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# PRACTICAL IEC 61850 FOR SUBSTATION AUTOMATION FOR ENGINEERS AND TECHNICIANS



## YOU WILL LEARN HOW TO:

- Explain the basic scope and outline of IEC 61850 (including Revision 2)
- Describe the IEC 61850 hardware architecture for substation automation
- Use the IEC 61850 data model to specify a substation automation system
- Use the IEC 61850 model as data integration platform
- Specify the most appropriate networking components for substation automation
- Perform device independent system specification and engineering
- Create SSD, ICD, IID and SCD files
- Create, capture and analyse GOOSE messages

## WHO SHOULD ATTEND:

This workshop is designed for personnel with a need to understand the techniques required to use and apply IEC 61850 to substation automation, hydro power plants, wind turbines and distributed energy resources as productively and economically as possible. This includes engineers and technicians involved with:

- Consulting
- Control and instrumentation
- Control systems
- Design
- Maintenance supervisors
- Electrical installations
- Process control
- Process development
- Project management
- SCADA and telemetry systems



*Technology Training that Works*

## The Workshop

Older ('legacy') substation automation protocols and hardware/software architectures provided basic functionality for power system automation, and were designed to accommodate the technical limitations of the technologies available at the time. However, in recent years there have been vast improvements in technology, especially on the networking side. This has opened the door for dramatic improvements in the approach to power system automation in substations.

The latest developments in networking such as high-speed, deterministic, redundant Ethernet, as well as other technologies including TCP/IP, high-speed Wide Area Networks and high-performance embedded processors, are providing capabilities that could hardly be imagined when most legacy substation automation protocols were designed.

IEC61850 is a part of the International Electro-technical Commission (IEC) Technical Committee 57 (TC57) architecture for electric power systems. It is an important new international standard for substation automation, and it will have a significant impact on how electric power systems are designed and built in future. The model-driven approach of IEC61850 is an innovative approach and requires a new way of thinking about substation automation. This will result in significant improvements in the costs and performance of electric power systems.

This workshop provides comprehensive coverage of IEC 61850 and will provide you with the tools and knowledge to tackle your next substation automation project with confidence.

### Pre-requisites

A basic working knowledge of data communications in general, or some exposure to Ethernet and TCP/IP, would be useful but is not essential.

## Practical Sessions

This is a practical, hands on workshop enabling you to work through practical exercises which reinforce the concepts discussed.

**To gain full value from this workshop, please bring your laptop/notebook computer.**

## On-Site Training

- ✓ SAVE over 50% by having an IDC workshop presented at your premises.
- ✓ Customise the training to YOUR workplace.
- ✓ Have the training delivered when and where you need it.

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FREE proposal.

## The Program

### DAY ONE

#### INTRODUCTION

- 7-layer communication model
- 8th layer as data
- Network topologies
- Utility Communication Architecture (UCA)
- Client/server concept
- Publish/subscribe concept
- Key features of IEC 61850
- IEC 61850 vs. DNP3 and IEC 60870

#### SCOPE AND OUTLINE OF IEC 61850

- General functional requirements (Parts 3, 4 and 5)
- Definition of abstract services (Part 7.2)
- Abstraction of data objects (Part 7.4)
- Common Data Classes (CDC) (Part 7.3)
- Mapping of abstract data objects and services onto the Manufacturing Messaging Specification (MMS) (Part 8.1)
- Mapping of Sample Measured Values onto serial links (Part 9.1)
- Mapping of Sample Measured Values onto ISO/IEC 8802-3 (IEEE 802.3/Ethernet)

#### IEC 61850 SUBSTATION ARCHITECTURE

- Merging Units (MUs)
- Station Bus
- Process Bus

#### ETHERNET COMMUNICATION WITHIN SUBSTATIONS

- Physical Interfaces (10/100/1000 Mbps)
- Media (copper, multi-mode fibre, single mode fibre)
- Media access (full duplex vs. CSMA/CD)
- MAC (L2) addressing: broadcasting, multicasting, unicasting
- Frame (packet) structure
- Differences between ISO/IEC 8802.3, ISO/IEC 8802.3 Ethertype, and ISO/IEC 8802.2 LLC
- Bridges/switches
- VLANs
  - Port-based vs. tagged VLANs
  - IEEE802.1p port prioritisation
  - IEEE802.1Q VLAN
- Time synchronisation
  - IEEE 1588
  - SAE AS6802
- Network redundancy
  - Redundant star
  - Redundant ring
  - Spanning tree protocols
  - Parallel Redundancy Protocol (IEC 62439-3)

#### TCP/IP AND RELATED CONCEPTS

- IP (L3) addressing: IPv4 vs. IPv6
- Subnet masks and default gateways
- Basic routing concepts
- Routers
- Ports/sockets
- TCP connections
- TCP vs. UDP

### DAY TWO

#### WAN COMMUNICATIONS ISSUES

- Reliability, determinism and speed issues
- Multi-Protocol Layer Switching (MPLS)
- IP over Dense Wavelength Division Multiplexing (IPoDWDM)
- MPLS Traffic Engineering – Fast Reroute over IP over Dense Wavelength Division Multiplexing (MPLS TE-FRR over IPoDWDM)
- IEEE 802.1Qav – Forwarding and Queuing Enhancements for Time-Sensitive Streams

#### DATA MODELING APPROACH

- The information model (IEC 61850-7-x and IEC 61400-25)
- The information exchange services and mappings (IEC 61850-7-2 and 8-1)
- Physical devices
- Logical devices
- Data elements
- Common Data Class (IEC 61850-7-3)

#### COMMUNICATION PROFILES

- Sampled Values (SV) multicast
- Generic Object Oriented Substation Event (GOOSE)
- GOOSE messages over L2
- GOOSE messages over L3 (IEC 61850-90-5)
- Generic Substation Status Event (GSSE)
- Time Sync (SNTP/GPS/IRIG-B)
- Manufacturing Message Specification (MMS)
- Application of and comparison between profiles

#### MAPPING OF IEC 61850 TO COMMUNICATION PROFILES

- Abstract Communication Service Interface (ACSI)
- Mapping of IEC61850 to MMS
- Object mapping
- Service mapping

#### CONFIGURATION

- Configuration of IEDs
- IEC 61850-6 Substation Configuration Language (SCL)
- Software tools

#### CONFORMANCE AND TESTING

- Documentation and process
- Assessment process
- Tools
- Testing methods
- Interpretation of Compliance Certificates

#### RECENT DEVELOPMENTS

- IEC 61850 Edition 2
- Object models for hydro power plants, wind turbines and Distributed Energy Resources (DER)
- Mapping of IEC 61850 on DNP3 and IEC 60870-5-101/-104
- The use of IEC 61499 (Distributed Function Blocks) in conjunction with IEC 61850
- Exchanging synchrophasor data between PMUs, PDCs, WAMPAC and control centre applications: IEC/TR 618-90-5:2012(E)
- Communication with the control centre based on IEC 61850 and Harmonisation with CIM

#### SUMMARY, OPEN FORUM AND CLOSING