools hands-on training in cooperation with STRI, Ludvika/Sweden

This hands-on training is offered as public or in-house events. The duration is usually 4 days. Contact NettedAutomation for details, dates and locations.

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| 00 | Module 1 | <p>Gives an introduction to the IEC 61850 standard together with a summary with real applications and the demonstration of STRI facilities for multivendor interoperability testing.</p> <p>Introduction to IEC 61850, the basics of the standard series, updates and other extensions. Presentation of the STRI multivendor application with ABB, Areva and Siemens IEDs for a typical substation. Demonstration of compliant IEC 61850 software, devices and test procedures in STRI's Independent IEC 61850 laboratory.</p> |
| 01 | Module 2 | <p>Gives an independent and more detailed update on the IEC 61850 standard for substation and device modeling as well as communication principles with real examples. IEC 61850 substation and device modeling and communication principles (GOOSE, Sample Values, Client/Server applications). What you need to know for specification, evaluation, verification and maintenance of IEC 61850 systems (whole substations and IEDs).</p> |
| 02 | Module 3 | <p>Presents possible functional allocation and architecture of a typical substation with state of the art IEDs from different manufacturers (ABB, Areva, Siemens) as well as available test sets (Omicron, Doble, Programma) with group sessions on how to optimize the solution.</p> <p>Review of available functions and possible architectures for substation automation. Optimized application of IEC 61850 in power utilities with examples based on the STRI multivendor application with ABB, Areva and Siemens IEDs for a typical substation. Morning session with theory and afternoon with group workshop to design and specify typical substation functions.</p> |
| 03 | Module 4A
IED interoperability workshop | <p>IEC 61850 hands-on workshop demonstrating inter-operability of protection and control devices from ABB, Areva and Siemens.</p> <p>The intention is to create a small system demonstrating interoperability of protection and control devices from ABB, Areva and Siemens. The participants will be divided in three subgroups with the task of browsing the IED model of each device (using self-description, validation of model and SCL file) and creating outgoing GOOSE messages from their relay. After lunch the network traffic is jointly analyzed and the reception of GOOSE messages will be configured in smaller groups. Finally the system is tested through e.g. simple multi-protection tripping schemes and the use of IEC 61850 compatible test devices.</p> <p>Participant gets hands-on experience of at least two vendors IEC 61850 implementation in IEDs and tools. Experience in system debugging and network traffic analysis using third party and open source tools is gained.</p> |
| 04 | Module 4B
Substation Configuration Language (SCL) workshop | <p>Substation Configuration Language (SCL) hands-on workshop. Learn what you need to know for specification, evaluation, verification, and maintenance of IEC 61850 substations and IEDs.</p> <p>The workshop focuses on the design of typical substation functions and the engineering of the substation and IEDs according to the engineering process described in edition 2 of IEC 61850-6 (SCL). The participants will use third-party functional specification, design and engineering tools to design ICD files, substation sections, communication sections, IED sections and DataTypeTemplates. The participants will create a SCD file that is used to generate a fully functional IED (IEC 61850) server simulator. The SCD file is also used as import file for an IED configuration tool to configure a real IED (data model, server and GOOSE message). During the last hour of the workshop the two groups join for the IED configuration by use of the SCD file created by the SCL group.</p> <p>This workshop 4B requires participants to bring their own notebooks (at least one for two attendees). The demo tools (from third parties) required will be provided by NettedAutomation prior to the beginning of the event.</p> |

Special hands-on Training opportunities for IEC 61850

[H-02] – General CIM (IEC 61968) hands-on training for in-house courses

- 00 Hands-on training with available CIM tool demonstration software The attendees will be guided through several sample tools. The students will learn how to use CIM compliant tools for sample applications.

Date and locations for public events: <http://www.nettedautomation.com/seminars/uca/sem.html#standardpublic>

In-house courses: <http://www.nettedautomation.com/seminars/uca/sem.html#inhouse>

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IEC 61850 Blog: <http://iec61850-news.blogspot.com>

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