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NUEVAS TENDENCIAS EN LA AUTOMATIZACION DE SUBESTACIONES DE POTENCIA

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DIOGENES NEMESIO GONZALES DE LA CRUZ

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Dedico este trabajo a:

La memoria de mi padre, Teofanes

A mi madre, Cristina por inculcarme los deseos de superación,

A Karen , por su amor y apoyo constante, y

A mi hija Alejandra por la felicidad que me brinda aun antes de nacer

SUMARIO

Desde hace 02 décadas las empresas eléctricas alrededor del mundo han experimentado cambios dramáticos. La tendencia en el ámbito mundial hacia la desregulación y privatización de los servicios de generación, transmisión y distribución de la Energía Eléctrica se encuentra centrada en la creación de empresas que operen en mercados competitivos. Las nuevas empresas se ven obligadas a minimizar sus gastos, optimizar sus inversiones y buscar nuevas filosofías de operación las cuales ahora son posibles debido a los avances actuales en la tecnología digital aplicada a los equipos de protección y control eléctrico así como en las comunicaciones.

Siendo la Subestación de Potencia una parte importante en los procesos operacionales de una Empresa Eléctrica , el presente informe tiene como objetivo general presentar los nuevos estándares y tendencias industriales relacionadas con la automatización de Subestaciones de potencia las mismas que deben ser tomadas en consideración en todo nuevo proceso de automatización de Subestaciones . El objetivo especifico del informe es detallar las características generales de la Norma IEC 61850 ***Communication Networks and systems in Substations***. y presentar los beneficios que su implementación traería a las diferentes áreas de la empresa eléctrica.

El capítulo I se presentan los Estándares Internacionales actuales y tendencias industriales en la automatización de Subestaciones de Potencia El objetivo de este capítulo es dar a conocer las normas internacionales actuales y tendencias que deben ser tomadas en cuenta en todo proceso de Automatización de Subestaciones.

El capítulo II presenta la Norma IEC 61850 y su marco teórico. se indican también los beneficios de su implementación así como los desarrollos futuros de la norma.

En el capítulo III se indican las aplicaciones de la norma alrededor del mundo lo cual comprueba las características de verdadero estándar mundial.

Finalmente se presentan las principales conclusiones del informe.

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INTRODUCCIÓN

Antecedentes

La automatización de Subestaciones es desde la aparición del IEC 61850 mas que solo la automatización de equipos. Es uno de los primeros pasos para la creación de un altamente confiable sistema de potencia que responda rápidamente a los eventos en tiempo real con apropiadas acciones y que soporte el planeamiento y administración necesaria para un costo efectivo en las operaciones. La automatización no es simplemente el reemplazo de procedimientos manuales mas bien debe permitir al Sistema de potencia operar de una forma basada en la precisión de la información en el momento oportuno.

En el pasado la atención de las empresas eléctricas estuvo enfocada solo en la administración de la infraestructura del sistema de potencia. Sin embargo el mundo ha cambiado, ahora hay 02 infraestructuras que deben ser administradas: La infraestructura del Sistema de Potencia y la Infraestructura del Sistema de Comunicaciones.

La automatización de Subestaciones tal como la presenta la IEC 61850 no estuvo disponible hasta hace algunos años atrás debido a que las comunicaciones no estuvieron disponibles para soportar las aplicaciones que en ese entonces se requerían. Por lo tanto uno de las principales habilitadores para que se logre la automatización de subestaciones fue reconocer que el cableado extenso entre los equipos en patio de llaves y la sala de control se podrían eliminar con la aplicación de la tecnología Ethernet . Hoy en día el desarrollo de las comunicaciones hace posible que las aplicaciones hasta ese entonces soñadas se efectúen.

Otro de los principales habilitadores es el avance de la tecnología digital que logro que los tradicionales equipamientos como medidores, relés de protección y Unidades Terminales Remotas (UTR) hayan adquirido nuevas características y funcionalidades, una de ellas es la capacidad de "hablar un lenguaje " (protocolo de comunicación) a fin de entregar toda la información valiosa que disponen.

Objetivos del Informe

El informe tiene por objetivo presentar las nuevas tendencias mundiales relacionadas con la automatización de Subestaciones de potencia las mismas que deben ser tomadas en consideración en todo nuevo proceso de automatización de Subestaciones fundamentalmente aquellas que se efectúan bajo la Norma IEC 61850.

Se presenta la Norma IEC 61850 como uno de de los primeros pasos para la creación de un altamente confiable sistema de potencia que responda rápidamente a los eventos en tiempo real con apropiadas acciones y que soporte el planeamiento y administración necesaria para un costo efectivo en las operaciones.

Se indica además como la implementación de la Norma IEC 61850 conduce a la formación de la red inteligente empresarial el cual traería muchos beneficios a las diferentes áreas de la empresa eléctrica.

Estructura del Informe

El documento está dividido en tres capítulos y conclusiones:

El capítulo I se presentan los Estándares Internacionales actuales y tendencias industriales en la automatización de Subestaciones de Potencia El objetivo de este capítulo es dar a conocer las normas internacionales actuales y tendencias que deben ser tomadas en cuenta en todo proceso de Automatización de Subestaciones.

El capítulo II presenta la Norma IEC 61850 y su marco teórico. se indican también los beneficios de su implementación así como los desarrollos futuros de la norma.

En el capítulo III se indican las aplicaciones de la norma alrededor del mundo lo cual comprueba las características de verdadero estándar mundial.

Finalmente se presentan las principales conclusiones del informe.

CAPÍTULO I

ESTANDARES INTERNACIONALES ACTUALES Y TENDENCIAS INDUSTRIALES DE AUTOMATIZACION DE SUBESTACIONES DE POTENCIA

1.1 Introducción

Este capítulo describe los estándares internacionales actuales asociados a la automatización de Subestaciones de Potencia y las nuevas tendencias industriales usadas como referencia en la planificación y desarrollo de las nuevas arquitecturas de automatización de Subestaciones.

1.2 Estándares Internacionales actuales

El avance de la tecnología digital y las comunicaciones en los equipos utilizados en las Subestaciones Eléctricas han traído como consecuencia la necesidad de nuevos estándares.

1.2.1 Operación de Equipos de Comunicaciones en Subestaciones Eléctricas : IEEE 1613 e IEC 61850-3

Hoy en día existen 04 estándares IEEE desarrollados por el Power Systems Relaying Commitee PRSC del IEEE dirigidos a la operación de los relés de protección en las Subestaciones Eléctricas

- ***ANSI/IEEE C37.90-1989 IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus***: Define las condiciones de servicio , niveles de tensión, rangos de temperatura , humedad y los requerimientos dieléctricos y capacidad de soporte al impulso de los relés de protección.

- ***IEEE Std C37.90.1-2002™ IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus***: Define la capacidad requerida para soportar los transitorios sin daño o falsa operación.

- ***C37.90.2 -2004 IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers:*** *Define los requerimientos de inmunidad para la operación de equipos de comunicaciones personales (walkie-talkies) en ambientes cercanos a los reles .*

- ***IEEE C37.90.3 Standard Electrostatic Discharge Tests for Protective Relays***: Define los requerimientos de inmunidad de los relés de protección para transitorios debido a baja humedad y tensiones de descarga estática.

Dado que hoy en día se utilizan muchos equipamientos de comunicaciones tales como Switches y Routers en el ambiente en donde operan los relés de protección (Subestaciones Eléctricas) dichos equipamientos deben tener el mismo o superiores requerimientos de performance que los relés de protección

Es asi que el Grupo de trabajo C2TF1 del IEEE Power Engineering Society Substations Committee elaboro el Estandard ***IEE1613 Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations*** el cual provee nuevos criterios para las pruebas de equipos en las Subestaciones. Básicamente el estándar indica que los equipos de Networking deben cumplir similar o superiores condiciones de prueba que los reles de protección. El estándar define condiciones de servicio, condiciones ambientales y valores de prueba para modems, firewall, Routers, Switches y todo equipamiento de Networking dentro de Subestaciones.

La norma IEE 1613 define 02 tipos de clase de performance:

PERFORMANCE CLASE 1 : Es para equipos usados para propósitos generales dentro de una Subestación donde perdidas temporales de comunicación y/o errores de comunicación pueden ser tolerados durante la ocurrencia de un transitorio.

PERFORMANCE CLASE 2 : Es para equipos usados dentro de subestaciones donde se desea ningún error en los equipos de comunicaciones ante la ocurrencia de un transitorio.

La Performance Clase 1 es el mínimo requerimiento del IEE 1613 , la performance Clase 2 no es mandataria y es una opción que puede ser usada por un fabricante o empresa eléctrica.

Para cumplir con los requerimientos de Performance Clase 2 es necesario tener Fibra óptica . Las fuentes de poder internas de los equipos tendrían que ser blindadas para que dichos transitorios no lleguen a las fuentes de poder.

Similar al **IEEE 1613** la norma **IEC61850** también define requerimientos ambientales para equipos de comunicaciones dentro de una Subestación. Este Estándar esta dividido en

10 partes el cual ofrece un marco completo de pruebas incluyendo EMI (Interferencia Electromagnética) , requerimientos de inmunidad y medioambiente (IEC 61850-3) .

1.2.2 Protocolos de Comunicación

Los protocolos de comunicación es el "lenguaje de los IEDs" . Son un conjunto de reglas que permiten que 02 equipos intercambien información. A continuación se describe los protocolos de comunicación de mayor uso en el ambiente eléctrico:

DNP3 SERIAL Y DNP3 LAN

DNP es basado en los estandards de la **IEC Technical Commitee 57, Working Group 3** quienes trabajaron en la estandarización de un protocolo de 3 capas OSI llamado "Enhanced Performance Architecture" (EPA) que es un protocolo para telecontrol. DNP fue seleccionada como una práctica recomendada del **IEEE C.2 task Force** como protocolo recomendado para unidades terminales remotas

DNP 3 es un protocolo de adquisición de datos utilizado por las compañías eléctricas, gas y agua . Es diseñado como un abierto, interoperable y simple protocolos para Sistemas Scada . Usa la interrogación Maestra/Esclava para enviar y recibir información.

DNP 3 es un protocolo de 03 capas (Capa física, Enlace de Datos y Aplicación) . Provee multiplexación, fragmentación de datos , corrección de errores, priorización . DNP 3 ofrece las siguientes importantes características:

- Transferencia de archivos
- Capacidad de soportar 65520 equipos
- Sincronización de tiempo y estampando de eventos
- Mensajes tipo Broadcast
- Confirmación en la capa de enlace de datos y Capa de aplicación

La capa de aplicación es basada en objetos y se cuenta con una lista extensa de objetos funciones y formatos para el que pregunta como el que responde. La Capa de enlace de datos provee métodos de conseguir la información tales como POLL-RESPONSE POLLED-REPORT-BY-EXCEPCION , UNSOLICITED-RESPONSED y PEER-TO-PEER lo cual permite múltiples maestras.

En años recientes muchos vendedores han usado TCP/IP para transportar los mensajes DNP 3 en lugar que los tradicionales medios seriales (RS 232 y RS 485) . La capa de enlace de datos son inmersas en paquetes TCP/IP. Esta característica ha hecho que DNP 3 tome ventaja de la tecnología Internet asi como de la tecnología Ethernet vía redes LAN y WAN.

Este protocolo es utilizado en Norte América y Latinoamérica como protocolo de comunicación entre el Centro de Control y las Subestaciones Eléctricas.

IEC 60870-5-101

El IEC 60870-5-101 utiliza las capas 1, 2 y7 del Modelo OSI . Dicho protocolo puedes ser implementado en dos modalidades:

A) Configuración tipo BUS, el cual utiliza una comunicación Maestra-Esclava con interrogaciones cíclicas
B) Configuración de conexiones individuales, el cual permite un balaceado acceso al medio y envío de datos en ambas direcciones.

Las aplicaciones que efectúa dicho protocolo son las siguientes:

- Adquisición de datos por interrogación cíclica
- Adquisición de eventos
- Sincronización de tiempo
- Transmisión de ordenes
- Interrogación general
- Transferencia de archivos

Este protocolo es utilizado con mucha regularidad en Europa como protocolo de comunicación entre el Centro de Control y las Subestaciones Eléctricas.

IEC 60870-5-103

Es un protocolo de comunicación creado para el intercambio de datos entre relés de protección dentro de una Subestación.

La capa física soporta 02 configuraciones : RS485 tanto para su interface eléctrica como de fibra óptica. Las velocidades de transmisión son de 9.6 kbps o de 19.2 kbps.

El protocolo opera como un Sistema Maestro esclavo y usa una interrogación cíclica como método de acceso al medio. Soporta las capas 1, 2 y 7 del modelo OSI.

UCA 2.0

El Electric Power Research Institute (EPRI) desarrolló la suite de protocolos conocida como "Utilities Communications Architecture versión 2" (UCA 2.0) . Este protocolo es basado en la utilización de Ethernet e incorpora la utilización de TCP/IP y MMS para las capas de aplicación.

El protocolo utiliza las 07 capas del modelo OSI . El principio CSMA/CD de ethernet es utilizado para el acceso al medio y soporta comunicaciones punto a punto asi como Maestro – Esclavo.

El protocolo UCA 2.0 puede ser utilizado dentro de una Subestación y hacia el centro de control.

UCA 2.0 ofrece interconectividad e interoperatividad entre equipos de diferentes fabricantes para intercambiar datos entiempo real en alta velocidad.

IEC 61850

IEC 61850 es un nivel superior al UCA 2.0 . Contiene muchas de las especificaciones del UCA 2.0 mas características adicionales . IEC 61850 fue publicada como estándar internacional el año 2003.

Este protocolo es aplicable para la automatización y protección sobre Ethernet dentro de una Subestación Eléctrica. Para el envío de información fuera de los limites de la Subestación un estándar complementario se encuentra en desarrollo.

Actualmente los principales fabricantes de IEDs (ABB, AREVA, GE, SEL, SIEMENS) ofrecen productos que cumplen con este estándar. IEC 61850 es diseñado para utilizar una comunicación punto a punto a alta velocidad usando mensajería GOOSE (Generic Object Orientated System Wide Events).

1.2.3 IEEE 802.3: Ethernet

El termino Ethernet se refiere a la familia de productos de Red de Area Local (LAN) cubiertos por el estándar IEEE 802.3 el cual define el comúnmente conocido protocolo CSMA/CD. 04 velocidades son actualmente definidos para operación sobre red de fibra óptica y par trensado:

10 Mbps – 10 Base T Ethernet

100 Mbps – Fast Ethernet

1000 Mbps – Gigabit Ethernet

10 Gigabit Ethernet el cual es el más reciente desarrollo publicado bajo el nombre IEEE 802.3ae como un suplemento al IEEE 802.3 .

Ethernet actualmente es usado por aproximadamente el 85% de las redes LAN de computadoras de todo el mundo por sus siguientes características:

- Es fácil de entender, implementar , administrar y efectuar mantenimiento.
- Permite bajos costos de implementación de la red
- Posee una flexibilidad topológica en las instalaciones
- Garantía en la exitosa interconexión debido a que los productos cumplen un estándar

Ethernet LANs consisten de Nodos y medios de interconexión. El medio de interconexión incluye 02 tipos de cable de cobre: Par trensado no apantallado (UTP) y par trensado apantallado (STP)., adicionalmente existen muchos tipos de cables de fibra óptica. En años recientes Wirelesss LAN (WI-FI) , estandarizado por el IEEE 802.11 ha sido adicionado en muchas instalaciones.

1.2.4 IPV4 e IPV6

IPV4 es descrito en el Internet Engineering Task Force (IETF) RFC 791 (Septiembre 1981) IPv4 es la versión 4 del Protocolo IP (Internet Protocol). Esta fue la primera versión del protocolo que se implementó extensamente, y forma la base de Internet.

IPv4 usa direcciones de 32 bits, limitándola a 2^32 = 4.294.967.296 direcciones únicas, muchas de las cuales están dedicadas a redes locales (LANs) en aproximadamente 18 millones o direcciones multicast (1 millon de direcciones) . Esto reduce el numero de direcciones que pueden ser usados como direcciones publicas de internet y como el numero de direcciones disponibles esta consumida, una escasez de direcciones parece ser inevitable a la larga.

Para conectar dos redes LAN utilizando la porción publica de internet, son utilizadas Virtual Private Network (VPN). VPNs trabajan insertando un Packete IP (Packete encapsulado) directamente dentro del campo de datos de otro packete IP (Packete

encapsulador) y usando una dirección IP publica enrutable en el packete encapsulador.
Una vez que el packete VPN es enrutado alrededor de la red pública y encuentra al punto final, el packete encapsulador es extraído y entonces transmitido en la red privada tan igual como si las 02 redes privadas estuvieran directamente conectadas. Opcionalmente, el packete encapsulado puede ser encriptado para asegurar el dato mientras viaja por la red pública.
IP tiene la capacidad de proveer un parámetro llamado calidad del servicio (QoS) . En una cabecera IP , 8 bits son asignados para definir a Tipo de Servicio (TOS) en términos de prioridad , retardo, rendimiento de procesamiento y confiabilidad. La idea original fue para especificar una preferencia sobre como la información será manejada en la Internet cuando esta se envíe a un destino especifico. Esos bits han sido redefinidos muy recientemente atraves del DIFFSERV Working Group del IETF y por los explícitos códigos de Notificación de congestión. Además nuevas tecnologías están emergiendo que requieren transmisión continua en tiempo real y por lo tanto se hará uso del campo TOS. Un ejemplo es Voz sobre IP (VoIP) el cual es usado para intercambio interactivo de voz , otra aplicación seria aplicaciones en tiempo real SCADA en el ambiente de una empresa eléctrica.
IPv6 es la versión 6 del Protocolo de Internet (Internet Protocol), un estándar en desarrollo del nivel de red encargado de dirigir y encaminar los paquetes a través de una red. IPv6 está destinado a sustituir al estándar IPv4, cuyo límite en el número de direcciones de red admisibles está empezando a restringir el crecimiento de Internet y su uso, especialmente en China, India, y otros países asiáticos densamente poblados. Pero el nuevo estándar mejorará el servicio globalmente; por ejemplo, proporcionando a futuras celdas telefónicas y dispositivos móviles con sus direcciones propias y permanentes. Al día de hoy se calcula que las dos terceras partes de las direcciones que ofrece IPv4 ya están asignadas

IPv4 soporta 4.294.967.296 (232) direcciones de red diferentes, un número inadecuado para dar una dirección a cada persona del planeta, y mucho menos para cada coche, teléfono, PDA, etcétera; mientras que IPv6 soporta 340.282.366.920.938.463.463.374.607.431.768.211.456 (2128 ó 340 sextillones) direcciones —cerca de 4,3 × 1020 (430 trillones) direcciones por cada pulgada cuadrada (6,7 × 1017 ó 670 mil billones direcciones/mm2) de la superficie de La Tierra.

Adoptado por el Internet Engineering Task Force en 1994 (cuando era llamado "IP Next Generation" o IPng), IPv6 cuenta con un pequeño porcentaje de las direcciones públicas de Internet, que todavía están dominadas por IPv4. La adopción de IPv6 ha sido frenada por la traducción de direcciones de red (NAT), que alivia parcialmente el problema de la falta de direcciones IP. Pero NAT hace difícil o imposible el uso de algunas aplicaciones P2P, como son la voz sobre IP (VoIP) y juegos multiusuario. Además, NAT rompe con la idea originaria de Internet donde todos pueden conectarse con todos. Actualmente, el gran catalizador de IPv6 es la capacidad de ofrecer nuevos servicios, como la movilidad, Calidad de Servicio (QoS), privacidad, etc. El gobierno de los Estados Unidos ha ordenado el despliegue de IPv6 por todas sus agencias federales para el año 2008.

Se espera que IPv4 se siga soportando hasta por lo menos el 2011, dado que hay muchos dispositivos heredados que no se migrarán a IPv6 nunca y que seguirán siendo utilizados por mucho tiempo.

1.2.5 ICCP

Las empresas de servicios públicos alrededor del mundo especifican el Inter Control Center Communications Protocol (ICCP) para proveer intercambio de datos entre centros de control. ICCP cumple con el IEC 60870-6/TASE.2 .

ICCP opera sobre redes LANs y WANs para habilitar el intercambio de datos en tiempo real , monitoreo y control de la información incluyendo valores de medición, datos de planificación, datos de conteo de energía y mensajes del operador. Intercambio de datos puede ocurrir entre los siguiente: Múltiples centros de control EMS, EMS y plantas de poder DCS , EMS y Sistemas Scada de distribución, EMS y otros sistemas y EMS/SCADA y Subestaciones.

Aplicaciones ICCP consisten de software Cliente y Servidor. El Software Cliente se conecta a otros miembros de la red para solicitar datos y/o control. El software servidor responde a las solicitudes del cliente por retornar el dato solicitado y ejecutar (si esta permitido) la solicitud de control. Códigos de calidad tales como Setting Manual y Falla en la telemetría son transmitidos con la información. Debido a la definición de grupos de puntos llamados Virtual RTUs

En el Perú el COES establece como requerimientos que las empresas de Generación, Transmisión y distribución Eléctrica remitan ciertos tipos de señales en protocolo ICCP con el fin de monitorear en tiempo real el comportamiento en estado estacionario del Sistema Interconectado Nacional.

1.2.6 Synchrophasores : IEEE Standard C37.118-2005

La medición Sincronizada del Fasor o Syncrophasor provee un método para comparar ángulos de las tensiones y corrientes en cualquier lugar del Sistema Eléctrico en donde se encuentre un IED que tenga estas características.

El equipo de medición del Fasor también llamado PMU es un equipo que reporta por medio de un puerto de comunicaciones los valores en tiempo real de los fasores de tensión y corriente los cuales son sincronizados por medio de un GPS. Para empresas de Trasmisión los PMUs dan una fotografía instantánea del estado del sistema eléctrico. Se estima que en EEUU la utilización del Syncrophasor permitirá incrementar en un 20% la eficiencia de la transmisión de la energía eléctrica.

Actualmente esta norma se encuentra en revisión del IEEE Power System Relaying Commitee.

1.2.7 Sincronización de tiempo para comunicaciones en Subestaciones

Para soportar precisiones mejores que 1 milisegundo la IEEE 1588 *Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems* define un protocolo de sincronización de tiempo en sistemas de medición y control implementados con tecnología de red. El protocolo es aplicable a sistemas de comunicación de redes LAN tales como ethernet.

Para implementar ello en cada Subestación debe tenerse un GPS . Dicho GPS sincroniza vía Network Time Protocol (NTP) o Simple Network Time protocol (SNTP) . El GPS debe tener uno o más IRIG-B conexiones para sincronizar equipos que no son posible de sincronizar por intermedio de la red LAN.

1.3 Tendencias Industriales Actuales

El avance de la tecnología digital y las comunicaciones también hizo posible que aparezcan nuevas tendencias aplicables en la automatización de Subestaciones.

1.3.1 Uso de los equipos Electrónicos Inteligentes (IEDs)

Hoy en día con el avance de la electrónica y las comunicaciones los tradicionales equipamientos como medidores, relés de protección y Unidades Terminales Remotas (UTR) han adquirido nuevas características y funcionalidades, una de ellas es la capacidad de "hablar un lenguaje " (protocolo de comunicación) a fin de entregar toda la información valiosa que dispone.

El termino IED el cual se utilizara a lo largo del presente informe se refiere a " cualquier dispositivo utilizado en Subestaciones Eléctricas que incorpora uno o mas procesadores con la capacidad de intercambiar datos y efectuar secuencias de control desde o hacia una fuente externa"

1.3.2 Utilización de la Fibra Óptica

La Fibra óptica provee aislamiento eléctrico entre los equipos de comunicación y aísla al personal y equipamientos de Sobre Tensiones peligrosas. Es totalmente inmune al ruido causado por campos electromagnéticos y puede ser tendida en áreas donde la instalación de cables de cobre sería peligroso o exista peligro de corrupción de la data. Los nuevos avances hacen que la fibra óptica sea una alternativa practica, económica y segura a los cables de cobre.

Numerosas pruebas han demostrado que los cables de cobre no apantallados y apantallados no son confiables para ser utilizados en redes de comunicación de datos en Subestaciones Eléctricas. Dichas pruebas muestran que los transitorios eléctricos de corta duración tienen severo impacto en la comunicación Ethernet si se usan los cables de cobre. Dichos transitorios aparecen por ejemplo en el momento que un relé de protección efectúa un disparo del interruptor. Por lo tanto es recomendable que cables de fibra óptica sean utilizados para conectar todos los IEDs hacia la red LAN de la Subestación.

1.3.3 Migración de Comunicación Serial a Ethernet

Las comunicaciones seriales son tradicionales en las instalaciones de las empresas eléctricas. Dichos equipos requieren una conexión física directa para enviar su información hacia una RTU . Una desventaja de las comunicaciones seriales es que usualmente se encuentra asociada a protocolos propietarios y cuentan con limitada velocidad. Ethernet en cambio ha ganado popularidad pues ofrece interoperabilidad y performance. Hoy en día existen equipos llamados terminal servers que convierten la comunicación serial en Ethernet llamados Terminal Servers .

1.3.4 División de la Data en Operacional y No Operacional

Actualmente en los procesos de automatización es necesaria la división de la data en Operacional y No Operacional para efectos de dar priorización de una información con respecto a la otra y de esta forma optimizar la performance de los equipos de comunicaciones.

La Data Operacional es la data en tiempo real que requiere un mínimo retraso entre el momento en que esta se genera hasta su visualización por los operadores del Sistema de Automatización. Ejemplos de ello son los estados de los equipos de protección y seccionamiento (abierto/cerrado) ,

La Data No Operacional también llamada data de soporte, es la información sobre un evento o situación que es almacenada en archivos por los IEDs. Esta data no esta sujeta a la necesidad de una inmediata visualización y por lo tanto es considerara como de baja prioridad en su entrega.

1.3.5 Ciber Seguridad

Hoy en día los terroristas alrededor del mundo pueden hacer mas daño atraves de un teclado que con una bomba.

El primer ataque extendido atraves de la red fue en 1988 cuando un hacker ataco a 6200 computadoras y causo 98 millones de dólares en daños en solo 2 días.

Estadísticas de diferentes fuentes demuestran que los ataques del Ciber espacio están creciendo en magnitud y consecuencia.

Un análisis de los daños del Blackout que afecto a los Estados Unidos revela que se ocasionaron entre 6 y 10 Billones de dólares en pérdidas. Imaginemos el impacto que pudiese darse si un hacker hubiese efectuado un ataque al Sistema de potencia.

Debido a ello la North American Electric Reliability Corporation (NERC) estableció unos estándares de Ciber Seguridad a fin de establecer la seguridad en la información de los

Sistema Eléctricos de Norte América. A continuación se presentan los siguientes estándares de Ciber Seguridad los cuales deben ser tomadas en cuenta en todo proceso de automatización de Subestaciones:

CIP-002-01- Critical Cyber Assets

Este estándar requiere la necesidad de la identificación y enumeración de los elementos críticos del Sistema Eléctrico. Una vez que estos son determinados se aplican los equipos de seguridad necesarios.

CIP-003-1 – Security Management Controls

Este estándar requiere la identificación de las entidades responsables que tendrán una administración de la seguridad para proteger los componentes críticos del Sistema Eléctrico. Se debe incluir específicamente políticas de seguridad , programas de protección y clasificación de la información, programas de control de accesos.

CIP-004- Personnel and Training:

Este estándar requiere que el personal al cual se le da acceso a los elementos críticos de la Subestación tenga conocimiento del riesgo que implica prestar la clave a otro personal. Para ello se hace necesario programas de entrenamiento en temas de seguridad de la información al personal involucrado.

CIP-005-Electronic Security

Este estándar requiere la identificación y protección del perímetro electrónico de seguridad donde residen los elementos críticos del Sistema Eléctrico.

CIP-006- Physical Security of Critical Cyber Assets

Este estándar requiere la implementación de un programa físico para la protección de los elementos identificados en CIP-002-01 . Tales protecciones serian por ejemplo personal de seguridad , mecanismos como necesidad de llaves de acceso y autorización para acceder a los elementos críticos.

CIP-007- System Security management

Este estándar requiere que las entidades responsables tengan sistemas de control de la seguridad con la suficiente capacidad para detectar y prevenir cualquier falla o alteración en la seguridad de los elementos críticos del sistema eléctrico causados por error, mal uso o actividad maliciosa.

CIP-008 – Incident Reporting and Response Planning

Este estándar establece la necesidad de identificación , clasificación responsabilidad y reporte de incidentes en la Ciber seguridad.

CIP-009 –Recovery Plans for Critical Cyber assets

Este estándar establece planes de recuperación de la información ante un evento de desastres no controlado.

Hoy en día existes equipos que cumplen las características solicitadas por la NERC algunos de los cuales los presentamos en el Anexo A.

En la Figura 1.1 se presenta algunos de estos equipos y su relación con los términos de Cyber Seguridad indicados.

En el Anexo C se presenta una marca de equipos de comunicaciones que cumple con el Estándar IEC61850 y también con los estándares de Ciber Seguridad de la NERC.

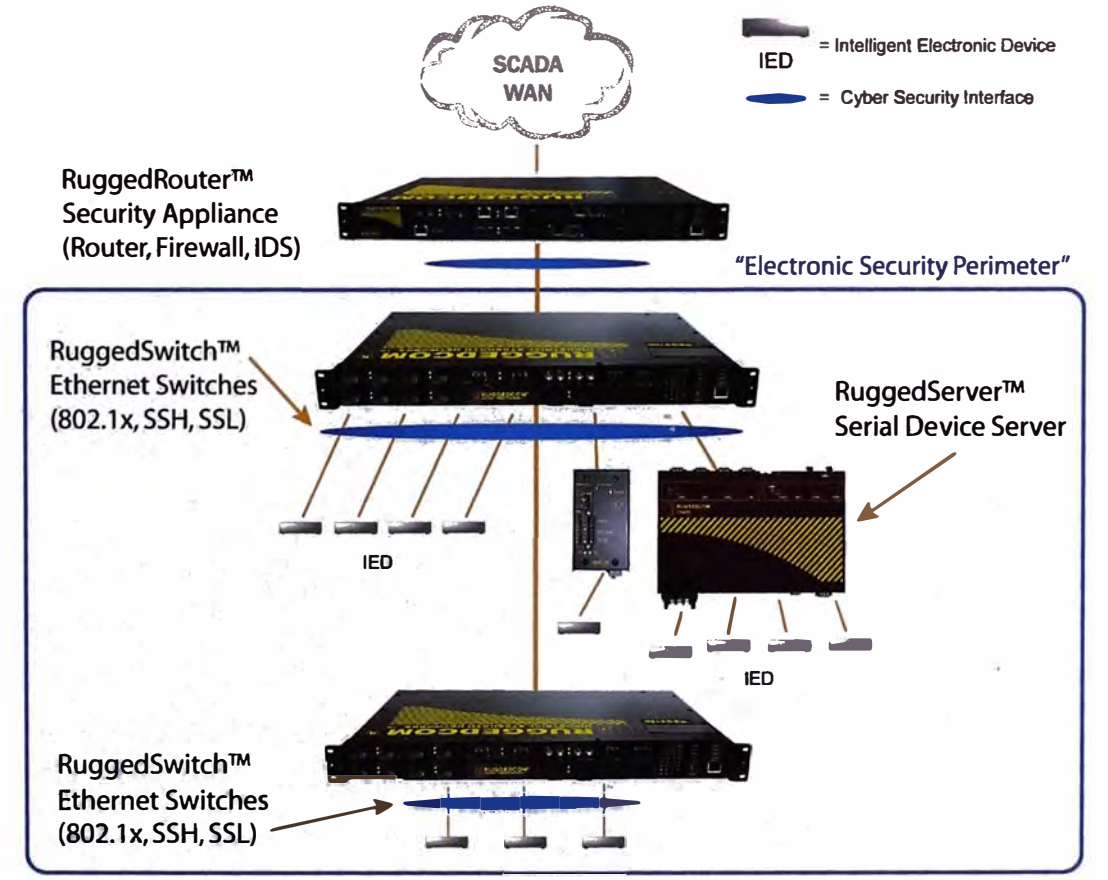


Figura 1.1 Niveles de Seguridad en una Subestación

CAPÍTULO II
IEC 61850

2.1. Introducción

La automatización de Subestaciones es un nuevo cambio para las empresas eléctricas particularmente cuando las nuevas funcionalidades indicadas en la IEC 61850 son utilizadas al máximo.

La automatización de Subestaciones es desde la aparición del IEC 61850 más que solo la automatización de equipos. Es uno de los primeros pasos para la creación de un altamente confiable sistema de potencia que responda rápidamente a los eventos en tiempo real con apropiadas acciones y que soporte el planeamiento y administración necesaria para un costo efectivo en las operaciones. La automatización no es simplemente el reemplazo de procedimientos manuales más bien debe permitir al Sistema de potencia operar de una forma basada en la precisión de la información en el momento oportuno.

En el pasado la atención de las empresas eléctricas estuvo enfocada solo en la administración de la infraestructura del sistema de potencia. Sin embargo el mundo ha cambiado, ahora hay 02 infraestructuras que deben ser administradas: La infraestructura del Sistema de Potencia y la Infraestructura del Sistema de Comunicaciones.

La automatización de Subestaciones tal como la presenta la IEC 61850 no estuvo disponible hasta hace algunos años atrás debido a que las comunicaciones no estuvieron disponibles para soportar las aplicaciones que en ese entonces se requerían. Por lo tanto uno de los principales habilitadores para que se logre la automatización de subestaciones fue reconocer que el cableado extenso entre los equipos en patio de llaves y la sala de control se podría eliminar con la aplicación de la tecnología Ethernet. Hoy en día el desarrollo de las comunicaciones hace posible que las aplicaciones hasta ese entonces soñadas se efectúen ahora.

La arquitectura por años utilizada en la automatización de Subestaciones estuvo enmarcada por la utilización de redes seriales RS232 y RS485 así como por una gran cantidad de cableado del patio de llaves hacia los relés de protección, medidores, RTUs , registradores de falla , etc. La Figura 2.1 indica la arquitectura entonces utilizada.

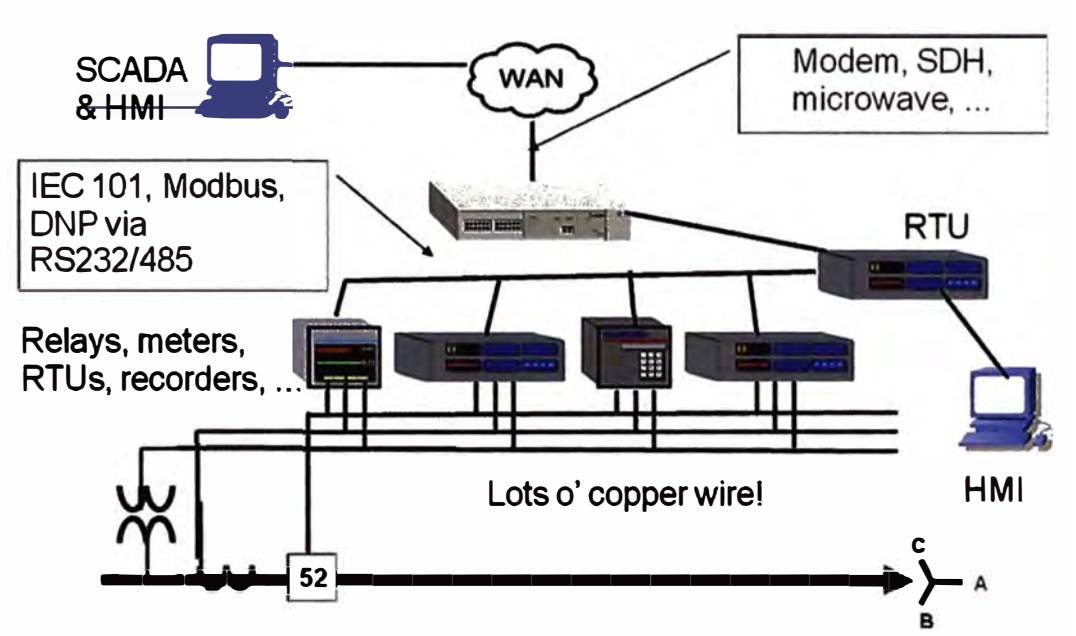


Figura 2.1 : Arquitectura de automatización de Subestaciones tradicional

Luego con el avance de la tecnología digital los relés, medidores y RTUs se transformaron en IEDs y la red Ethernet se convirtió en la red escogida por muchos a fin de lograr la Automatización de la Subestaciones. La Figura 2.2 indica la arquitectura actualmente utilizada. Como principal característica se nota los esfuerzos necesarios para reducir el cableado.

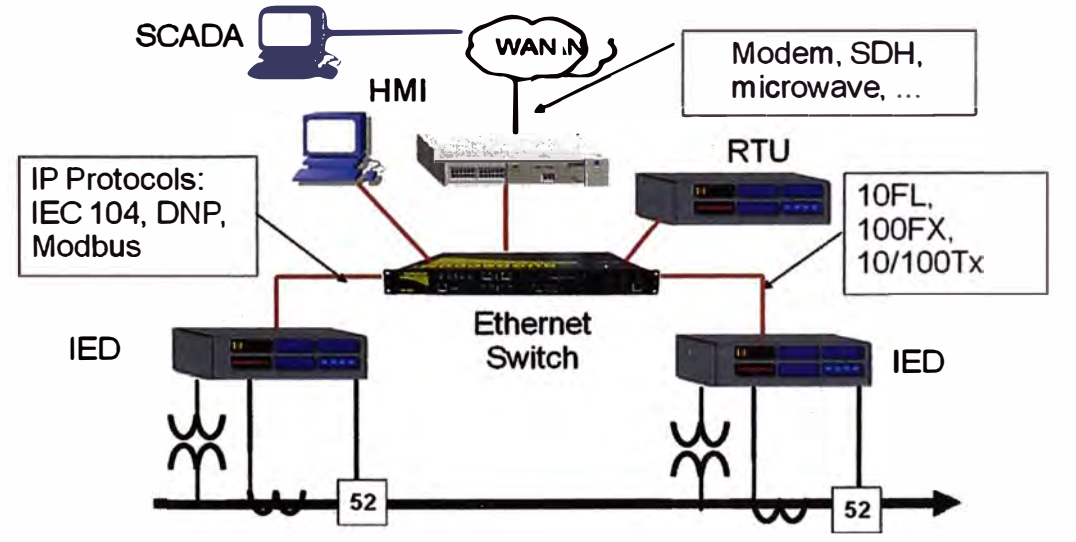


Figura 2.2 : Arquitectura de automatización actual

Otro de los esfuerzos de los ingenieros de automatización fue buscar un protocolo de comunicación único debido a los diferentes que existían en el mundo. En la Figura 2.3 se presenta los principales protocolos de comunicación existentes en el mundo

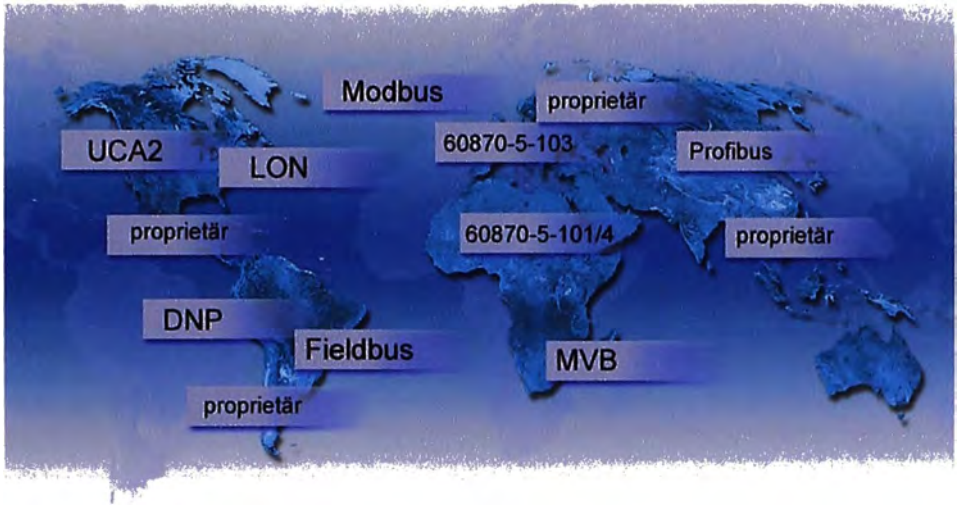


Figura 2.3 : Protocolos de Comunicación alrededor del mundo

El objetivo buscado por años ha sido definir una infraestructura de comunicaciones que permita una perfecta integración de los IEDs con independencia del fabricante. La definición de un Bus de estación ha sido por años el centro de estandarización mundial. También la búsqueda continua en la reducción del cableado tanto del tipo eléctrico como de comunicación así como el sacar las mayores funcionalidades a los IEDs son parte de los innumerables desvelos de los ingenieros de Automatización. La respuesta a todos esos requerimientos fue plasmada en la norma IEC 61850 tal como lo indica la Figura 2.4.

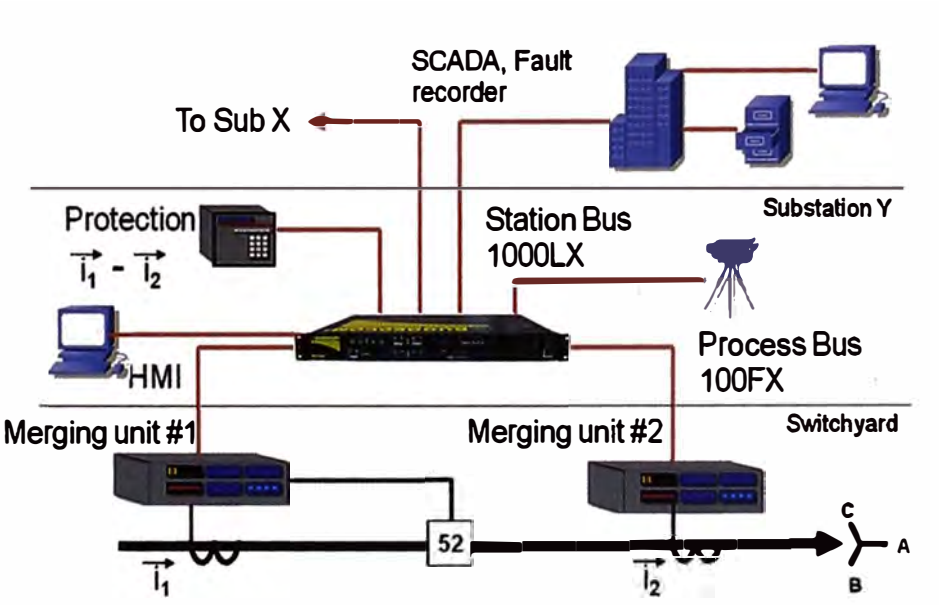


Figura 2.4 : Arquitectura de Automatización bajo la norma IEC 61850

En el Anexo A se presentan algunas arquitecturas tradicionales en IEC 61850.

2.2. Descripción

En los años 90 tanto la EPRI como la IEEE hicieron los primeros esfuerzos en lograr una Utility Communications Arquitecture (UCA) . Se centraron primero en los protocolos de comunicación entre Centros de Control el concluyo con las especificaciones ICCP mas tarde adaptadas por el IEC como la 61850 TASE.2 .

La siguiente fase del UCA llamada UCA 2.0 comenzó en el año 1994 y se enfoco en el "Bus de datos de la Subestación". En el año 1996 el Comité Técnico 57 del IEC comenzó a trabajar en la Norma IEC 61850 también enfocado al "Bus de datos de la Subestación".

En el año 1997 los 02 grupos de trabajo EPRI/IEEE e IEC unieron esfuerzos en la definición de un estándar internacional que combine el trabajo de ambos grupos. El resultado fue la norma IEC 61850 actual. En la Figura 2.5 se presenta el proceso de desarrollo de la Norma IEC 61850

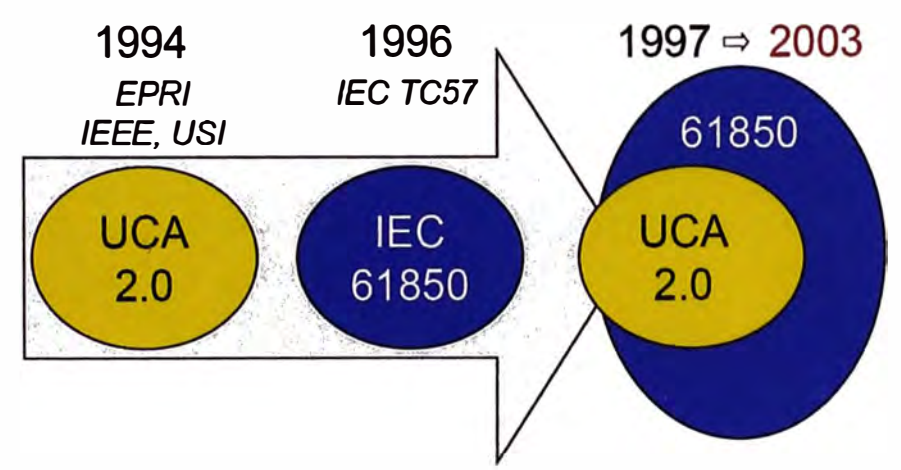


Figura 2.5 : Proceso de desarrollo de la Norma IEC 61850

IEC 61850 es un nivel superior al UCA 2.0 . Contiene muchas de las especificaciones del UCA 2.0 más características adicionales . IEC 61850 fue publicada como estándar internacional el año 2003 . En el Anexo D se presentan un resumen de las normas constituyentes de la IEC 61850 las cuales son las siguientes:

IEC 61850-1 , Part 1 : Introduccion and Overview
Presenta una introducción y una visión general de la norma.

IEC 61850-2 , Part 2 : Glosario
Presenta la terminología y definiciones utilizadas en toda la norma.

IEC 61850-3 , Part 3 : General requeriments
Define requerimientos ambientales para equipos de comunicaciones dentro de una Subestación. Ofrece un marco completo de pruebas incluyendo EMI (Interferencia Electromagnética), requerimientos de inmunidad y medioambiente .

IEC 61850-4 , Part 4 : System and proyect management
La especificación de esta pertenece a la administración del proyecto y del sistema en lo relacionado a : Los procesos de ingeniería y herramientas de soporte, El Ciclo de vida de IEDs, El aseguramiento de la calidad.

IEC 61850-5 , Part 5 : Communications requirements for functions and device models
Establece el modelo utilizado por el estándar para las funciones y modelos de equipos utilizados por la norma.

IEC 61850-6 , Part 6 : Configuration description language for communication in electrical substation related to IEDs
Especifica las características del lenguaje de configuración de los IEDs que utilizan esta norma. Este lenguaje es llamado Subestation Configuration Description Language (SCL).

IEC 61850-7-1 , Part 7-1 : Basic Communication structure for substation and feeders equipment – Principies and models
Esta parte del IEC 61850 provee una vista general de la arquitectura de comunicaciones e interacciones entre equipos tales como Reles de protección, interruptores, transformadores, etc.

IEC 61850-7-2 , Part 7-2 : Basic Communication structure for substation and feeders equipment – Abstract communication service interface (ACSI)

Esta parte del IEC 61850 define el Abstract Communication Service Interface (ACSI) para usar dentro de la Subastación que requiere cooperación en tiempo real de IEDs.

IEC 61850-7-3 , Part 7-3 : Basic Communication structure for substation and feeders equipment – Common Data Clases

Define los tipos de atributos y clases relativos a las aplicaciones utilizadas en subestaciones.

IEC 61850-7-4 , Part 7-4 : Basic Communication structure for substation and feeders equipment – Compatible logical node classes and data classes

Esta parte especifica los nombres de los Nodos Lógicos y Datos asi como la relación entre los mismos.

IEC 61850-7-410 , Part 7-410 : Hydroelectric Power Plants – Communication for monitoring and control

Especifica los nombres de los Nodos Lógicos y Datos no mencionados en la IEC 61850-7-4.

IEC 61850-8-1 , Part 8-1 : Specific Communication Service Mapping (SCMS) – Mappings to MMS (ISO 9501 and ISO 9506-2) and ISO/IEC 8802-3

Esta parte especifica un método de intercambio de datos critica y no critica atraves de redes LAN para efectuar el Mapping de ACSI a MMS en muestras del tipo Ethernet.

IEC 61850-9-1 , Part 9-1 : Specific Communication Service Mapping (SCMS) – Sampled Values over serial unidirectional multidrop point to point link

Esta parte aplica a equipos electrónicos que sirven de interface entre los transformadores de corriente y tensión y los equipos de medición y reles de protección. Estos equipos son llamados " Merging Units"

IEC 61850-9-2 , Part 9-2 : Specific Communication Service Mapping (SCMS) – Sampled Values over ISO/IEC 8802-3

Esta parte aplica al envió sobre Ethernet de las señales de los transformadores de corriente y tensión electrónicos.

IEC 61850-10 , Part 10 : Conformance Testing

Especifica los procesos de prueba que deben cumplir los IEDs a fin de cumplir con la norma IEC 61850.

En la figura 2.6 se presenta un resumen de estructura de la Norma IEC 61850

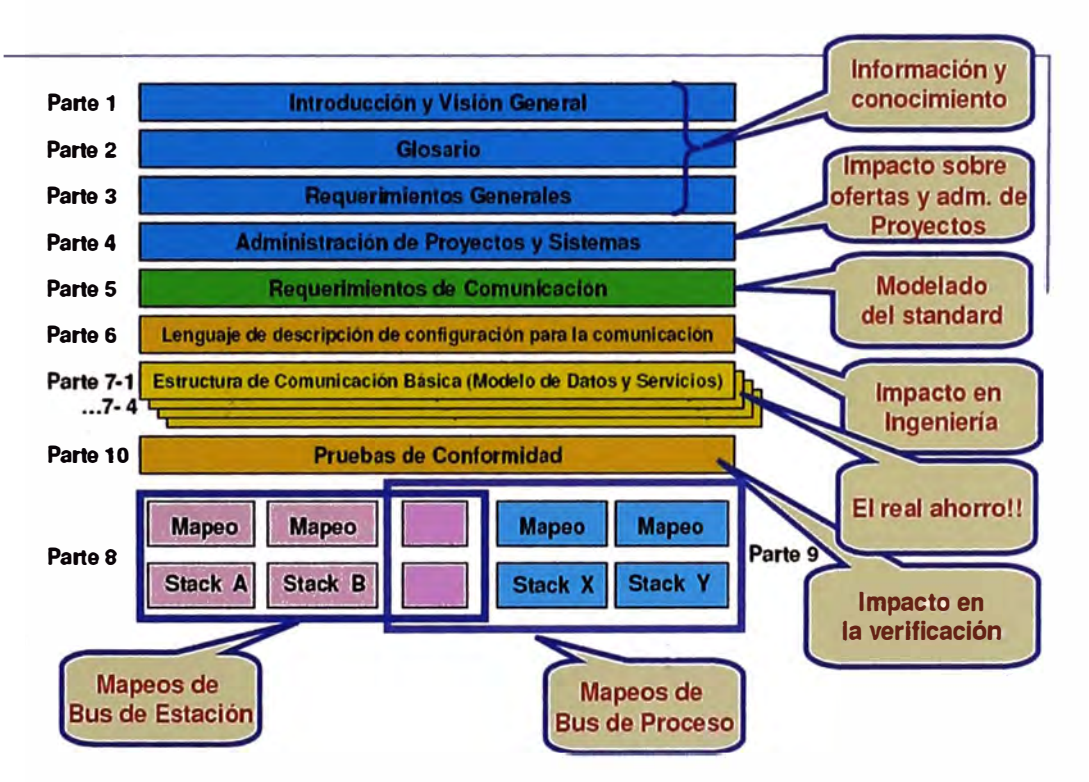


Figura 2.6 : Estructura del Estándar IEC 61850

El IEC 61850 provee interoperabilidad entre dispositivos electrónicos inteligentes (IED's) para las aplicaciones de protecciones, monitoreo, medición, control y automatización en las subestaciones. La funcionalidad de la automatización está dada por las tareas (de los IED's) y no por el IEC 61850. De esta forma, el sistema de comunicaciones interno de la subestación (Red LAN) es la red troncal de la automatización y el IEC 61850 es una herramienta para el de diseño de la automatización. Este protocolo utiliza modelos orientados a objetos para la descripción de los dispositivos y su funcionalidad y la selección de la tecnología de comunicaciones está basada en las especificaciones de

usuario, lo cual constituye una las características más robustas del IEC 61850. La funcionalidad de las interconexiones debe describirse también y se hace mediante la ayuda del software "SCL" ("Substation Configuration description Language" herramienta basada en lenguaje de marcaciones extensibles XML).

2.3. Características

Interoperabilidad

El IEC 61850 requiere que cualquier IED que cumpla su norma provea un SCL (generalmente un archivo) con la descripción de sus capacidades. El Nombre de tal archivo es con extensión ICD (IED configuration description). Éste puede suministrarse en CD o dentro de su misma unidad. Es importante que este archivo pueda ser leído por otros dispositivos que cumplan la norma y tengan la herramienta. Además debe poseer una base de datos para el integrador.

El resultado del proceso de diseño para IEC 61850 puede almacenarse en un archivo SCD que contiene las comunicaciones lógicas entre IED's dentro de las subredes y los switches dentro de las subredes. Las figuras 2.7 especifican todo el proceso de interoperabilidad.

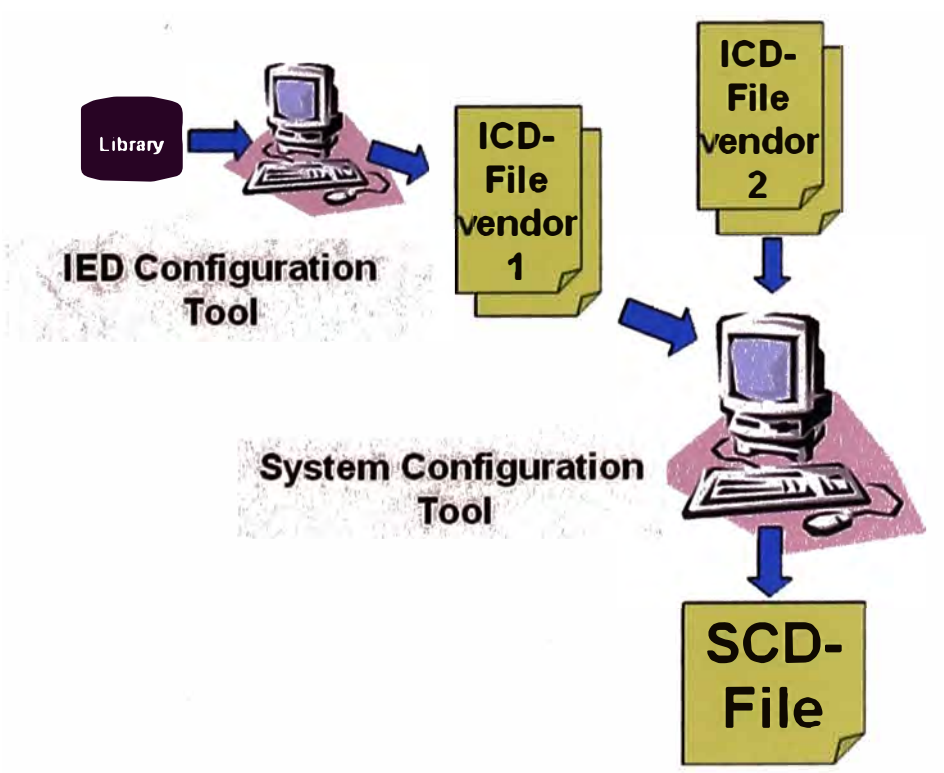


Figura 2.7 : Interoperabilidad entre archivos ICD de diferentes fabricantes de IEDs

La estructura del Archivo SCD es mostrado en la Figura 2.8.

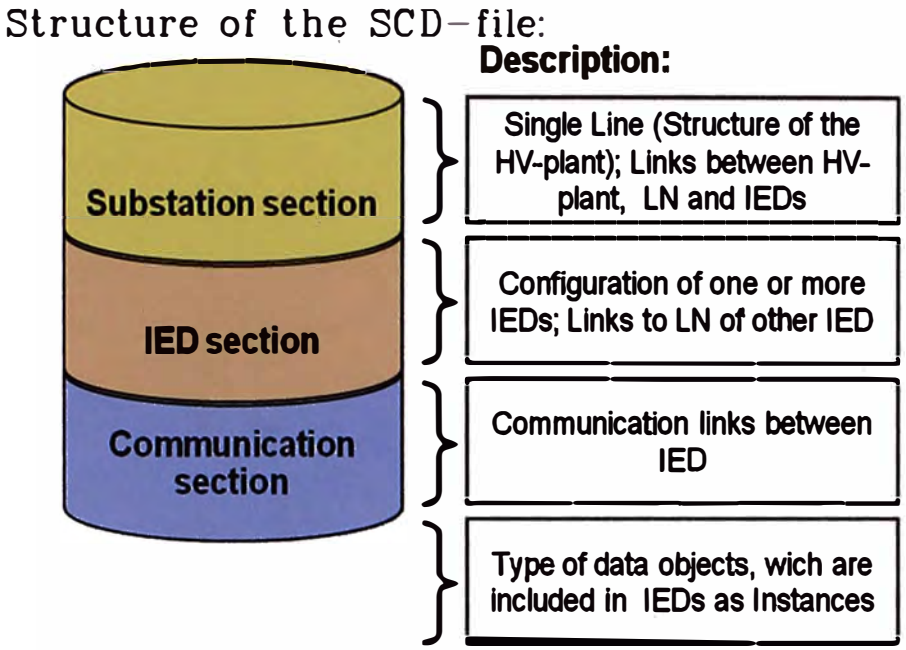


Figura 2.8 : Estructura del Archivo SCD

La Figura 2.9 muestra el diagrama completo de interoperabilidad entre IEDs

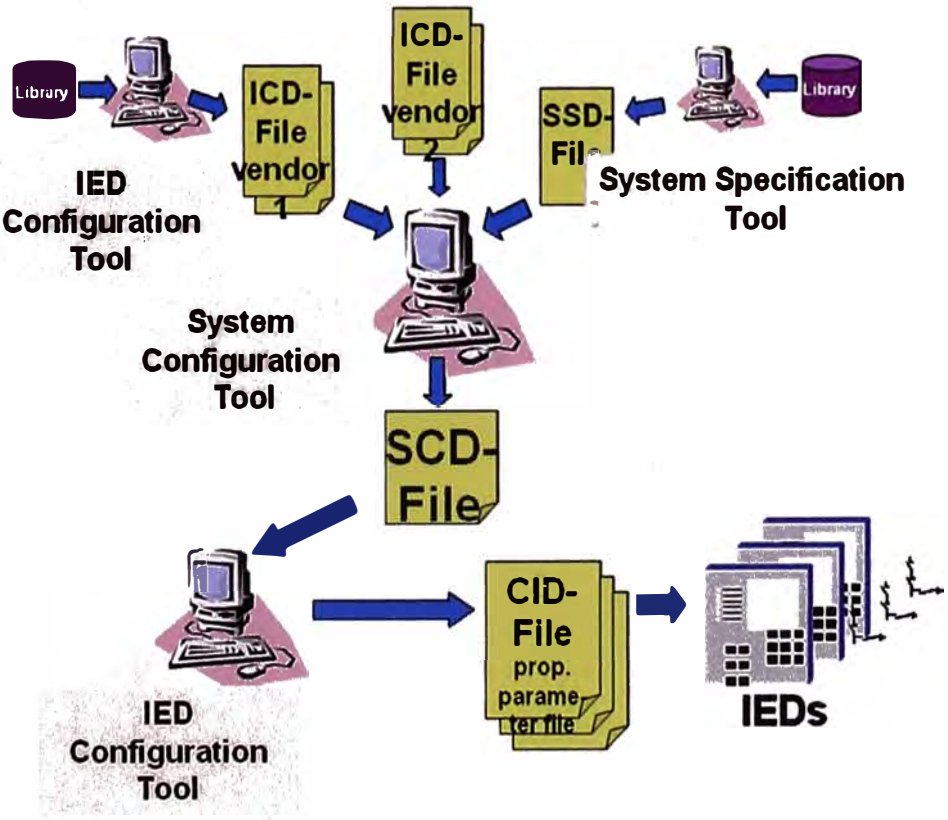


Figura 2.9 : Diagrama completo de interoperabilidad entre IEDs

Definición de Objetos

Tradicionalmente para lecturar desde un HMI la información que posee un IED esta es reconocida por una serie de "Números Mágicos" los cuales representan tipos de datos. El problema es que el "Contexto de los datos" se pierde y se requiere denodados esfuerzos de ingeniería para lograr tener la configuración del Mapping de direcciones del HMI hacia los IEDs.

Ahora con el IEC 61850 la información de un IED es dividida en "Grupos Lógicos" los cuales a su vez se dividen en Nodos Lógicos . Adicionalmente se tienen Clases de Datos correspondientes a cada Nodo Lógico. La Figura 2.10 presenta un diagrama esquemático del Mapping en IEC 61850

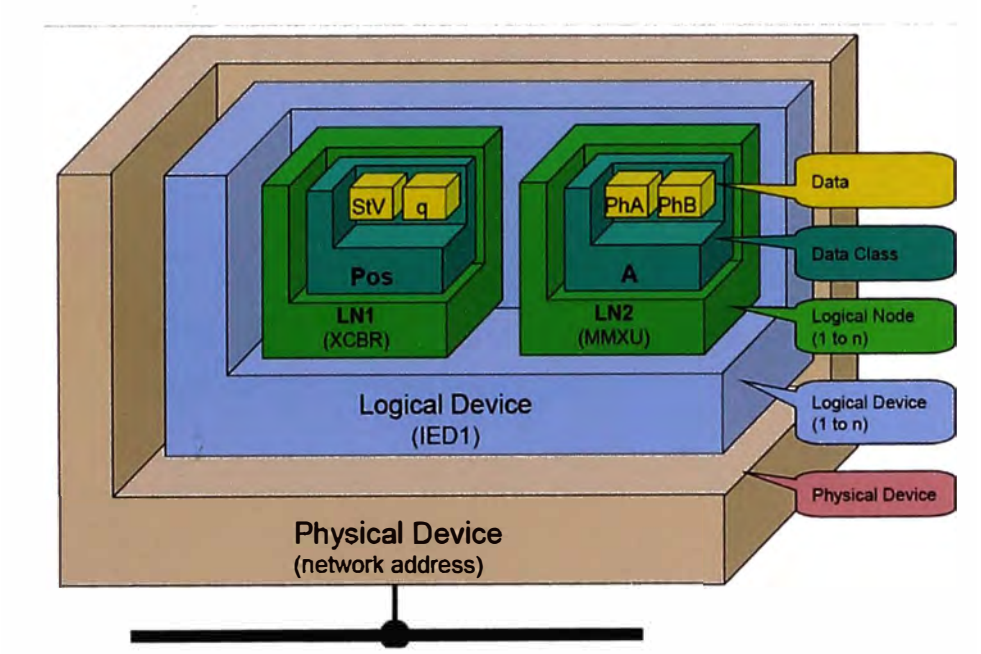


Figura 2.10 : Diagrama esquemático del Mapping en IEC 61850

En el Anexo B se presenta la forma de efectuar los procesos de integración de IEDs bajo la Norma IEC 61850.

Comunicación Punto a Punto (GOOSE)

GOOSE es un acrónimo de Generic Object Orintated System Wide Events . Esta reemplaza el convencional Cableado para que los IEDs intercambien información entre ellos. En el momento que se detecta un evento (cambio de estado de un Interruptor en un IED por ejemplo) , el IED usa una comunicación del tipo Multicast para notificar a los otros IEDs que se encuentran en el mismo BUS que ha ocurrido un evento. La performance del tiempo de envío es exigente, no mas de 4ms es permitido como tiempo transcurrido entre que el evento ocurra y hasta que este es transmitido a los otros IEDs.
La Figura 2.11 presenta el diagrama esquemático de los mensajes GOOSE entre IEDs

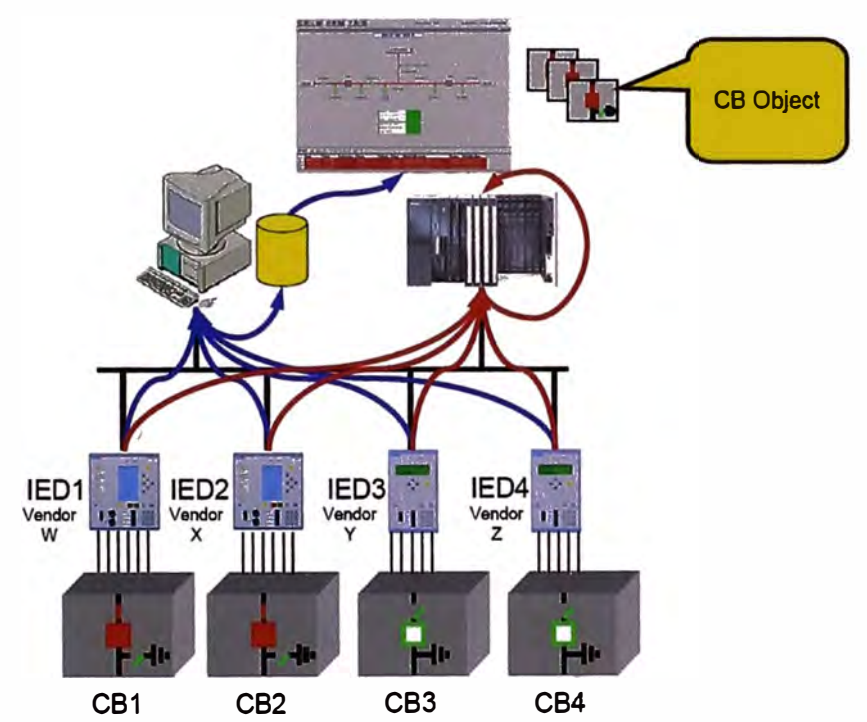


Figura 2.11 : diagrama esquemático de los mensajes GOOSE entre IEDs

El Numero de IEDs, la topología de la red y el tipo de evento generado contribuyen a la cantidad de datos que será generada después de un evento. Dado que las colisiones son posibles en una red Ethernet , los mensajes son GOOSE son retransmitidos múltiples veces por cada IED. Los Switches de 10MB y 100Mb pueden entregar 100 mensajes GOOSE dentro de 4 milisegundos.

Bus de Proceso

Los términos Bus de Proceso y Bus de Estación inicialmente usados por las tempranas publicaciones del IEC 61850 ahora son historia. Hoy en día IEC 61850 no efectúa precisiones con respecto a la arquitectura de la Subestación.

Cuando el IEC 61850 inicio planteo una arquitectura de 03 niveles : Bus de estación, Bis de Bahía y Bus de proceso. El Bus de Estación (IEC 61850 , Parte 8) fue planeado para la comunicación entre la Estación (PC) y el Nivel de Bahía (IEDs) , El bus de proceso (IEC 61850, Parte 9) para la comunicación entre el nivel de bahía y el nivel de proceso. La Figura 2.12 presenta el planteo inicial de la arquitectura por Niveles del IEC 61850.

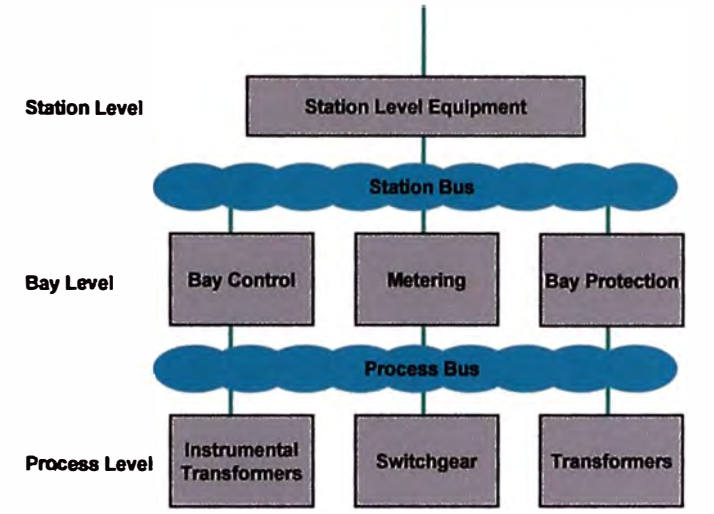


Figura 2.12 : Niveles Iníciales del IEC 61850

Conforme el proceso de estandarización del IEC 61850 progreso y la armonización con el UCA era necesario, se decidió que el IEC 61850 no restrinja los limites de las interfaces de comunicación en los 03 niveles. Por lo tanto se decido que la comunicación Ethernet (ISO/IEC 8802-3) sea la base de las comunicaciones.

IEC 61850-9-1 e IEC 61850-9-2 son dedicados para especificar los modelos para la transmisión de las muestras de las formas de onda de los parámetros eléctricos a monitorear.

IEC 61850-9-1 es unidireccional y es dirigido a utilizarse para una comunicación punto a punto de las muestras de las formas de onda hacia un IED. El IEC 61850-9-2 es mas general y está dirigida hacia una comunicación con varios IEDs.

2.4. El Futuro de IEC 61850

La edición Nro 2 del Estándar se encuentra actualmente en preparación. Dicha edición incorpora nuevos requerimientos y nuevas aplicaciones tales como medición de la calidad de la energía. Tenemos actualmente los siguientes desarrollos futuros de la norma IEC 61850:

IEC 61850 Fuera de la Subestación

- Actualmente se encuentra en desarrollo el estándar que permitirá la comunicación bajo la norma IEC 61850 de los IEDs de diferentes subestaciones eléctricas.
- Actualmente se encuentra en desarrollo el estándar que permitirá la comunicación bajo la norma IEC 61850 entre un centro de control y las subestaciones.

IEC 61850 en Centrales de Generación:

Actualmente se encuentra en desarrollo la norma IEC 61850 para Centrales hidroeléctricas y Centrales Eólicas.

2.5. IEC 61850 y la "Red Inteligente Empresarial"

Actualmente las empresas eléctricas alrededor del mundo se encuentran transformando su "red electromecánica" de la centuria anterior por la "red Inteligente" constituida por IEDs y Computadores. Las mismas tecnologías que revolucionaron las computadoras y las comunicaciones y crearon Internet ahora se encuentran transformando la infraestructura de las Subestaciones Eléctricas.

Un numero de entidades tales como la EPRI y el Departamento de Energía de los EEUU (DOE) han planteado iniciativas direccionadas a modernizar la infraestructura de las empresas eléctricas así tenemos la "EPRI's IntelliGrid" y "DOE's GridWise" .

La Figura 2.13 presenta una vista conceptual de los componentes típicos de la información empresarial de una compañía eléctrica. Dicha infraestructura utiliza una misma infraestructura para el acceso a la información en todas las áreas de la empresa. Esta visión requiere una estratégico conocimiento de las necesidades de cada área y las capacidades de integración de las mismas así como la integración de diversas bases de datos.

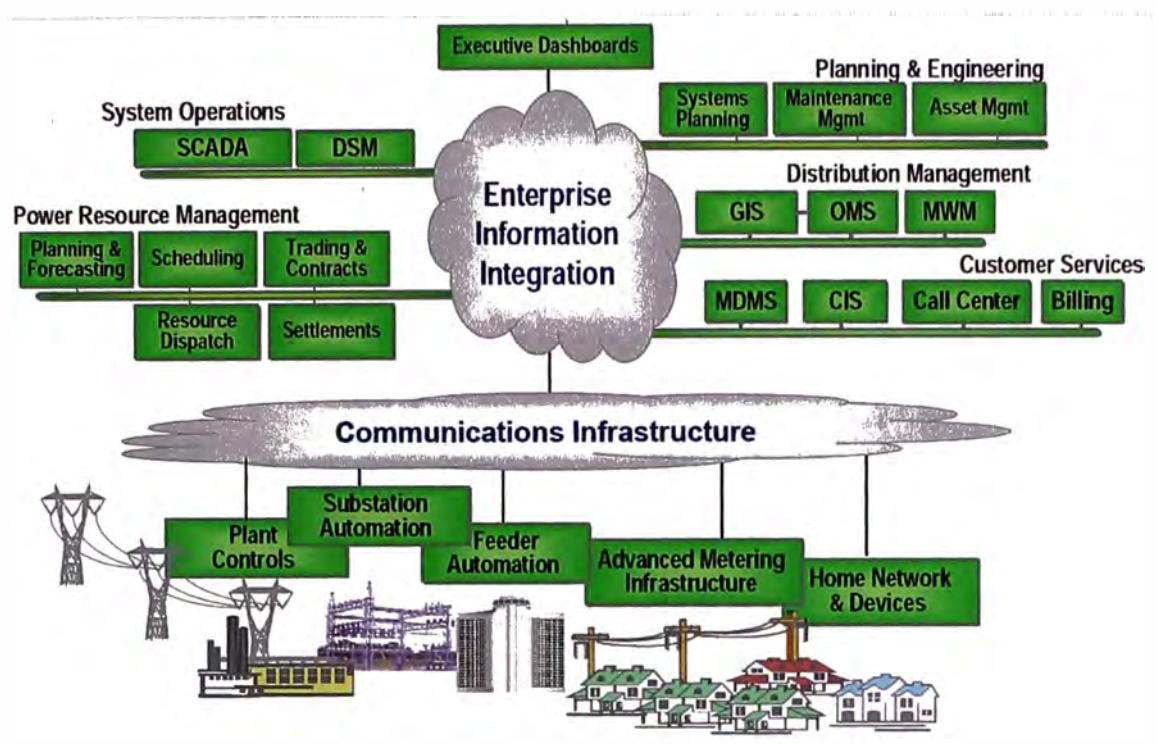


Figura 2.13 : Red Inteligente Empresarial

Los habilitadores para que se forme la Red inteligente empresarial son los IEDs y el protocolo IEC 61850.

2.6. Beneficios Económicos por Implementación del IEC 61850

La implementación de la Automatización de Subestaciones bajo el esquema del IEC 61850 ofrece los siguientes beneficios económicos a la empresa

1.- Ahorro en Costos directos de capital como resultado del monitoreo continuo de los interruptores y transformadores por el uso de los IEDs . Esto trae como consecuencia un ahorro por reducir la probabilidad de una falla catastrófica y la vida útil de dichos equipos. Los mantenimientos usuales y mensuales se ven optimizados pues continuamente las condiciones de los equipos principales de la subestación se encuentran monitoreadas.

2.- Ahorro por reducción en el tiempo de Análisis de la Falla . Los tiempos de análisis de la falla e investigación de sucesos permitirán la restauración inmediata de los elementos críticos de una Subestación. Ello es posible gracias a las herramientas de análisis de los IEDs (análisis de eventos, oscilografías y alarmas).

3.- Ahorro por el conocimiento preciso de las características de sobrecarga de líneas de transmisión y transformadores . El continuo calculo y monitoreo de las condiciones dinámicas de los equipos por parte de los IEDs habilita a las empresas eléctricas a plantear restricciones referentes a la máxima capacidad a transmitir sin sobrecargar excesivamente los equipos y así evitar deterioro de sus aislamientos.

4.- Ahorro por el conocimiento oportuno y preciso de las alarmas asociadas a los IEDs . El procesamiento inteligente de las alarmas de los IEDs de una Subestación hace que se tomen las decisiones mas acertadas referentes al envío del personal a la Subestación con los consiguientes gastos que esto implica.

5.- Ahorro por el conocimiento oportuno y preciso de los valores del Factor de potencia y Tensión . El conocimiento del factor de potencia durante las horas punta y fuera punta habilita a la empresa eléctrica a reducir las pérdidas eléctricas y a tener un mejor conocimiento a la hora de efectuar transferencias de carga.

Los anteriores puntos fueron cuantificados por KEMA CONSULTING tomando como ejemplo una empresa eléctrica americana . Dichos resultados son mostrados en la Tabla 2.1.

Tabla2.1 : Ahorro anual por implementación del IEC 61850 (Fuente KEMA CONSULTING)

FUNCION	EQUIPO DE UNA SUBESTACION	MONTO ESTIMADO DE AHORRO ANUAL
Ahorro por el Monitoreo continuo de Interruptores y transformadores.	Transformador de 500kV	$ 44028
	Transformador de 230kV	$22014
	Interruptor de 500kV	$9638
	Interruptor de 230kV	$22286
Ahorro por Mejora en el tiempo de Análisis de la falla.	Línea en 500kV	$2500
	Línea en 230kV	$1600
	Circuito de Distribución	$300
Ahorro por el conocimiento preciso de las características de sobrecarga de líneas de transmisión y transformadores.	Transformador de 500kV	Se difiere $4 Millones en el lapso de 3 años
	Transformador de 230kV	Se difiere $3 Millones en el lapso de 3 años
Ahorro por el conocimiento preciso de las alarmas asociadas a los IEDs.	Toda la Subestación	$1500
Ahorro por el conocimiento oportuno y preciso de los valores del Factor de potencia y Tensión.	Circuitos de Distribución	$13029

CAPÍTULO III

APLICACIÓNES ALREDEDOR DEL MUNDO DEL IEC 61850

3.1 Introducción

Hasta diciembre del año 2005 aproximadamente se han efectuado aproximadamente 110 Sistemas de Automatización de Subestaciones basados en el IEC 61850 . 70 de ellos ya se encuentran en operación.

3.2 Aplicaciones Internacionales

SUIZA

ABB Suiza realizo la primera implementación mundial del IEC 61850 en Noviembre del año 2004 . Hay sin embargo otros importantes proyectos iniciados incluyendo la modernización dºe la Subestación Laufenburg en 380kV . Esta Subestación es un importante nodo del Sistema Interconectado Europeo. El proyecto Laufenburg comenzó en Diciembre del año 2004 y el punto central es lograr la modernización de 17 bahías para fines del año 2006 utilizando el IEC 61850.

ALEMANIA

Alemania posee el mas grande numero de implementaciones operativas y cuenta con muchas otras en proceso de pruebas. El punto de vista de un Fabricante Alemán es que el Estándar IEC 61850 comience a ser el estándar único para comunicación de subestaciones en el mundo. Esta opinión refleja el esfuerzo gastado para mejorar equipos y para definir configuración estandarizada. . Conforme se incremente el uso del IEC61850 , otros protocolos de comunicación gradualmente desaparecerán. Otro factor importante es que en 2/3 partes de los caso en donde se usa el IEC 61850 el nivel de tensión es superior a los 100 kV lo cual indica la importancia de su utilización.

ITALIA

Tema, EL Operador del Sistema Eléctrico Italiano, ha desarrollado una serie de especificaciones para el uso del IEC61850 como estándar dentro de las Subestaciones. El nombre del proyecto llamado SICAS es un esfuerzo por crear un estándar integrado de comunicaciones que sirva a las necesidades de TERNA mientras al mismo tiempo , atraves del uso del IEC 61850, mantiene la autonomía del vendedor. Dicho requerimiento especifica que los diseños de cada vendedor sean intercambiables en el Nivel de Bahía. Por lo tanto, mientras el diseño de cada bahía podría diferir en aspectos, la comunicación externa seria la misma.

ESPAÑA

IBERDROLA , una empresa eléctrica Española, ha diseñado un SAS (Sistema de Automatización de Subestaciones) basado en el IEC 61850. Este proyecto es llamado "Ciudad Universitaria" . El proyecto es diseñado para comprobar la efectividad del IEC 61850 y también comprobar la interoperabilidad entre IEDs.

Para Iberdrola , el IEC 61850 abre nuevas posibilidades para la integración y uso de Sistemas de Protección y Control. Además Iberdrola considera dos características importantes del protocolo que deben ser probadas:

Interoperatibilidad : Equipos de protección y Control de diferentes fabricantes deberían trabajar consistentemente como indica la teoría.

Herramientas de Ingeniería: Los beneficios de trabajos de ingeniería deberían corresponder a la teoría.

La "Ciudad Universitaria" comenzó en el año 2004 con la creación de grupos de trabajo y la participación de Iberinco quien al igual que Iberdrola, se familiarizo con el IEC 61850 y tuvo extensiva experiencia en SAS. Después de algún retardo en el proceso de construcción de la Subestación , otra Subestación en España escogió introducir el IEC 61850.

Uno de las conclusiones del proyecto fue efectuar muchas consultas técnicas al grupo de desarrollo del IEC 61850.

CONCLUSIONES

Las nuevas tendencias en la automatización de subestaciones de potencia son las siguientes:

1. La utilización de IEDs con tecnología digitales como medidores, relés de protección y Unidades Terminales Remotas (UTR) que ahora tienen nuevas características y funcionalidades, una de ellas es la capacidad de "hablar un lenguaje " (protocolo de comunicación) a fin de entregar toda la información valiosa que disponen.
2. La Utilización de la tecnología Ethernet en Fibra Óptica en Subestaciones.
3. El establecimiento de criterios de seguridad en la información procesada en las subestaciones (tales como la norma NERC indicada en 1.3.5).
4. Utilización de la Norma IEC 61850 en el ambiente de la Subastación la cual a su vez trae los siguientes beneficios:
   - Interoperabilidad, IEDs de diferentes fabricantes pueden intercambiar y usar información sobre medios de comunicación comunes (la funcionalidad en los diferentes dispositivos no es necesariamente la misma).
   - La ingeniería y configuración de datos es transportable entre herramientas de diferentes fabricantes.
   - Reduce la ingeniería y la configuración
   - Capacidades de comunicación, adquisición de datos, y control son incluidas directamente en los equipos primarios.
   - Libre asignación de funciones en sistemas de configuraciones centralizadas o descentralizadas.
   - Reducción del cableado convencional.
   - Redes LAN en lugar de múltiples cables de cobre seriales en las Subestaciones Eléctricas.
   - Los servicios y las inversiones serán duraderos a pesar de los rápidos cambios tecnológicos.
   - El estándar está diseñado para seguir tanto el progreso en las tecnologías de comunicación, como los requerimientos que envuelven a estos sistemas.
5. Posibilita la creación de la "red inteligent e empresarial" el cual traería muchos beneficios a las diferentes áreas de la empresa eléctrica.

ANEXO A

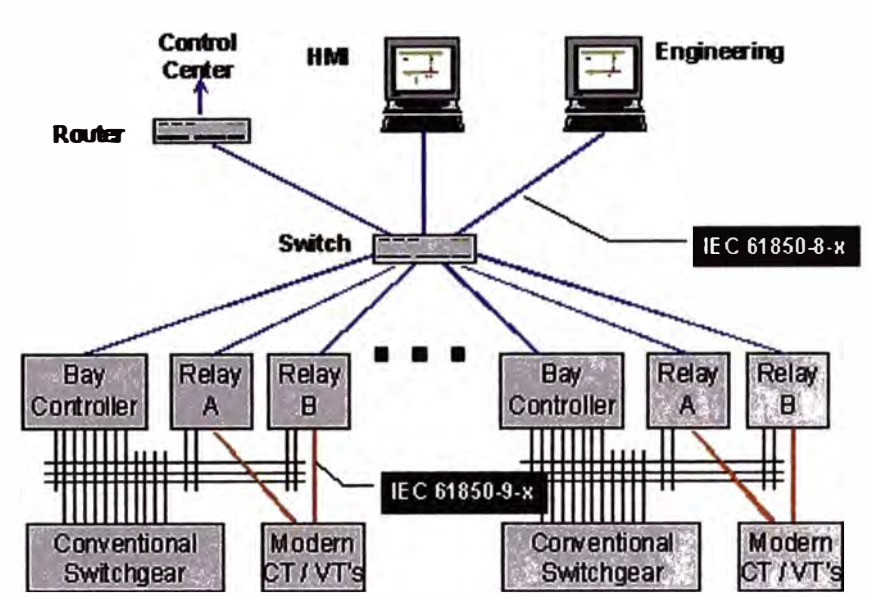
ARQUITECTURAS TRADICIONALES BAJO LA NORMA IEC 61850

ANEXO B

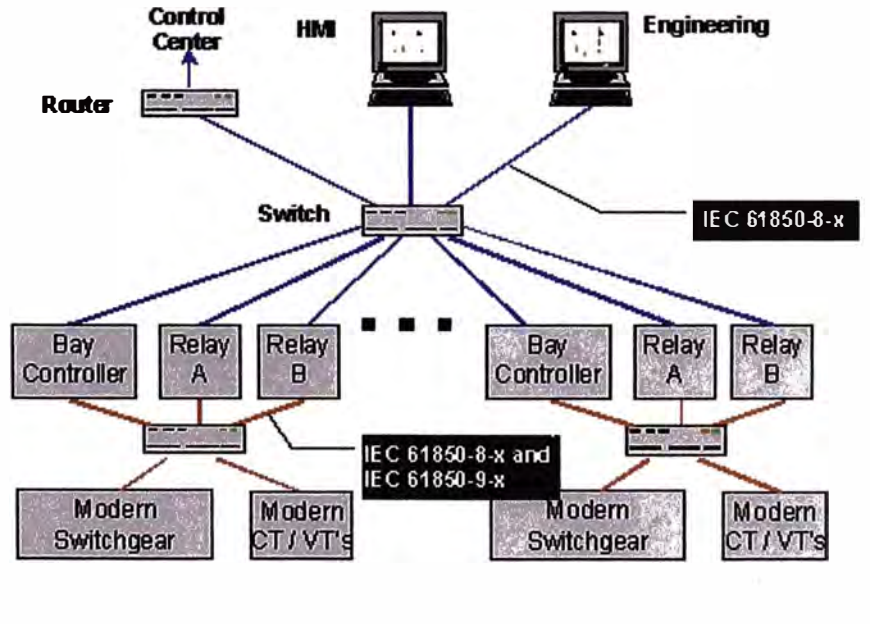
PROCESO DE INTEGRACION DE IEDS BAJO LA NORMA IEC 61850

ANEXO A

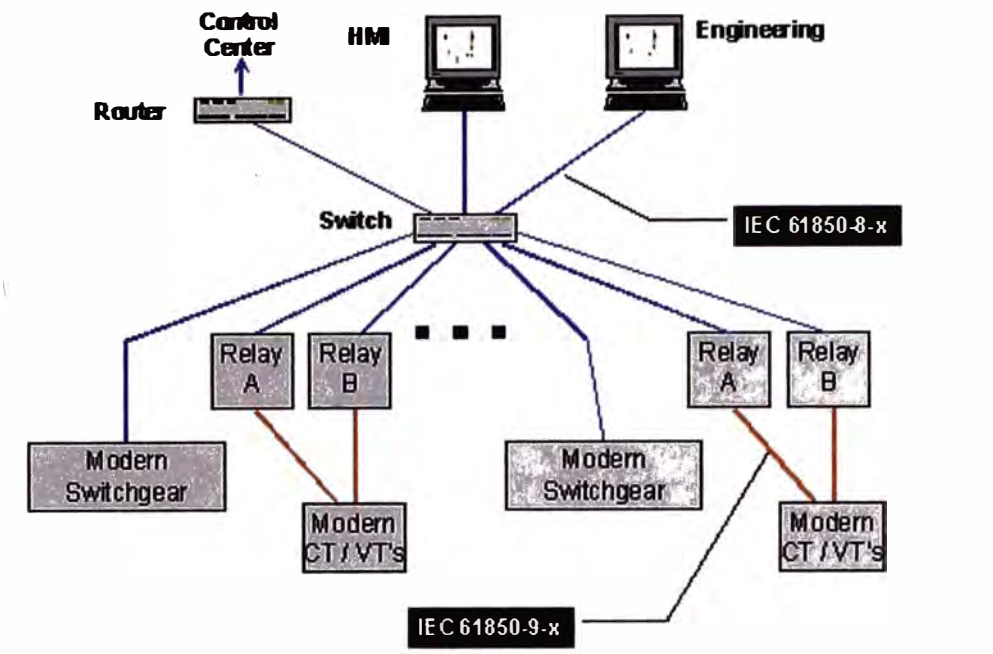
ARQUITECTURAS TRADICIONALES BAJO LA NORMA IEC 61850



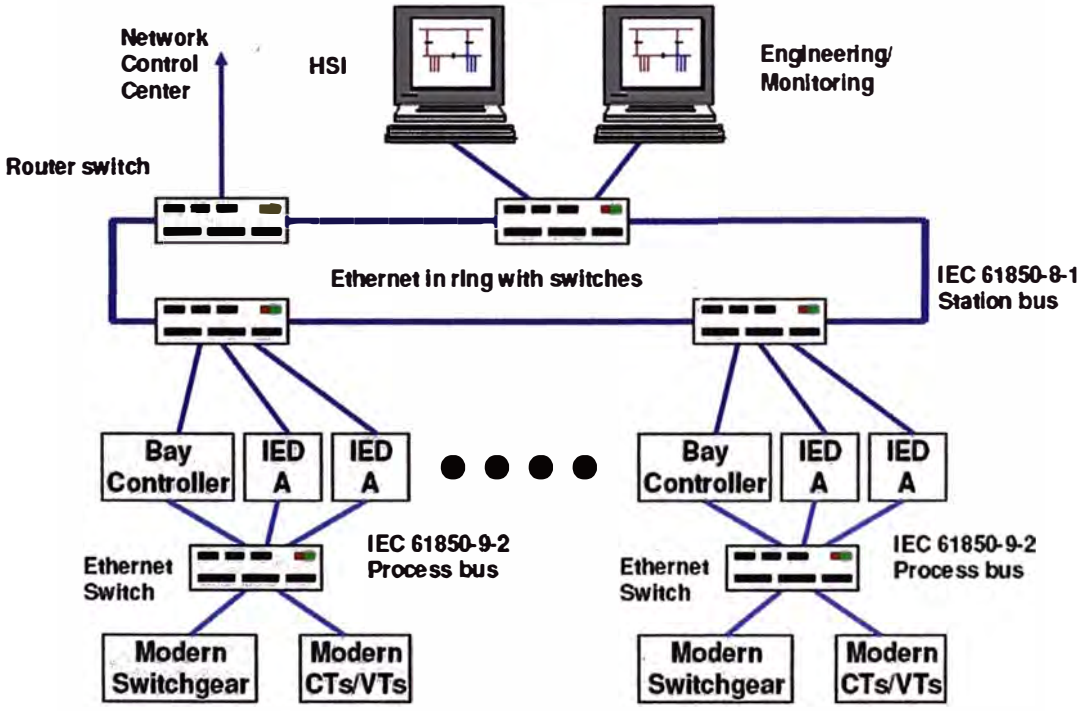
Arquitectura de Implementación Mixta



Arquitectura de Implementacion con Bus de Proceso



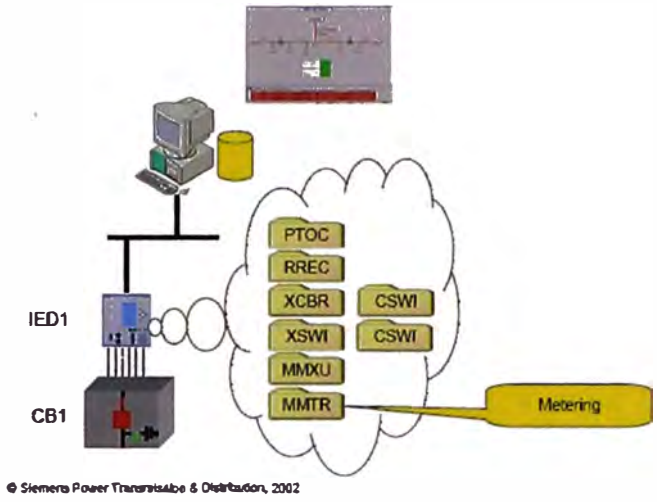
Arquitectura con un solo Switch



Arquitectura en anillo

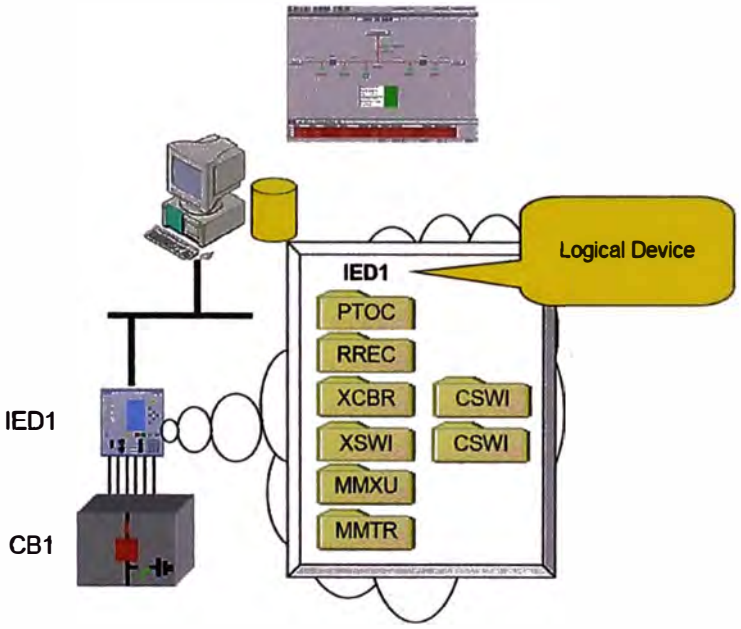
ANEXO B

PROCESO DE INTEGRACION DE IEDS BAJO LA NORMA IEC 61850



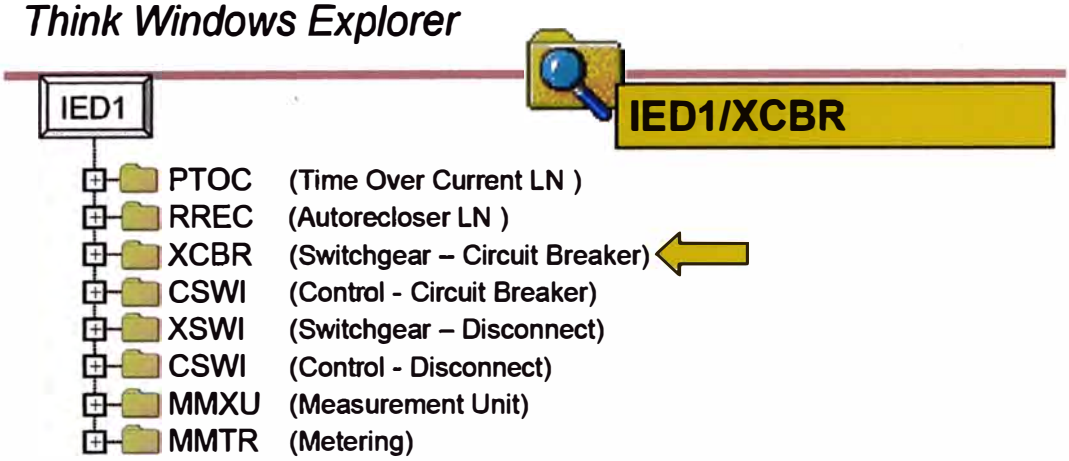
IED1 is a multi-function IED and supports the following features:

Protection (Time Over Current, 51)	PTOC LN
Protection related (Autoreclosing, 79)	RREC LN
Monitoring of CB	XCBR LN
Control of CB	CSWI LN
Monitoring of Disconnect Switch	XSWI LN
Control of Disconnect Switch	CSWI LN
Measurement (V, A, W, etc)	MMXU LN
Metering (Energy)	MMTR LN



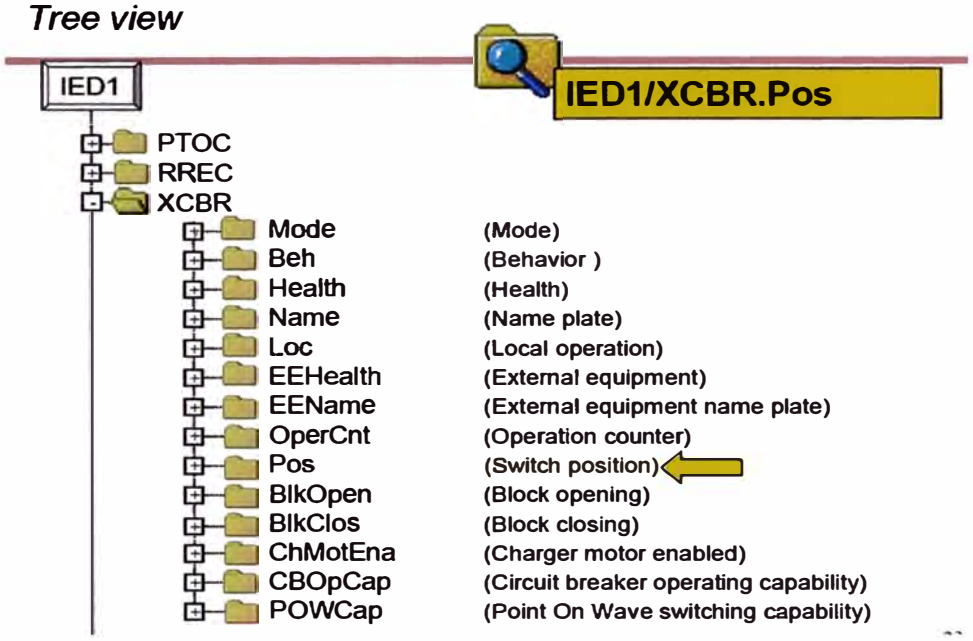
Accessing Data

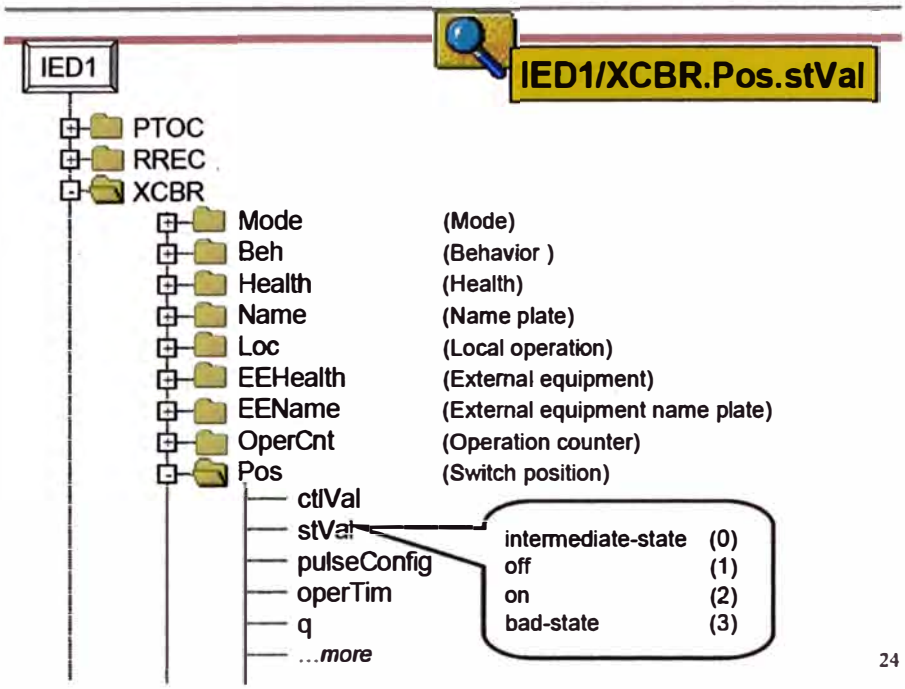
Think Windows Explorer



Accessing Data

Tree view





Logical Node Groups	Group Designator
System Logical Nodes	L
Protection functions	P
Protection related functions	R
Supervisory control	C
Generic References	G
Interfacing and Archiving	I
Automatic Control	A
Metering and Measurement	M
Switchgear	X
Instrument Transformer	T
Power Transformer	Y
Further power system equipment	Z
Sensors	S

Logical Node Groups	Group Designator	Number
System Logical Nodes	L	2
Protection functions	P	27
Protection related functions	R	1 0
Supervisory control	C	4
Generic References	G	3
Interfacing and Archiving	I	4
Automatic Control	A	4
Metering and Measurement	M	7
Switchgear	X	2
Instrument Transformer	T	2
Power Transformer	Y	4
Further power system equipment	Z	14
Sensors	S	3
		86

PDIR Directional element
PHAR Harmonic restraint
PSCH Protection Scheme
PTEF Transient Earth Fault
PZSU Zero speed or underspeed
PDIS Distance protection
PVPH Volts per Hz relay
PTUV Undervoltage
PDOP Directional over power
...more

MMXU Measuring (Measurand unit)
MMTR Metering
MSQI Sequence and Imbalance
MHAI Harmonics and Inter-harmonics
MDIF Differential Measurements
...more

XCBR Circuit Breaker
XSWI Circuit Switch

Data Classes	Number
System information	13
Physical device information	11
Measurands	66
Metered values	14
Controllable Data	36
Status information	85
Settings	130
	355

A - Phase to ground amperes for Phases 1, 2, and 3
Ampe - Current of a non three phase circuit
Ang - Angle between phase voltage and current
AnIn - Analogue Input used for generic I/O
ChAnVal - Array of analogue channel numbers and actual values at a certain time (time tag)
CircA - Measured circulating current in a transformer paralleling application
CtlV - Voltage on secondary of transformer as used for voltage control.
Den - Density of gas or other insulating Medium
DQ0Seq - Direct, quadrature, and zero axis quantity
ECC - This is the measured current through a Petersen Coil in neutral compensated networks.
FDkm - The distance to a fault in kilometres
FDOhm - The distance to e fault in Ohms
HaRmsA - Current Harmonic RMS (un-normalized THD) for A, B, C, N
HaRmsV - Voltage Harmonic RMS (un-normalized THD) for AB, AN, BC, BN, CA, CN, NG
HaTdA - Current Total Harmonic Distortion
HaTdV - Voltage Total Harmonic Distortion
More.....

ANEXO C

EQUIPOS DE COMUNICACIONES QUE CUMPLEN CON LA NORMA IEC 61850

RuggedCom

“Industrial Strength Networks”

Product Overview

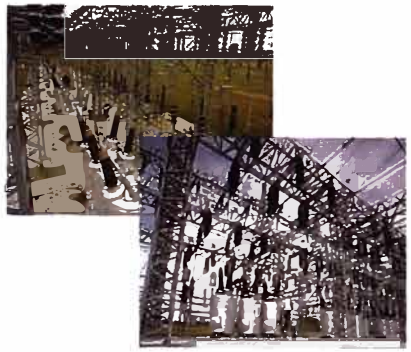
RuggedCom Products

- Exceeds IEC 61850-3 EMI Immunity
- Designed for IEC 61850-8-1 Station Bus
- Zero-Packet-Loss™ for IEC 61850-9-2 Process Bus
- Supports up to Gigabit Speeds for Process Bus Applications
- Use RuggedServer™ to Connect Legacy Serial Devices to the Station Bus LAN

- Plus all Products are RuggedRated™ for Operation in Harsh Environments

RuggedCom Products are Designed for
Mission Critical Systems where
High Reliability and Uptime are of Paramount Importance

RuggedRated™ Technology



- Rated for reliable operation in harsh electrical environments
  - Electric utility substations: Meets **IEEE 1613,** Exceeds **IEC 61850-3**
- Rated for operation over a **wide temperature range**
  - **-40°C to +85°C** (+185°F)
  - Passive cooling – no fans
  - CSA/UL 60950 safety approval to +85°C
- Rated for **high availability**
  - Integrated single and dual redundant power supplies
  - 24VDC (12VDC), 48VDC, or 88-300VDC/85-264VAC
  - Dual power supplies can be powered from different sources
- Rated for **substation installations**
  - 18 or 20 gauge galvanized steel enclosure for durability
  - heavy duty 19" rack or din rail mount
  - industrial terminal blocks for power and I/O connections
- **5-Year Warranty**

Other RuggedRated™ Features

- High MTBF of > 500,000hrs
- Network Availability of > 99.999%
- No Moving Parts for Increased Reliability
- IP66/67 Rated Products (Waterproof)
- Shock and Vibration Resistant
- High Humidity Range (> 95%)

RuggedCom …
The Communications Backbone for IEC 61850

- The Worldwide Leader in Substation Hardened Ethernet
- Largest Installed Base of IEC 61850 Applications Worldwide
- Most Complete Line of Hardened Ethernet Products:
  Routers, Switches, Serial Servers, Media Converters
- Preferred Supplier of Substation Ethernet Devices by Major OEMs
  (Siemens, ABB, Areva, SEL, GE …)

Recipient of Frost and Sullivan 2006 “Excellence in Technology” Award for Substation Hardened Ethernet Switches.

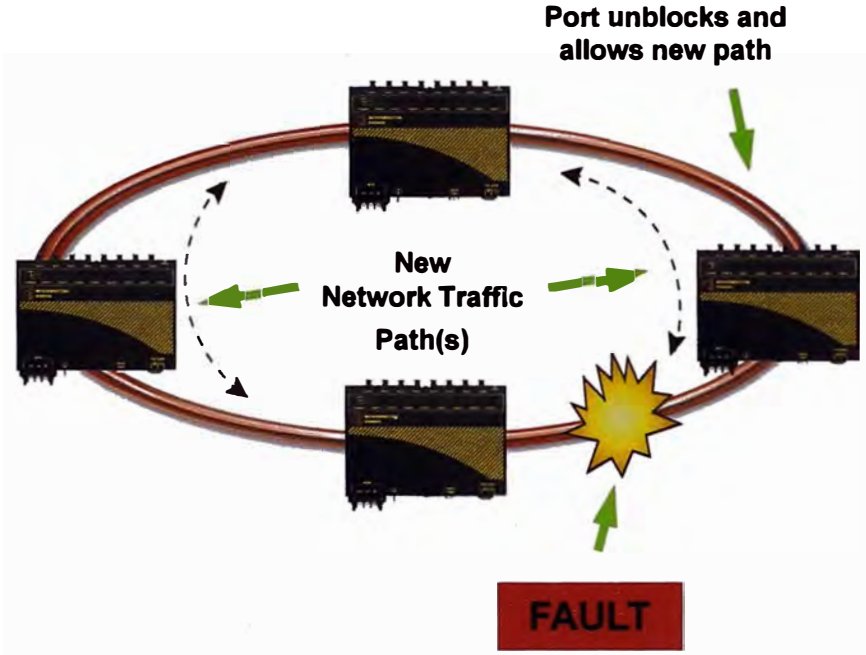
Industrial Power Supply

Power Supply 1

Power Supply 2 (Optional)

- **Fully integrated** power supply (no external adaptors)
- **Universal high-voltage range**:
  88-300VDC or 85-264VAC
- **Popular low voltage DC ranges**:
  24VDC, 48VDC
- **CSA/UL 60950 safety approved to +85°C**
- **Dual redundant** power supply option
- **Parallel load sharing** with true N+1 redundancy
- **Can be powered from different sources**:
  - e.g. PS 1 from 110VAC and PS 2 from 48VDC
  - e.g. PS 1 from 125VDC and PS 2 from 220VAC
  - e.g. PS 1 24VDC and PS 2 from 125VDC
  - Any combination!

eRSTP™ Technology



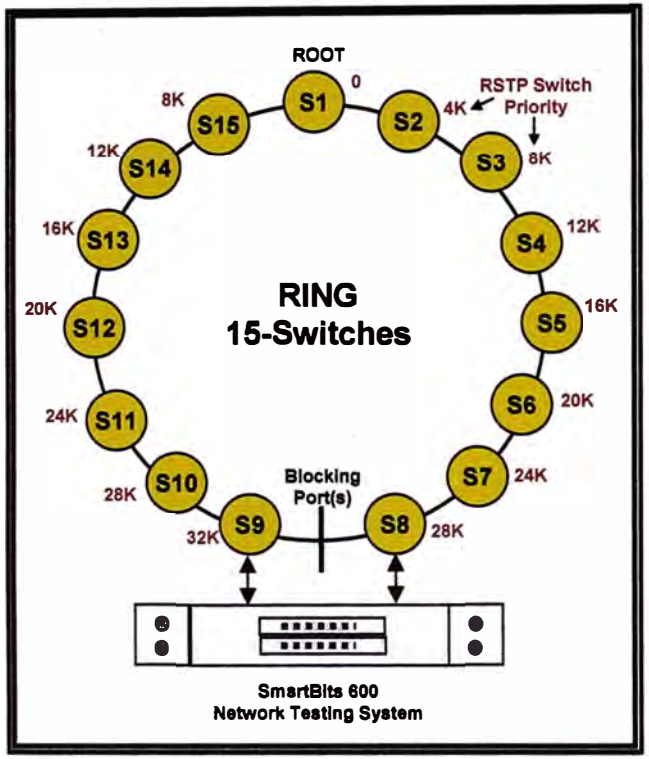
Enhanced Rapid Spanning Tree Protocol (eRSTP™)

- **Enhanced IEEE 802.1w** Rapid Spanning Tree Protocol
- **High-Speed** Fault Tolerant Ring Architectures
- **Fast Fault Recovery:** < 5ms/hop fault recovery
- **Large Rings Configurations**: up to 80 switches
- **Compatible** with RSTP (IEEE 802.1w)

*eRSTP™ **Fastest** Network Fault Recovery in the Industry …*
***<5ms/hop vs. 300ms** of competitors*

eRSTP™ Fault Recovery Tests

Test Setup



Test Results

Fault applied between Switches	Fault Recovery Time [ms]
1,2	25.78
2,3	23.87
3,4	21.87
4,5	20.35
5,6	18.37
6,7	16.71
7,8	11.96
8,9	0.00
9,10	5.94
10,11	13.48
11,12	14.17
12,13	16.36
13,14	18.00
14,15	19.82
15,1	20.99

eRSTP™ Performance Example:

For a network comprised of 15 RuggedSwitch Ethernet switches (i.e. S1 – S15) in a ring topology we can expect better than 5ms/hop fault recovery performance:

Expected worst case Fault Recovery time:
< 75ms

Actual testing performed on RuggedSwitch switches with eRSTP technology using an industry standard SmartBits network analyzer revealed:

Actual worst case Fault Recovery time:
< 26ms

eRSTP™ actual performance is 2x better than expected!

Rugged Operating System™

Rugged Operating System (ROS™)

- **Zero Collisions:** IEEE 802.3x Full Duplex Operation
- **Priority Queuing:** IEEE 802.1p for high priority real-time control
- **VLAN:** IEEE 802.1q for isolating real-time traffic
- **Enhanced** IEEE 802.1w **Rapid Spanning Tree** for fast fault recovery
- **IGMP Snooping** for multicast filtering and management
- **Network management**: including SNMP, RMON, Port Mirroring
- Rich set of **diagnostic tools**
- **Common firmware** across all managed switches
- **Simple firmware upgrade** as new features become available

Fully Managed Switch Designed for Real-Time Control

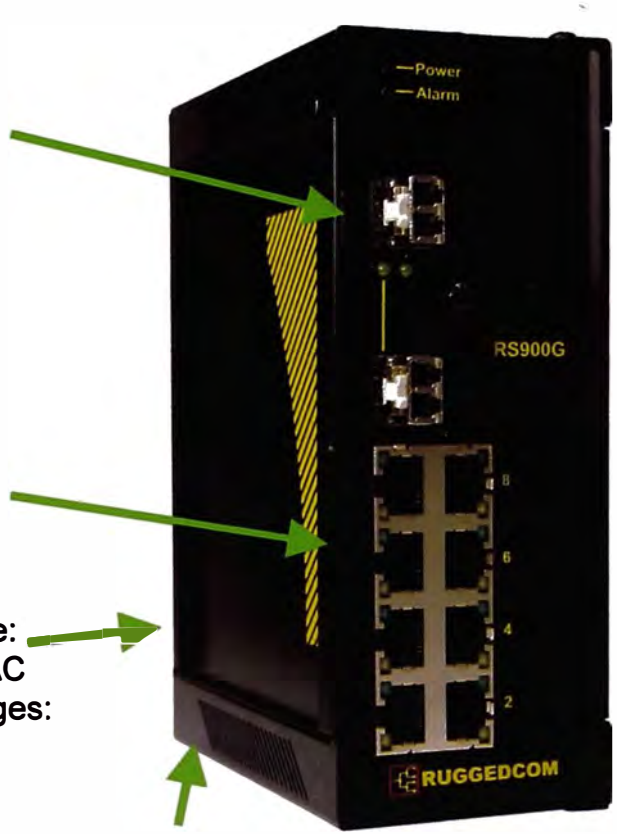
RuggedSwitch™ RS900G

Industrially Hardened – Gigabit Managed Ethernet Switch

Dual Gigabit Ports:
- Fiber Optical (MMF/SMF)
- Pluggable Optics (SFP)
- SC, ST, LC and MTRJ
- Bi-directional (single strand)
- Distances up to 70km

Fast Ethernet Ports:
- 8 - Fast Ethernet Ports (10/100BaseTX)

Integrated Power Supply
- Universal high-voltage range: 88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges: 24VDC, 48VDC
- Dual Redundant (Optional)
- Parallel Load Sharing



Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

- **Gigabit** – Dual fiber optical 1000BaseX ports allow for high-speed Gigabit backbone (up to 70km).
- **RuggedRated™** - Industrially Hardened
  - EMI Immunity (IEC 61850-3, IEEE 1613),
  - Operating Temperature (-40 to +85°C)
- **ROS™ (Rugged Operating System)**
  - Advanced Layer 2 and 3 Network Management
- **eRSTP™** for high speed (<5ms) network fault recovery and redundancy
- **Port rate limiting** (128, 256, 512, 4000, 8000 kbps) for network traffic management
- **Hazardous Location Certification:**
  - Class 1 Division 2

The RuggedSwitch™ RSG2100

"Modularity plus Gigabit Ethernet"

- **Modularity** – 3 Gigabit Ports, 16 Fast Ethernet Ports (virtually any mix of fiber or copper desired)
- **RuggedRated™ "Industrially Hardened":** IEC 61850-3, IEEE 1613, (-40 to +85°C)
- **Integrated Dual Redundant Power Supplies** 24Vdc, 48Vdc, or (88 – 300Vdc / 85 – 264Vac)
- **Zero-Packet-Loss™ Technology** for immunity to high levels of EMI
- **ROS™ (Rugged Operating System)** Advanced Layer 2 and 3 Management
- **eRSTP™** for **high speed** (<5ms) network **fault recovery** and redundancy
- **Port rate limiting** (128, 256, 512, 4000, 8000 kbps) for network traffic management

The RuggedSwitch™ RSG2100

Gigabit Ports:
- up to 3 Gigabit Ethernet Ports
- 10/100/1000 TX RJ45
- 1000SX Multimode
- 1000LX Singlemode
- Pluggable Optics (SFP)
- SC, ST, LC and MTRJ

3 Gigabit Ports

Integrated Power Supply
- Universal high-voltage range:
  88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges:
  24VDC, 48VDC
- Dual Redundant (Optional)
- Parallel Load Sharing

Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

Modularity (8x2)

Mounting Options
- Panel/Din Rail
- 19" Rack Mount

Modular HMI:
- Front or Rear Mount

Fast Ethernet Ports:
- up to 16 Fast Ethernet Ports
- virtually any mix of fiber or copper desired
- 10/100TX RJ45
- 10FL Multi- and Singlemode
- 100FX Multi- and Singlemode

The RuggedSwitch™ RSG2200

"9 Port Modular Managed Gigabit Ethernet Switch"

- **Modularity** – 9 Gigabit Ports (virtually any mix of fiber or copper desired)
- **RuggedRated™ "Industrially Hardened":** IEC 61850-3, IEEE 1613, (-40 to +85°C)
- **Zero-Packet-Loss™** Technology for immunity to high levels of EMI
- **Integrated Dual Redundant Power Supplies** 24Vdc, 48Vdc, or (88 – 300Vdc / 85 – 264Vac)
- **ROS™ (Rugged Operating System)** Advanced Layer 2 and 3 Management
- **eRSTP™** for high speed (<5ms) network fault recovery and redundancy
- **Port rate limiting** (128, 256, 512, 4000, 8000 kbps) for network traffic management

The RuggedSwitch™ RSG2200

Gigabit Ports:
- up to 3 Gigabit Ethernet Ports
- 10/100/1000 TX RJ45
- 1000SX Multimode
- 1000LX Singlemode
- Pluggable Optics (SFP)
- SC, ST, LC and MTRJ

9 Gigabit Ports

Integrated Power Supply
- Universal high-voltage range: 88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges: 24VDC, 48VDC
- Dual Redundant (Optional)
- Parallel Load Sharing

Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

Mounting Options
- Panel/Din Rail
- 19" Rack Mount

Modular HMI:
- Front or Rear Mount

Modularity:
- 5 available slots
- up to 9 ports

RSG2200/2100 Mounting Options

Front Mounting

All communications ports out the front, power port from the rear

---

Rear Mounting

Both power and communications ports from the rear, HMI port from front

RSG2200/2100 Mounting Options

DIN Rail / Panel Mount

The RuggedSwitch™ RS969

"The World's First IP65/IP67 Rated, Fully Managed, Industrial Ethernet Switch with Gigabit"

- **Waterproof:** IP65 (Water Jets) and IP67 (Immersion)
- **Industrial Operating Temperature**: -40 to +85C
- **High Immunity to EMI:** Meets or exceeds IEC 61850-3, IEEE 1613, NEMA TS-2 and more ...
- **Integrated Power Supplies:** Low and high voltage ranges with true (N+1) redundancy option
- **High Speed Fault Recovery:** eRSTP™ delivers < 5ms per hop fault recovery performance
- **Fully Managed:** ROS™ delivers advanced networking and management features
- **Gigabit:** 2-Gigabit fiber optical waterproof ports for high-bandwidth applications

RS969 (M12 Connectors)

Fast Ethernet Ports:
- 8 - Fast Ethernet Ports (10/100BaseTX)
- M12 Connectors
- High EMI immunity
- Transient and Surge protected

LED Indicators
- Link Activity per port
- Power and Alarm

Console Port:
- RS232 programming port

Water-proof Enclosure
- IP65 Rated (Water-Jet)
- IP67 Rated (Immersed)
- DIN Rail or Flush Mount
- Aluminum

Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

Power Supply
- Universal high-voltage range: 88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges: 24VDC, 48VDC
- M12 Connector

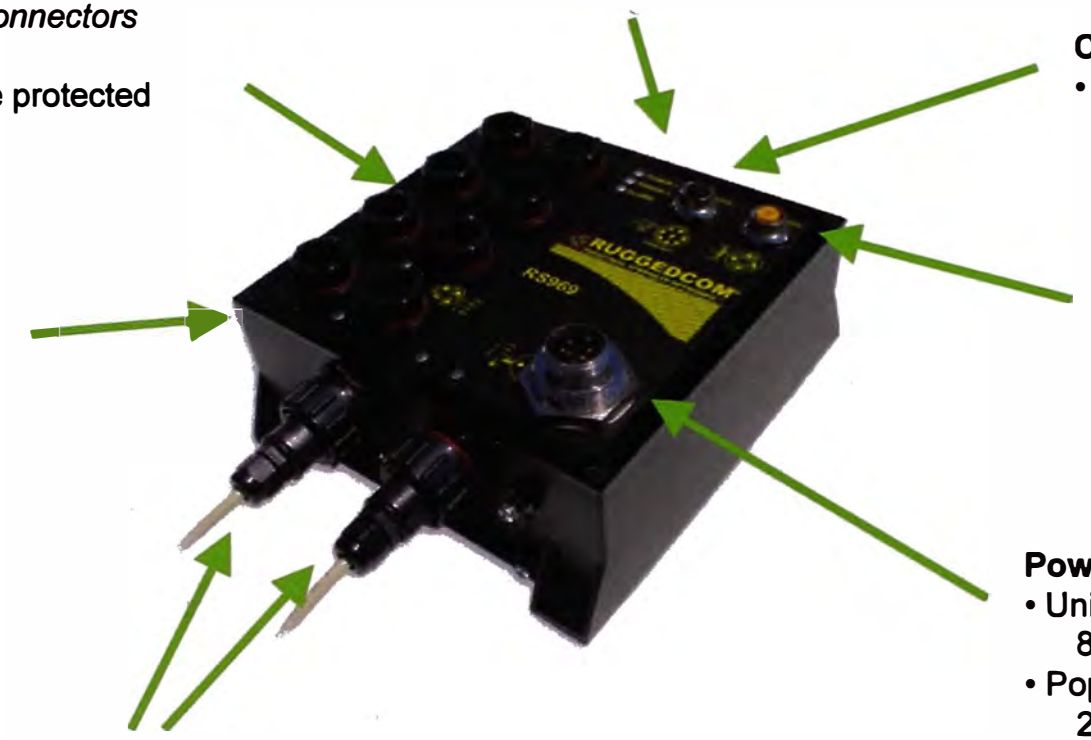
Fiber Optical Gigabit Ethernet Ports
- 2 - Fiber Optical Gigabit Ethernet Ports (1000BaseX)
- Fiber Optical (up to 25km)
- Waterproof covers when not in use

RS969 (RJ45 Connectors)

Fast Ethernet Ports:
- *8 - Fast Ethernet Ports (10/100BaseTX)*
- *IP67 Rated RJ45 Connectors*
- High EMI immunity
- Transient and Surge protected

LED Indicators
- Link Activity per port
- Power and Alarm

Console Port:
- RS232 programming port



Water-proof Enclosure
- IP65 Rated (Water-Jet)
- IP67 Rated (Immersed)
- DIN Rail or Flush Mount
- Aluminum

Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

Power Supply
- Universal high-voltage range: 88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges: 24VDC, 48VDC
- M23 Connector
- *Dual-Redundant (option)*
- *Parallel Load Sharing*
- *Can be different sources!*

Fiber Optical Gigabit Ethernet Ports
- 2 - Fiber Optical Gigabit Ethernet Ports (1000BaseX)
- Fiber Optical (up to 25km)
- Waterproof covers when not in use

The RuggedRouter™ RX1000

"Industrially Hardened Cyber Security Appliance"

- **Integrated Router/Firewall/VPN**
- **Wide Operating Temperature** Range: -40 to +85C
- **High Immunity to EMI**: Meets or exceeds IEC 61850-3, IEEE 1613, NEMA TS-2 and more ...
- **Integrated Power Supplies:** Low and high voltage ranges with true (N+1) redundancy option
- **RuggedRated™** for Harsh Environments
- **Modular:** Various Types and Configuration of Interface Ports
- **5 Year Warrantee**

RX1000 Physical Features

Multiple Ethernet Ports:
- Quad 10/100 Mbps
- Fiber or Copper
- LC, ST, MTRJ, SC

Multiple WAN ports
- Quad T1/E1
- Dual DSL
- Dual DDS 56/64kbps Activity

Modular HMI:
- Front or Rear Mount

V.90 Modem (Optional)
- 56 kbps

GPS/IRIG Ports
- Built-in GPS, Antenna Input
- Multiple IRIG-B Outputs
- Manchester, AM, Baseband, IRIG-B Types

Mounting Options
- Panel/Din Rail
- 19" Rack Mount

RX1000 Physical Features

Integrated Power Supply
- Universal high-voltage range:
  88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges:
  24VDC, 48VDC
- Dual Redundant (Optional)
- Parallel Load Sharing

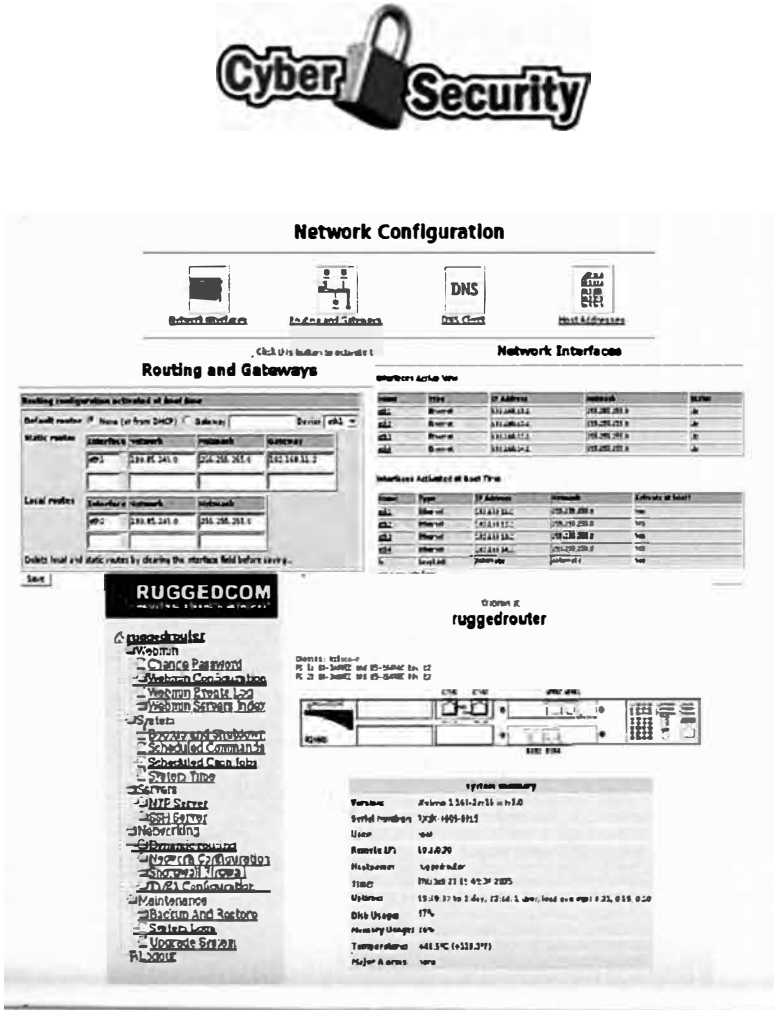
Enclosure
- IP40
- 18 AWG Galvanized Steel

Operating Temperature
- -40C to +85C
- No Fans

Failsafe Output Relay
- Form-C contact output
- 1A@30VDC

EMI Immunity
- Meets IEEE 1613 (electric power substations)
- Exceeds IEC 61850-3 (electric utility substations)
- Exceeds IEEE 61800-3 (variable speed drive system)
- Exceeds IEC 61000-6-2 (generic industrial environment)
- Exceeds NEMA TS-2 (traffic control equipment)

RX1000 Key Router Features



Security Appliance Functions

- Integrated Router/Firewall/VPN
- Stateful Firewall with NAT
- Full IPSec Virtual Private Networking
- VPN with 3DES, DES, AES
- IDS (coming soon)

Protocols

- WAN: Frame Relay, PPP, PAP, CHAP Authentication, PPPoE (coming soon)
- IP: Routing, RIP/RIPII, OSPF, DHCP Agent
- Traffic shaping and policing

Management Tools

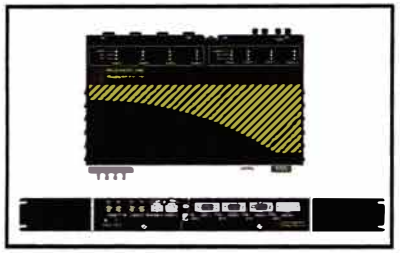
- Web Based GUI, SSH, CLI (command line interface)
- SNMP v2/v3
- Remote Syslog
- Rich set of diagnostics with logging and alarming

RuggedServer™ RS400
Serial to Ethernet

"Industrially Hardened Serial Device Server"

- **Highly Integrated Device**
  - 4 isolated serial ports, a 4-port Managed Ethernet Switch (fiber and copper options), V.90 Modem
- **Multifunctional Operation**
  - serial-to-ethernet, remote access server, and router functionality
- **Managed Ethernet Switch**
  - advanced networking features for fault-tolerant networks suitable for real-time control
- **Advanced Serial Functionality**
  - supports Modbus and DNP 3.0 protocols
  - serial encapsulation; COM port redirection with serial IP
- **RuggedRated™** for Harsh Environments
  - Serial ports have 2kV of galvanic isolation to protect against ground potential rise during ground faults
- **Integrated Power Supplies**
  - Low and high voltage ranges
- **Wide Operating Temperature Range**
  - -40 to +85C
- **High Immunity to EMI**
  - Meets or exceeds IEC 61850-3, IEEE 1613, NEMA TS-2 IEC 61000-6-2, IEC 61800-3

RuggedServer™ RS400
Serial to Ethernet



Serial Ports
- 4 - RS485/RS232 Ports
- 3kV Isolation per Port

Ethernet Ports
- 4-Port Ethernet Switch
- Fiber & Copper Ports

Mounting Options
- Panel/Din Rail
- 19" Rack Mount

Integrated Power Supply
- Universal high-voltage range:
  88-300VDC or 85 - 264VAC
- Popular low voltage DC ranges:
  24VDC, 48VDC

Integrated V.90 Modem
- 56 kbps

Failsafe Output Relay
- (220 VDC / 250 VAC)

ANEXO D

RESUMEN DE NORMAS IEC 61850

TECHNICAL REPORT

IEC TR 61850-1

First edition
2003-04

Communication networks and systems in substations –

Part 1: Introduction and overview

Réseaux et systèmes de communication dans les postes –

Partie 1:
Introduction et vue d'ensemble

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE W

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 1: Introduction and overview

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this technical report may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61850-1, which is a technical report, has been prepared by IEC technical committee 57: Power system control and associated communications

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/524/CDV	57/561/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations* [1].

Part 1: Introduction and overview

Part 2: Glossary [2]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models [3]

Part 6: Configuration description language for communication in electrical substations related to IEDs [2]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3 [2]

Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 [2]

Part 10: Conformance testing [2]

This part is an introduction and overview of the IEC 61850 standard series. It describes the philosophy, the work approach, the contents of the other parts, and documents of other bodies which have been reviewed.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
  withdrawn;
  replaced by a revised edition, or
- amended.

---

1 For more details, see Clause 10.

2 Under consideration.

3 To be published.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 1: Introduction and overview

1 Scope

This technical report is applicable to substation automation systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the substation and the related system requirements.

This part gives an introduction and overview of the IEC 61850 standard series. It refers to and includes text and Figures from other parts of the IEC 61850 standard series.

2 Reference documents

IEC 60870-5-103:1997, *Telecontrol equipment and systems – Part 5-103: Transmission protocols – Companion standard for the informative interface of protection equipment*

IEC 61850-3: *Communication networks and systems in substations – Part 3: General requirements*

IEC 61850-5: *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-7-1: *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2: *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3: *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4: *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

ISO 9001, 2001: Quality management systems – Requirements

IEEE C37.2,1996 *IEEE Standard Electrical Power System Device Function Numbers and Contact Designations*

IEEE 100,1996, *IEEE Standard Dictionary of Electrical and Electronic Terms*

IEEE-SA TR 1550,1999: *Utility Communications Architecture (UCA) Version 2.0 – Part 4: UCA Generic Object Models for Substation and Feeder Equipment (GOMSFE)*

TECHNICAL SPECIFICATION

IEC TS 61850-2

First edition
2003-08

Communication networks and systems in substations –

Part 2: Glossary

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE X

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 2: Glossary

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61850-2, which is a technical specification, has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
57/615/DTS	57/645/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*.

Part 1: Introduction and overview

Part 2: Glossary

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models

Part 6: Configuration description language for communication in electrical substations related to IEDs [1]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) over ISO/IEC 8802-3 [1]

Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 [1]

Part 10: Conformance testing [1]

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be either

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

---

[1] Under consideration.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS -

Part 2: Glossary

1 Scope

This part of the IEC 61850 series applies to Substation Automation Systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the substation and the related system requirements.

This part of the IEC 61850 series contains the glossary of specific terminology and definitions used in the context of Substation Automation Systems within the various parts of the standard.

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
61850-3

Première édition
First edition
2002-01

Réseaux et systèmes de communication dans les postes –

Partie 3: Prescriptions générales

Communication networks and systems in substations –

Part 3: General requirements

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE Q

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For price, see current catalogue

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

RÉSEAUX ET SYSTÈMES DE COMMUNICATION DANS LES POSTES –

Partie 3: Prescriptions générales

AVANT-PROPOS

1) La CEI (Commission Électrotechnique Internationale) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de la CEI). La CEI a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, la CEI, entre autres activités, publie des Normes internationales. Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec la CEI, participent également aux travaux. La CEI collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de la CEI concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux intéressés sont représentés dans chaque comité d'études.
3) Les documents produits se présentent sous la forme de recommandations internationales. Ils sont publiés comme normes, spécifications techniques, rapports techniques ou guides et agréés comme tels par les Comités nationaux.
4) Dans le but d'encourager l'unification internationale, les Comités nationaux de la CEI s'engagent à appliquer de façon transparente, dans toute la mesure possible, les Normes internationales de la CEI dans leurs normes nationales et régionales. Toute divergence entre la norme de la CEI et la norme nationale ou régionale correspondante doit être indiquée en termes clairs dans cette dernière.
5) La CEI n'a fixé aucune procédure concernant le marquage comme indication d'approbation et sa responsabilité n'est pas engagée quand un matériel est déclaré conforme à l'une de ses normes.
6) L'attention est attirée sur le fait que certains des éléments de la présente Norme internationale peuvent faire l'objet de droits de propriété intellectuelle ou de droits analogues. La CEI ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de propriété et de ne pas avoir signalé leur existence.

La Norme internationale CEI 61850-3 a été établie par le comité d'études 57 de la CEI: Conduite des systèmes de puissance et communications associées.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
57/557/FDIS	57/572/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/CEI, Partie 3.

L'annexe A est donnée uniquement à titre d'information.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 3: General requirements

FOREWORD

1) The IEC (International Electrotechnical Commission) is a world-wide organisation for standardisation comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardisation in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organisations liasing with the IEC also participate in this preparation. The IEC collaborates closely with the International Organisation for Standardisation (ISO) in accordance with conditions determined by agreement between the two organisations.
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4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-3 has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/557/FDIS	57/572/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annex A is for information only.

La CEI 61850 comprend les parties suivantes, présentées sous le titre général: *Réseaux et systèmes de communication dans les postes:*

Partie 1: Introduction et vue générale[1]

Partie 2: Glossary[1]

Partie 3: Prescriptions générales

Partie 4: Gestion du système et gestion de projet

Partie 5: Communication requirements for functions and device models[1]

Partie 6: Substation automation system configuration description language[1]

Partie 7-1: Basic communication structure for substation and feeder equipment – Principles and models[1]

Partie 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)[1]

Partie 7-3: Basic communication structure for substation and feeder equipment – Common data classes[1]

Partie 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes[1]

Partie 8-1: Specific communication service mapping (SCSM) – Mapping to MMS (ISO/IEC 9506 Part 1 and Part 2)[1]

Partie 9-1: Specific communication service mapping (SCSM) – Serial unidirectional multidrop point to point link[1]

Partie 9-2: Specific communication service mapping (SCSM) – Mapping on a IEEE 802.3 based process bus[1]

Partie 10: Conformance testing[1]

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant 2004. A cette date, la publication sera

- reconduite;
- supprimée;
- remplacée par une édition révisée, ou
- amendée.

---

[1] A l'étude.

IEC 61850 consists of the following parts, under the general title: Communication networks and systems in substations:

Part 1: Introduction and overview[1]

Part 2: Glossary[1]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models[1]

Part 6: Substation automation system configuration description language[1]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models[1]

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)[1]

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes[1]

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes[1]

Part 8-1: Specific communication service mapping (SCSM) – Mapping to MMS (ISO/IEC 9506 Part 1 and Part 2)[1]

Part 9-1: Specific communication service mapping (SCSM) – Serial unidirectional multidrop point to point link[1]

Part 9-2: Specific communication service mapping (SCSM) – Mapping on a IEEE 802.3 based process bus[1]

Part 10: Conformance testing[1]

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

---

[1] Under consideration.

RÉSEAUX ET SYSTÈMES DE COMMUNICATION DANS LES POSTES –

Partie 3: Prescriptions générales

1 Domaine d'application et objet

La présente partie de la CEI 61850 s'applique aux systèmes d'automatisation de poste (SAS). Elle définit la communication entre les dispositifs électroniques intelligents (IED) dans le poste ainsi que les prescriptions concernant les systémes associés.

Les spécifications de la présente partie font partie des prescriptions générales du réseau de communication, en mettant l'accent sur les prescriptions de qualité. Cette partie traite également des lignes directrices relatives aux conditions d'environnement et aux services auxiliaires, en donnant des recommandations sur la pertinence des prescriptions spécifiques d'autres normes et spécifications.

2 Références normatives

Les documents normatifs suivants contiennent des dispositions qui, par suite de la référence qui y est faite, constituent des dispositions valables pour la présente partie de la CEI 61850. Pour les références datées, les amendements ultérieurs ou les révisions de ces publications ne s'appliquent pas. Toutefois, les parties prenantes aux accords fondés sur la présente partie de la CEI 61850 sont invitées à rechercher la possibilité d'appliquer les éditions les plus récentes des documents normatifs indiqués ci-après. Pour les références non datées, la dernière édition du document normatif en référence s'applique. Les membres de la CEI et de l'ISO possèdent le registre des Normes internationales en vigueur.

CEI 60654-4:1987, *Conditions de fonctionnement pour les matériels de mesure et commande dans les processus industriels – Quatrième partie: Influences de la corrosion et de l'érosion*

CEI 60694:1996, *Spécifications communes aux normes de l'appareillage à haute tension*

CEI 60870-2-1:1995, *Matériels et systèmes de téléconduite – Partie 2: Conditions de fonctionnement – Section 1: Alimentation et compatibilité électromagnétique*

CEI 60870-2-2:1996, *Matériels et systèmes de téléconduite – Partie 2: Conditions de fonctionnement – Section 2: Conditions d'environnement (influences climatiques, mécaniques et autres influences non électriques)*

CEI 60870-4:1990, *Matériels et systèmes de téléconduite – Quatrième partie: Prescriptions relatives aux performances*

CEI 61000-4-3:1995, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 3: Essai d'immunité aux champs électromagnétiques rayonnés aux fréquences radioélectriques*

CEI 61000-4-4:1995, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 4: Essais d'immunité aux transitoires électriques rapides en salves*. Publication fondamentale en CEM

CEI 61000-4-5:1995, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 5: Essai d'immunité aux ondes de choc*

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 3: General requirements

1 Scope and object

This part of IEC 61850 applies to substation automation systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the substation and the related system requirements.

The specifications of this part pertain to the general requirements of the communication network, with emphasis on the quality requirements. It also deals with guidelines for environmental conditions and auxiliary services, with recommendations on the relevance of specific requirements from other standards and specifications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61850. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61850 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60654-4:1987, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60870-2-1:1995, *Telecontrol equipment and systems – Part 2: Operating conditions – Section 1: Power supply and electromagnetic compatibility*

IEC 60870-2-2:1996, *Telecontrol equipment and systems – Part 2: Operating conditions – Section 2: Environmental conditions (climatic, mechanical and other non-electrical influences)*

IEC 60870-4:1990, *Telecontrol equipment and systems – Part 4: Performance requirements*

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test*. Basic EMC Publication

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

CEI 61000-4-6:1996, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 6: Immunité aux perturbations conduites, induites par les champs radioélectriques*

CEI 61000-4-8:1993, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 8: Essai d'immunité au champ magnétique à la fréquence du réseau*

CEI 61000-4-10:1993, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 10: Essai d'immunité au champ magnétique oscillatoire amorti*

CEI 61000-4-12:1995, *Compatibilité électromagnétique (CEM) – Partie 4: Techniques d'essai et de mesure – Section 12: Essai d'immunité aux ondes oscillatoires*

CEI 61000-4-16:1998, *Compatibilité électromagnétique (CEM) – Partie 4-16: Techniques d'essai et de mesure – Essai d'immunité aux perturbations conduites en mode commun dans la gamme de fréquences de 0 Hz à 150 kHz*

CEI TS 61000-6-5:2001, *Compatibilité électromagnétique (CEM) – Partie 6: Normes génériques – Section 5: Immunité pour les environnements de centrales électriques et de postes*

CISPR 22:1997, *Appareils de traitement de l'information – Caractéristiques des perturbations radioélectriques – Limites et méthodes de mesure*

IEEE C37.90.2:1995, *IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 8: Power frequency magnetic field immunity test*

IEC 61000-4-10:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 10: Damped oscillatory magnetic field immunity test*

IEC 61000-4-12:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test*

IEC 61000-4-16:1998, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC TS 61000-6-5:2001, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments*

CISPR 22:1997, *IEEE Standard for Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement*

IEEE C37.90.2:1995, *Withstand capability of relay systems to radiated electromagnetic interference from transceivers*

NORME INTERNATIONALE

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Réseaux et systèmes de communication dans les postes –

Partie 4: Gestion du système et gestion de projet

Communication networks and systems in substations –

Part 4: System and project management

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

Commission Electrotechnique Internationale
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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

RÉSEAUX ET SYSTÈMES DE COMMUNICATION DANS LES POSTES –

Partie 4: Gestion du système et gestion de projet

AVANT-PROPOS

1) La CEI (Commission Électrotechnique Internationale) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de la CEI). La CEI a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, la CEI, entre autres activités, publie des Normes internationales. Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec la CEI, participent également aux travaux. La CEI collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de la CEI concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux intéressés sont représentés dans chaque comité d'études.
3) Les documents produits se présentent sous la forme de recommandations internationales. Ils sont publiés comme normes, spécifications techniques, rapports techniques ou guides et agréés comme tels par les Comités nationaux.
4) Dans le but d'encourager l'unification internationale, les Comités nationaux de la CEI s'engagent à appliquer de façon transparente, dans toute la mesure possible, les Normes internationales de la CEI dans leurs normes nationales et régionales. Toute divergence entre la norme de la CEI et la norme nationale ou régionale correspondante doit être indiquée en termes clairs dans cette dernière.
5) La CEI n'a fixé aucune procédure concernant le marquage comme indication d'approbation et sa responsabilité n'est pas engagée quand un matériel est déclaré conforme à l'une de ses normes.
6) L'attention est attirée sur le fait que certains des éléments de la présente Norme internationale peuvent faire l'objet de droits de propriété intellectuelle ou de droits analogues. La CEI ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de propriété et de ne pas avoir signalé leur existence.

La Norme internationale CEI 61850-4 a été établie par le comité d'études 57 de la CEI: Conduite des systèmes de puissance et communications associées.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
57/558/FDIS	57/573/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/CEI, Partie 3.

Les annexes A et B sont données uniquement à titre d'information.

La CEI 61850 comprend les parties suivantes, présentées sous le titre général: Réseaux et systèmes de communication dans les postes:

Partie 1: Introduction et vue générale[1]

[1] l'étude.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 4: System and project management

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-4 has been prepared by IEC technical committee 57: Power system control and associated communications

The text of this standard is based on the following documents:

FDIS	Report on voting
57/558/FDIS	57/573/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A and B are for information only.

IEC 61850 consists of the following parts, under the general title: Communication networks and systems in substations:

Part 1: Introduction and overview[1]

[1] Under consideration.

Partie 2: Glossary[1]

Partie 3: Prescriptions générales

Partie 4: Gestion du système et gestion de projet

Partie 5: Communication requirements for functions and device models[1]

Partie 6: Substation automation system configuration description language[1]

Partie 7-1: Basic communication structure for substation and feeder equipment – Principles and models[1]

Partie 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)[1]

Partie 7-3: Basic communication structure for substation and feeder equipment – Common data classes[1]

Partie 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes[1]

Partie 8-1: Specific communication service mapping (SCSM) – Mapping to MMS (ISO/IEC 9506 Part 1 and Part 2)[1]

Partie 9-1: Specific communication service mapping (SCSM) – Serial unidirectional multidrop point to point link[1]

Partie 9-2: Specific communication service mapping (SCSM) – Mapping on a IEEE 802.3 based process bus[1]

Partie 10: Conformance testing[1]

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant 2004. A cette date, la publication sera

- reconduite;
- supprimée;
  remplacée par une édition révisée, ou
  amendée.

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1 A l'étude.

Part 2: Glossary[1]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models[1]

Part 6: Substation automation system configuration description language[1]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models[1]

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)[1]

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes[1]

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes[1]

Part 8-1: Specific communication service mapping (SCSM) – Mapping to MMS (ISO/IEC 9506 Part 1 and Part 2)[1]

Part 9-1: Specific communication service mapping (SCSM) – Serial unidirectional multidrop point to point link[1]

Part 9-2: Specific communication service mapping (SCSM) – Mapping on a IEEE 802.3 based process bus[1]

Part 10: Conformance testing[1]

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

---

[1] Under consideration.

RÉSEAUX ET SYSTÈMES DE COMMUNICATION DANS LES POSTES –

Partie 4: Gestion du système et gestion de projet

1 Domaine d'application et objet

Cette partie de la CEI 61850 s'applique aux systémes d'automatisation de poste (SAS). Elle définit la communication entre les dispositifs électroniques intelligents (IED) dans le poste ainsi que les exigences concernant les systémes associés.

Les spécifications contenues dans cette partie se rapportent à la gestion du systéme et à la gestion de projet en ce qui concerne:

– le processus d'étude et les outils de support associés;
– le cycle de vie du systéme global et de ses IED;
– l'assurance qualité, de l'étape de développement jusqu'à l'arrêt de fabrication et la mise hors service du SAS et de ses IED.

Les exigences du processus de gestion du systéme et de gestion de projet ainsi que celles des outils de support spécifiques pour l'étude et les essais sont décrites.

2 Références normatives

Les documents normatifs suivants contiennent des dispositions qui, par suite de la référence qui y est faite, constituent des dispositions valables pour la présente partie de la CEI 61850. Pour les références datées, les amendements ultérieurs ou les révisions de ces publications ne s'appliquent pas. Toutefois, les parties prenantes aux accords fondés sur la présente partie de la CEI 61850 sont invitées à rechercher la possibilité d'appliquer les éditions les plus récentes des documents normatifs indiqués ci-aprés. Pour les références non datées, la derniére édition du document normatif en référence s'applique. Les membres de la CEI et de l'ISO possédent le registre des Normes internationales en vigueur.

CEI 60848:1988, *Etablissement des diagrammes fonctionnels pour systèmes de commande*

CEI 61082 (toutes les parties), *Etablissement des documents utilisés en électrotechnique*

CEI 61175:1993, *Désignations des signaux et connexions*

CEI 61346 (toutes les parties), *Systèmes industriels, installations et appareils, et produits industriels – Principes de structuration et désignations de référence*

ISO 9001:1994, *Systèmes qualité – Modèle pour l'assurance de la qualité en conception, développement, production, installation et prestations associées* (en anglais seulement)

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 4: System and project management

1 Scope and object

This part of IEC 61850 applies to substation automation systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the substation and the related system requirements.

The specifications of this part pertain to the system and project management with respect to:

– the engineering process and its supporting tools;
– the life cycle of the overall system and its IEDs;
– the quality assurance beginning with the development stage and ending with discontinuation and decommissioning of the SAS and its IEDs.

The requirements of the system and project management process and of special supporting tools for engineering and testing are described.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61850. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61850 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60848:1988, *Preparation of function charts for control systems*

IEC 61082 (all parts), *Preparation of documents used in the electrotechnology*

IEC 61175:1993, *Designations for signals and connections*

IEC 61346 (all parts), *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations*

ISO 9001:1994, *Quality systems – Model for quality assurance in design, development, production, installation and servicing*

INTERNATIONAL STANDARD

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Communication networks and systems in substations –

Part 5: Communication requirements for functions and device models

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 5: Communication requirements for functions and device models

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-5 has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/641/FDIS	57/649/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The content of this part of IEC 61850 is based on existing or emerging standards and applications. In particular the approach to formulate the requirements is based upon

CIGRE Technical Report, Ref. No. 180, *Communication requirements in terms of data flow within substations*. CE/SC 34 03, 2001, 112 pp. Ref. No. 180

K.P. Brand, *Communication requirements in terms of data flow within substations – Results of WG34.03 and standardization within IEC*, **Electra** 173, 77-85 (1997)

IEEE-SA TR 1550-2003: *IEEE-SA Technical Report on Utility Communications Architecture (UCA™), Version 2.0, Part 4: UCA Generic Object Models for Substation and Feeder Equipment (GOMSFE)*.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*.

Part 1: *Introduction and overview*

Part 2: *Glossary* [1]

Part 3: *General requirements*

Part 4: *System and project management*

Part 5: *Communication requirements for functions and device models*

Part 6: *Configuration description language for communication in electrical substations related to IEDs* [2]

Part 7-1: *Basic communication structure for substation and feeder equipment – Principles and models*

Part 7-2: *Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

Part 7-3: *Basic communication structure for substation and feeder equipment – Common data classes*

Part 7-4: *Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

Part 8-1: *Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3* [2]

Part 9-1: *Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link*

Part 9-2: *Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3* [2]

Part 10: *Conformance testing* [2]

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

reconfirmed;
withdrawn;
replaced by a revised edition, or
amended.

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1 To be published.

2 Under consideration.

INTRODUCTION

The IEC 61850 series is intended to provide interoperability between all devices in substations. Communication between these devices has to fulfil a lot of requirements imposed by all the functions to be performed in substations. Depending on the philosophy both of the vendor and of the user and on the state-of-the-art in technology, the allocation of functions to devices and control levels is not commonly fixed. This results in different requirements for the different communication interfaces within the substation. The IEC 61850 series shall support any allocation of functions.

The IEC 61850 series should have a long lifetime but be able to follow the fast changes in communication technology by both its technical approach and its document structure. Figure 1 shows the relationship of this part of the IEC 61850 series to subsequent parts of the IEC 61850 series. The IEC 61850 series has been organized so that changes to one part do not require a significant rewriting of another part, i.e. the parts are based on the communication requirements in this part of the IEC 61850 series; the derived modelling requirements in subsequent parts will not change the requirements of this part of the IEC 61850 series. The general parts, the requirement specification and the modelling parts are independent from any implementation. The implementation needed for the use of the IEC 61850 series is defined in some dedicated parts.

This part of the IEC 61850 series defines the communication requirements for functions and device models for substations.

The modelling of communication requires the definition of objects (for example, data objects, data sets, report control, log control) and services provided by objects (for example, get, set, report, create, delete). This is defined in IEC 61850-7-x with a clear interface to implementation. To use the benefits of communication technology, in the IEC 61850 series, no new OSI stacks are defined but a standardized mapping on existing stacks is given in IEC 61850-8-x and IEC 61850-9-x. A substation configuration language (IEC 61850-6) and a standardized conformance testing complement the IEC 61850 series. Figure 1 shows the general structure of the documents of the IEC 61850 series, as well as the relative position of IEC 61850-5 within this series.

NOTE To keep the layered approach of the IEC 61850 series which does not mix application and implementation requirements, terms such as client, server, data objects, etc. are normally not used in this part of the IEC 61850 series (requirements). In IEC 61850-7-x (modeling), IEC 61850-8-x and IEC 61850-9-x (specific communication service mapping) terms belonging to application requirements such as PICOMs are normally not used.

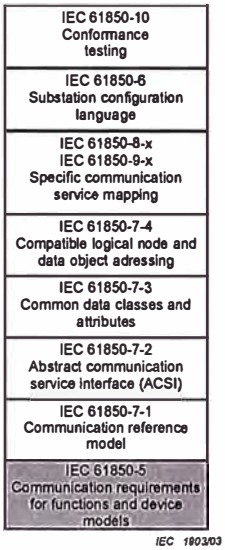

Figure 1 – Relative position of this part of the IEC 61850 series

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 5: Communication requirements for functions and device models

1 Scope

This part of IEC 61850 applies to Substation Automation Systems (SAS). It standardizes the communication between intelligent electronic devices (IEDs) and the related system requirements.

The specifications of this part refer to the communication requirements of the functions being performed in the substation automation system and to device models. All known functions and their communication requirements are identified.

The description of the functions is not used to standardize the functions, but to identify communication requirements between technical services and the substation, and communication requirements between Intelligent Electronic Devices within the substation. The basic goal is interoperability for all interactions.

Standardizing functions and their implementation is completely outside the scope of this part of IEC 61850. Therefore, a single philosophy for allocating functions to devices cannot be assumed in the IEC 61850 series. To support the resulting request for free allocation of functions, a proper breakdown of functions into parts relevant for communication is defined. The exchanged data and their required performance are defined. These definitions are supplemented by informative data flow calculations for typical substation configurations.

Intelligent electronic devices from substations such as protective devices are also found in other installations such as power plants. Using this part of IEC 61850 for such devices in these plants also would facilitate the system integration but this is beyond the scope of this part of IEC 61850.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60044-8, *Instrument transformers – Part 8: Electronic current transformers*

IEC 60870-4, *Telecontrol equipment and systems – Part 4: Performance requirements*

IEC 61346 (all parts), *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations*

IEC 61850-2, *Communication networks and system in substations – Part 2: Glossary* [3]

IEC 62053-22, *Electricity metering equipment (a.c.) – Particular Requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

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[3] To be published.

IEEE Std C37.2:1996, *IEEE Standard Electrical Power System Device Function Numbers and Contact Designations*

NOTE Informative references are found in the Bibliography.

INTERNATIONAL STANDARD

IEC 61850-7-1

First edition
2003-07

Communication networks and systems in substations –

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
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International Standard IEC 61850-7-1 has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/637/FDIS	57/646/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*.

Part 1: Introduction and overview

Part 2: Glossary [1]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models

Part 6: Configuration description language for communication in electrical substations related to IEDs [2]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3 [2]

Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 [2]

Part 10: Conformance testing [2]

The content of this part is based on existing or emerging standards and applications.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

reconfirmed;
withdrawn;
replaced by a revised edition, or
amended.

A bilingual version of this standard may be issued at a later date.

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1 To be published.

2 Under consideration.

INTRODUCTION

This part of the IEC 61850 series provides an overview of the architecture for communication and interactions between substation devices such as protection devices, breakers, transformers, substation hosts etc.

This document is part of a set of specifications which details a layered substation communication architecture. This architecture has been chosen to provide abstract definitions of classes (representing hierarchical information models) and services such that the specifications are independent of specific protocol stacks, implementations, and operating systems.

The goal of the IEC 61850 series is to provide interoperability between the IEDs from different suppliers or, more precisely, between functions to be performed in a substation but residing in equipment (physical devices) from different suppliers. Interoperable functions may be those functions that represent interfaces to the process (for example, circuit breaker) or substation automation functions such as protection functions. This part of the IEC 61850 series uses simple examples of functions to describe the concepts and methods applied in the IEC 61850 series.

This part of the IEC 61850 series describes the relationships between other parts of the IEC 61850 series. Finally this part defines how inter-operability is reached.

NOTE Interchangeability, i.e. the ability to replace a device from the same vendor, or from different vendors, utilising the same communication interface and as a minimum, providing the same functionality, and with no impact on the rest of the system. If differences in functionality are accepted, the exchange may require some changes somewhere in the system also. Interchangeability implies a standardisation of functions and, in a strong sense, of devices which are both outside the scope of this standard. Interchangeability is outside the scope, but it will be supported following this standard for interoperability.

Table 1 – Guide for the reader

User		IEC 61850-1 (Introduction and overview)	IEC 61850-5 (Requirements)	IEC 61850-7-1 (Principles)	IEC 61850-7-4 (Logical nodes and data classes)	IEC 61850-7-3 (Common data classes)	IEC 61850-7-2 (Information exchange)	IEC 61850-6[a] (Configuration language)	IEC 61850-8-x IEC 61850-9-x [a] (Concrete communication stack)
Utility	Manager	x	–	Clause 5	–	–	–	–	–
	Engineer	x	x	x	x	x	In extracts	x	–
Vendor	Application engineer	x	x	x	x	x	In extracts	x	In extracts
	Communication engineer	x	x	x	–	–	x	–	x
	Product manager	x	x	x	x	In extracts	In extracts	In extracts	–
	Marketing	x	x	Clause 5	In extracts	In extracts	In extracts	In extracts	–
Consultant	Application engineer	x	x	x	x	x	–	x	–
	Communication engineer	x	–	x	–	–	x	x	x
All others		x	x	x	–	–	–	–	–

The "**x**" means that this part of the IEC 61850 series should be read.

The "**in extracts**" means that extracts of this part of the IEC 61850 series should be read to understand the conceptual approach used.

The "**–**" means that this part of the IEC 61850 series may be read.

[a] These documents are under consideration.

This part of the IEC 61850 series is intended for all stakeholders of standardised communication and standardised systems in the utility industry. It provides an overview of and an introduction to IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2, IEC 61850-6, and IEC 61850-8-1.

Table 1 provides a simplified guide as to which parts of the IEC 61850 series should be read by various stakeholders. Four groups are shown: utility, vendor, various consultants, and others.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

1 Scope

This part of the IEC 61850 series introduces the modelling methods, communication principles, and information models that are used in the parts of IEC 61850-7-x. The purpose of this part of the IEC 61850 series is to provide – from a conceptual point of view – assistance to understand the basic modelling concepts and description methods for:

– substation-specific information models for substation automation systems,

– device functions used for substation automation purposes, and

– communication systems to provide interoperability within substations.

Furthermore, this part of the IEC 61850 series provides explanations and provides detailed requirements relating to the relation between IEC 61850-7-4, IEC 61850-7-3, IEC 61850-7-2 and IEC 61850-5. This part explains how the abstract services and models of IEC 61850-7-x are mapped to concrete communication protocols as defined in IEC 61850-8-1.

The concepts and models provided in this part of the IEC 61850 series may also be applied to describe information models and functions for:

– substation to substation information exchange,

– substation to control centre information exchange,

– information exchange for distributed automation,

– information exchange for metering,

– condition monitoring and diagnosis, and

– information exchange with engineering systems for device configuration.

NOTE 1 This part of IEC 61850 uses examples and excerpts from other parts of the IEC 61850 series. These excerpts are used to explain concepts and methods. These examples and excerpts are informative in this part of IEC 61850.

NOTE 2 Examples in this part use names of classes (e.g. XCBR for a class of a logical node) defined in IEC 61850-7-4, IEC 61850-7-3, and service names defined in IEC 61850-7-2. The normative names are defined in IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2 only.

NOTE 3 This part of IEC 61850 does not provide a comprehensive tutorial. It is recommended that this part be read first – in conjunction with IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2. In addition, it is recommended that IEC 61850-1 and IEC 61850-5 also be read.

NOTE 4 This part of IEC 61850 does not discuss implementation issues.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary* [3]

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and devices models* [3]

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8825 (all parts), *Information technology – ASN.1 encoding rules*

ISO 9506-1:2003, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2:2003, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

INTERNATIONAL STANDARD

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Communication networks and systems in substations –

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organisation for standardisation comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardisation in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organisations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organisation for Standardisation (ISO) in accordance with conditions determined by agreement between the two organisations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 61850-7-3 has been prepared by IEC technical committee 57: Power system control and associated communications.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/618/FDIS	57/635/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*.

Part 1: Introduction and overview

Part 2: Glossary [1]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models [2]

Part 6: Configuration description language for communication in electrical substations related to IEDs [1]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3 [1]

Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3

Part 10: Conformance testing [1]

The content of this part of IEC 61850 is based on existing or emerging standards and applications. In particular the definitions are based upon:

- the specific data types defined in IEC 60870-5-101 and IEC 60870-5-103;
- the common class definitions from the *Utility Communication Architecture 2.0: Generic Object Models for Substation & Feeder Equipment (GOMSFE) (IEEE TR 1550).*

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

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1 Under consideration.

2 To be published.

INTRODUCTION

This document is part of a set of specifications, which details layered substation communication architecture. This architecture has been chosen to provide abstract definitions of classes and services such that the specifications are independent of specific protocol stacks and objects. The mapping of these abstract classes and services to communication stacks is outside the scope of IEC 61850-7-x and may be found in IEC 61850-8-x (station bus) and IEC 61850-9-x (process bus).

IEC 61850-7-1 gives an overview of this communication architecture. This part of IEC 61850 defines common attribute types and common data classes related to substation applications. These common data classes are used in IEC 61850-7-4. To define compatible data classes, the attributes of the instances of data shall be accessed using services defined in IEC 61850-7-2.

This part is used to specify the **abstract common data class** definitions. These abstract definitions shall be mapped into concrete object definitions that are to be used for a particular protocol (for example MMS, ISO 9506).

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

1 Scope

This part of IEC 61850 specifies common attribute types and common data classes related to substation applications. In particular it specifies:

- common data classes for **status information**,
- common data classes for **measured information**,
- common data classes for **controllable status information**,
- common data classes for **controllable analogue set point information**,
- common data classes for **status settings**,
- common data classes for **analogue settings** and
- **attribute types** used in these common data classes.

This international standard is applicable to the description of device models and functions of substations and feeder equipment.

This international standard may also be applied, for example, to describe device models and functions for:

- substation to substation information exchange,
- substation to control centre information exchange,
- power plant to control centre information exchange,
- information exchange for distributed generation, or
- information exchange for metering.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary* [3]

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

ISO 1000, SI units and recommendations for the use of their multiples and of certain other units

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[3] Under consideration.

IEC 61850-7-410

Edition 1.0 2007-08

INTERNATIONAL STANDARD

Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-410: Hydroelectric power plants – Communication for monitoring and control

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61850-410 has been prepared by IEC technical committee 57: *Power systems management and associated information exchange*.

It has been decided to amend the general title of the IEC 61850 series to *Communication networks and systems for power utility automation*. Henceforth, new editions within the IEC 61850 series will adopt this new general title.

The text of this standard is based on the following documents:

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57/886/FDIS	57/905/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61850 series, under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The present standard includes all additional logical nodes, not included in IEC 61850-7-4:2003, required to represent the complete control and monitoring system of a hydropower plant.

Most of the Logical Nodes in IEC 61850-7-410 that are of general use, Logical Nodes the names of which do not start with the letter "H", will be transferred to the future Edition 2 of IEC 61850-7-4. In the same manner, all Common Data Classes specified in IEC 61850-7-410 will be transferred to future Edition 2 of IEC 61850-7-3.

Once future Editions 2 of IEC 61850-7-3 and IEC 61850-7-4 are published, IEC 61850-7-410 will be revised to include only those Logical Nodes that are specific to hydropower use.

Before Edition 2 of IEC 61850-7-410 is published, there will be a period where the Common Data Class (CDC) and Logical Node (LN) specifications will overlap with IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2). During this time, the specifications in IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2) will apply.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-410: Hydroelectric power plants – Communication for monitoring and control

1 Scope

IEC 61850-7-410 is part of the IEC 61850 series. This part of IEC 61850 specifies the additional common data classes, logical nodes and data objects required for the use of IEC 61850 in a hydropower plant.

The Logical Nodes and Data Objects defined in this part of IEC 61850 belong to the following fields of use:

- **Electrical functions**. This group includes LN and DO used for various control functions, essentially related to the excitation of the generator. New LN and DO defined within this group are not specific to hydropower plants; they are more or less general for all types of larger power plants.
- **Mechanical functions**. This group includes functions related to the turbine and associated equipment. The specifications of this document are intended for hydropower plants, modifications might be required for application to other types of generating plants. Some more generic functions are though defined under Logical Node group K.
- **Hydrological functions**. This group of functions includes objects related to water flow, control and management of reservoirs and dams. Although specific for hydropower plants, the LN and DO defined here can also be used for other types of utility water management systems.
- **Sensors**. A power plant will need sensors providing measurements of other than electrical data. With a few exceptions, such sensors are of general nature and not specific for hydropower plants.

NOTE All Logical Nodes with names not starting with the letter "H" will be included in a future edition 2 of IEC 61850-7-4. When that document is published, the Logical Nodes in IEC 61850-7-4 (Edition 2) will take precedence over Logical Nodes with the same name in this part IEC 61850-7-410.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies:

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems in substations – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication services interface (ACSI)*

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes*

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Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-8-1 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/692/FDIS	57/712/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations:*

Part 1: Introduction and overview

Part 2: Glossary

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models

Part 6: Configuration description language for communication in electrical substations related to IEDs

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

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Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3

Part 10: Conformance testing [1]

This document specifies in Annex E specialized CDCs (Common Data Classes) based on CDCs defined in IEC 61850-7-3:2003.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

reconfirmed;
withdrawn;
replaced by a revised edition, or
amended.

A bilingual version of this document may be issued at a later date.

---

[1] Under consideration.

INTRODUCTION

This document is part of a set of specifications which details layered substation communication architecture.

This part of IEC 61850 is intended to provide inter-device operation of a variety of substation and feeder devices to achieve interoperability providing detailed information on how to create and exchange concrete communication messages that implement abstract services and models specified in IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2.

The mapping allows for data exchange over ISO/IEC 8802-3 Local Area Networks between all kinds of substation devices. Some of the protocol stacks used within this document are routable. Therefore the actual communications path may not be restricted to the LAN. Data exchange consists of real-time monitoring and control data, including measured values, to name just a few.

NOTE This part of IEC 61850 does not provide tutorial material. It is recommended that IEC 61850-5 and IEC 61850-7-1 be read in conjunction with IEC 61850-7-2.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

1 Scope

This part of IEC 61850 specifies a method of exchanging time-critical and non-time-critical data through local-area networks by mapping ACSI to MMS and ISO/IEC 8802-3 frames.

MMS services and protocol are specified to operate over full OSI and TCP compliant communications profiles. The use of MMS allows provisions for supporting both centralized and distributed architectures. This standard includes the exchange of real-time data indications, control operations, report notification.

This part of IEC 61850 specifies the mapping of the objects and services of the ACSI (Abstract Communication Service Interface, IEC 61850-7-2) to MMS (Manufacturing Message Specification, ISO 9506) and ISO/IEC 8802-3 frames.

This standard also specifies the mapping of time-critical information exchanges to non-MMS protocol. The protocol semantics are defined in IEC 61850-7-2. This standard contains the protocol syntax, definition, mapping to ISO/IEC 8802-3 frame formats, and any relevant procedures specific to the use of ISO/IEC 8802-3.

This mapping of ACSI to MMS defines how the concepts, objects, and services of the ACSI are to be implemented using MMS concepts, objects, and services. This mapping allows interoperability across functions implemented by different manufacturers.

This part of the standard defines a standardized method of using the ISO 9506 services to implement the exchange of data. For those ACSI services, defined in IEC 61850-7-2 that are not mapped to MMS, this part defines additional protocols. This standard describes real substation devices with respect to their external visible data and behaviour using an object oriented approach. The objects are abstract in nature and may be used to a wide variety of applications. The use of this mapping goes far beyond the application in the substation communications.

This part of IEC 61850 provides mappings for the services and objects specified within IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60874-10-1:1997, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 60874-10-2:1997, *Connectors for optical fibres and cables – Part 10-2: Detail specification for fibre optic connector type BFOC/2,5 terminated to single-mode fibre type B1*

IEC 60874-10-3:1997, *Connectors for optical fibres and cables – Part 10-3: Detail specification for fibre optic connector type BFOC/2,5 for single and multimode fibre*

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Part 7-1: Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

IEC 61850-9-1, *Communication networks and systems in substations – Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link*

IEC 61850-9-2, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 8072:1996, *Information technology – Open systems interconnection – Transport service*

ISO/IEC 8073:1997, *Information technology – Open Systems Interconnection – Protocol for providing the connection-mode transport service definition*

ISO/IEC 8326:1996, *Information processing system – Open Systems Interconnection – Session service definition*

ISO/IEC 8327-1:1997, *Information technology – Open Systems Interconnection – Connection-oriented session protocols: Protocol specification*

ISO/IEC 8348:2002, *Information technology – Open Systems Interconnection – Network service definition*

ISO/IEC 8473-1:1998, *Information technology – Protocol for providing the connectionless-mode network service: Protocol specification*

ISO/IEC 8473-2:1996, *Information technology – Protocol for providing the connectionless-mode network service – Part 2: Provision of the underlying service by an ISO/IEC 8802 subnetwork*

ISO/IEC 8602:1995, *Information technology – Protocol for providing the OSI connectionless-mode transport service*

ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Associated Control Service Element*

ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*

ISO/IEC 8802-2:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification*

ISO/IEC 8824-1:1999, Information technology – Abstract Syntax Notation One (ASN. 1): Specification of basic notation
Amendment 1 (2000)
Amendment 2 (2000)

ISO/IEC 8825-1:2000, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 8877:1992, *Information technology – Telecommunications and information exchange between systems – Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T*

ISO/IEC 9542:1988, *Information processing systems – Telecommunications and information exchange between systems – End system to Intermediate system routeing exchange protocol for use in conjunction with the Protocol for providing the connectionless-mode network service (ISO 8473)*

ISO/IEC 9548-1:1996, *Information technology – Open Systems Interconnection – Connectionless Session protocol: Protocol specification*

ISO/IEC 9576-1:1995, *Information technology – Open Systems Interconnection – Connectionless Presentation protocol: Protocol specification*

ISO/IEC 10035-1:1995, *Information technology – Open Systems Interconnection – Connectionless protocol for the Association Control Service Element: Protocol specification*
Amendment 1 (1998)

ISO/IEC ISP 10608-1:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 1: General overview and subnetwork-independent requirements*

ISO/IEC ISP 10608-2:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 2: TA51 profile including subnetwork-dependent requirements for CSMA/CD Local Area Networks (LANs)*

ISO/IEC ISP 11188-1:1995, *Information technology – International Standardized Profile – Common upper layer requirements – Part 1: Basic connection oriented requirements*

ISO/IEC ISP 11188-3:1996, *Information technology – International Standardized Profile – Common upper layer requirements – Part 3: Minimal OSI upper layer facilities*

ISO 9506-1:2003, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2:2003, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

ISO/ISP 14226-1:1996, *Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 1: Specification of ACSE, Presentation and Session protocols for use by MMS*

ISO/ISP 14226-2:1996, *Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 2: Common MMS requirements*

ISO/ISP 14226-3:1996, *Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 3: Specific MMS requirements*

IEEE C37.111:1999, *IEEE Standard for Common Format for Transient Data Exchange (COMTRADE) for Power Systems*

IEEE 754:1985, *IEEE Standard for Binary Floating-Point Arithmetic*

IEEE 802.1Q:1998, *IEEE Standards for Local and Metropolitan Networks: Virtual Bridged Local Area Networks*

RFC 542, *File Transfer Protocol for the ARPA Network, IETF, available at <http://www.ietf.org>*

RFC 768, *User Datagram Protocol, IETF, available at <http://www.ietf.org>*

RFC 791, *Internet Protocol – DARPA Internet Program Protocol Specification, IETF, available at <http://www.ietf.org>*

RFC 792, *Internet Control Message Protocol – DARPA Internet Program Protocol Specification, IETF, available at <http://www.ietf.org>*

RFC 793, *Transmission Control Procedure – DARPA Internet Program Protocol Specification, IETF, available at <http://www.ietf.org>*

RFC 826, *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware, IETF, available at <http://www.ietf.org>*

RFC 894, *A Standard for the Transmission of IP datagrams over Ethernet Networks, IETF, available at <http://www.ietf.org>*

RFC 919, *Broadcasting Internet Datagrams, IETF, available at <http://www.ietf.org>*

RFC 922 *Broadcasting Internet Datagrams in the presence of subnets, IETF, available at <http://www.ietf.org>*

RFC 950, *Internet Standard Subnetting Procedure, IETF, available at* <http://www.ietf.org>

RFC 959, *File Transfer Protocol (FTP), IETF, available at* <http://www.ietf.org>

RFC 1006 *ISO transport services on top of TCP: Version 3, IETF, available at <http://www.ietf.org>*

RFC 1112, *Host Extensions for IP Multicasting, IETF, available at <http://www.ietf.org>*

RFC 1122, *Requirements for Internet Hosts – Communication Layers, IETF, available at <http://www.ietf.org>*

RFC 1123, *Requirements for Internet Hosts – Application and Support, IETF, available at <http://www.ietf.org>*

RFC 2030, *Simple Network Time Protocol (SNTP) Version 4, IETF, available at <http://www.ietf.org>*

INTERNATIONAL STANDARD

IEC 61850-9-1

First edition
2003-05

Communication networks and systems in substations –

Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

FOREWORD

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International Standard IEC 61850-9-1 has been prepared by IEC technical committee 57: Power system control and associated communications.

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This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations.*

Part 1: Introduction and overview

Part 2: Glossary [1]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and devices models [2]

Part 6: Configuration description language for communication in electrical substations related to IEDs [1]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

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Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 [1]

Part 10: Conformance testing [1]

The relationship between IEC 60044-8 and this standard is as follows:

IEC 60044-8 defines a merging unit as interface to electronic current and voltage transformers. Data objects provided by that merging unit are specified in IEC 60044-8. This standard specifies a serial communication interface between the merging unit and equipment using the digital output of the merging unit like protection or metering equipment. For the specification of that serial interface, a subset of the abstract communication services defined in IEC 61850-7-2 are mapped on an ISO/IEC 8802-3 based communication link.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

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1 Under consideration.

2 To be published.

INTRODUCTION

This part of IEC 61850 applies to electronic current and voltage transformers (ECT and EVT) with a digital output via a merging unit, for use with electronic measuring instruments and electronic protective devices.

The transformer technology can be based on optical arrangements equipped with electronic components, on air core coils (with or without a built-in integrator) or, on iron core coils with integrated burden and used as a current to voltage converter, alone or equipped with electronic components.

For digital output, this standard takes into account a point to point connection from the merging unit to electronic measuring instruments and electronic devices.

This mapping allows interoperability between devices from different manufacturers.

This standard does not specify individual implementations or products, nor does it constrain the implementation of entities and interfaces within a computer system. This standard specifies the externally visible functionality of implementations.

Reading Guide

- The point to point transformer interface as defined here is based on the concepts described in IEC 60044-8. This standard extends this concept and proposes an alternative link layer to provide a solution for transmitting sampled measured values via Ethernet based interfaces. For the definition and measurement of the accuracy, synchronisation methods, data rates etc. of the transformers, refer to IEC 60044-8.

- This document can best be understood if the reader is thoroughly familiar with Parts 7-1, 7-2, 7-3 and 7-4 of this Standard.

- No explanations to the ACSI services are given in this part of the standard. For detailed information about the use of the ACSI services, refer to IEC 61850-7-2.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

1 Scope

This part of IEC 61850 specifies the specific communication service mappings for the communication between bay and process level and it specifies a mapping on a serial unidirectional multidrop point to point link in accordance with IEC 60044-8. This part of IEC 61850 specifies a mapping of the abstract service for the transmission of sampled values (as defined in IEC 61850-7-2) on a serial unidirectional multidrop point to point link in accordance with IEC 60044-8. It applies to the communication between merging units of electronic current (ECT) or voltage-transformers (EVT) and bay devices such as protection relays. If higher requirements on sampling rate, further sampled measured value data sets in addition to the universal data set, inter-bay communication and synchronisation apply, these will be covered by IEC 61850-9-2[3]. Figure 1 shows the schematics of this interface.

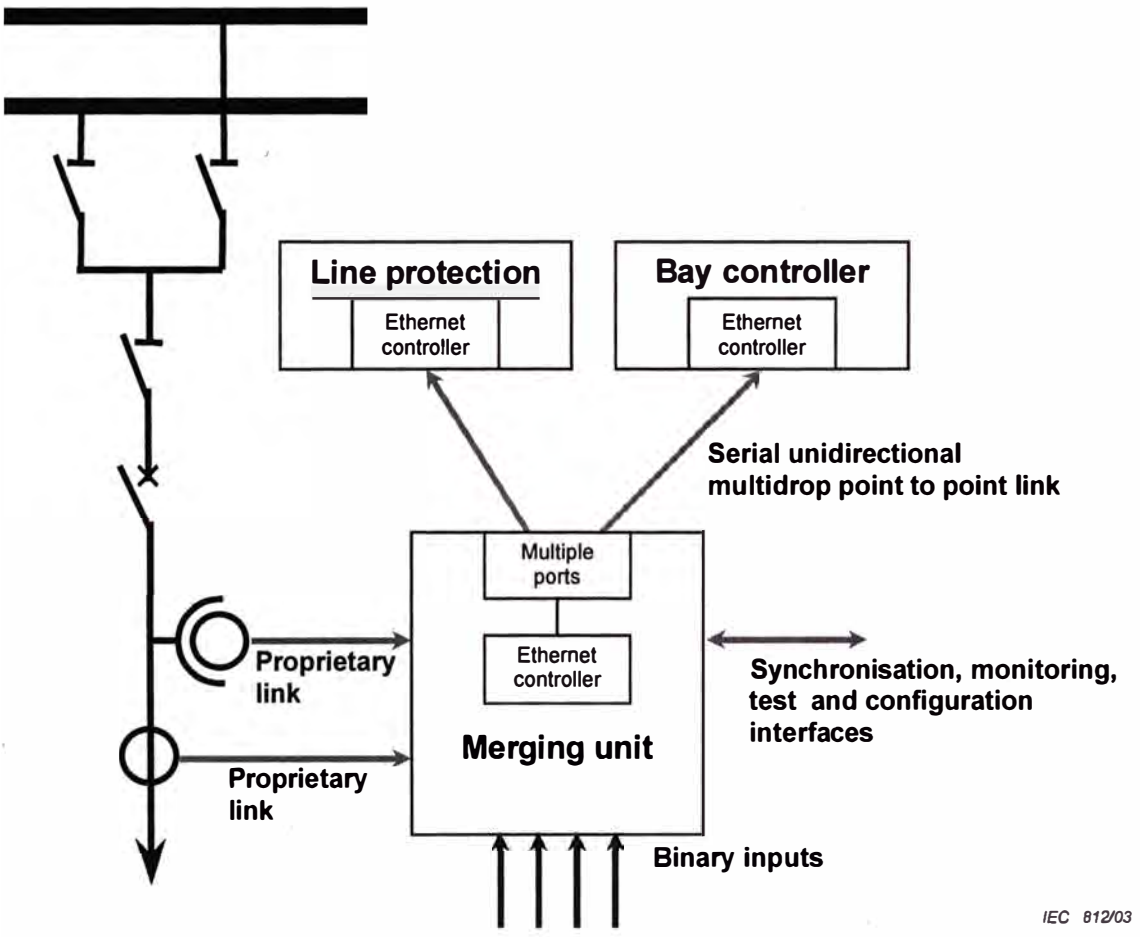

Figure 1 – Example for the use of the serial unidirectional multidrop point to point link

3 Under consideration.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60044-7: *Instrument Transformers – Part 7: Electronic voltage transformers*

IEC 60044-8: *Instrument Transformers – Part 8: Electronic current transformers*

IEC 60874-10-1:1997, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 61850-7-2: *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3: *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

ISO/IEC 8802-3: *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8825-1: *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

IEEE 802.1Q-1998: *IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks*

IEEE 802.3: *Information Technology – Telecommunication and Information Exchange Between Systems – LAN/MAN – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61850-9-2 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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Part 10: Conformance testing [1]

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- reconfirmed;
- withdrawn;
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A bilingual version of this document may be issued at a later date.

[1] Under consideration.

INTRODUCTION

This part of IEC 61850 defines the SCSM for sampled values over ISO/IEC 8802-3. The intent of this SCSM definition is to supplement IEC 61850-9-1 to include the complete mapping of the sampled value model.

This part of IEC 61850 applies to electronic current and voltage transformers (ECT and EVT having a digital output), merging units, and intelligent electronic devices for example protection units, bay controllers and meters.

Process bus communication structures can be arranged in different ways as described in Annex B and IEC 61850-1. In addition to the transmission of sampled value data sets, which are directly connected to ISO/IEC 8802-3, a selection of IEC 61850-8-1 services are necessary to support the access to the SV control block. References to the relevant IEC 61850-8-1 services are provided in this SCSM. For less complex devices (for example merging units) the sampled value control block can be pre-configured, in which case there is no need to implement IEC 61850-8-1 services based on the MMS-Stack.

This document defines the mapping of sampled value class model (IEC 61850-7-2) to ISO/IEC 8802-3. This SCSM, in combination with IEC 61850-7 and IEC 61850-6, allows interoperability between devices from different manufacturers.

This standard does not specify individual implementations or products, nor does it constrain the implementation of entities and interfaces within a computer system. This standard specifies the externally visible functionality of implementations together with conformance requirements for such functionalities.

Reading Guide

- This document is an extended mapping specification of IEC 61850-9-1 and IEC 61850-8-1 to cover sampled value transmission over ISO/IEC 8802-3.

- This document can best be understood if the reader is thoroughly familiar with IEC 61850-7-1, IEC 61850-7-2, IEC 61850-7-3 and IEC 61850-7-4.

- The ACSI services defined in IEC 61850-7-2 are not explained in this part of the standard.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3

1 Scope

This part of IEC 61850 defines the Specific Communication Service Mapping (SCSM) for the transmission of sampled values according to the abstract specification in IEC 61850-7-2. The mapping is that of the abstract model on a mixed stack using direct access to an ISO/IEC 8802-3 link for the transmission of the samples in combination with IEC 61850-8-1.

Each SCSM consists of three parts:

– a specification of the communication stack being used,

– the mapping of the abstract specifications of IEC 61850-7 on the real elements of the stack being used, and

– the implementation specification of functionality, that is not covered by the stack being used.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60874-10-1, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 60874-10-2, *Connectors for optical fibres and cables – Part 10-2: Detail specification for fibre optic connector type BFOC/2,5 terminated to single-mode fibre type B1*

IEC 60874-10-3, *Connectors for optical fibres and cables – Part 10-3: Detail specification for fibre optic adaptor type BFOC/2,5 for single and multimode fibre*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Part 7-1: Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

IEC 61850-8-1, *Communication networks and systems in substations – Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC 61850-9-1, *Communication networks and systems in substations – Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 8326:1996, *Information processing systems – Open Systems Interconnection – Session service definition*

ISO/IEC 8327-1:1997, *Information technology – Open Systems Interconnection – Connection-oriented session protocols: Protocol specification*

ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Associated Control Service Element*

ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification*

ISO/IEC 8824-1:1999, *Information technology – Abstract Syntax Notation One (ASN. 1): Specification of basic notation*
Amendment 1 (2000)
Amendment 2 (2000)

ISO/IEC 8825-1, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO 9506-1:2003, *Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

ISO 9506-2:2003, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

IEEE 754:1985, *IEEE Standard for Binary Floating-Point Arithmetic*

IEEE 802.1Q:1998, *IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks*

RFC 791, *Internet Protocol; IETF, available at <http://www.ietf.org>*

RFC 792, *Internet Control Message Protocol; IETF, available at <http://www.ietf.org>*

RFC 793, *Transmission Control Procedure; IETF, available at <http://www.ietf.org>*

RFC 826, *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware; IETF, available at <http://www.ietf.org>*

RFC 894, *A Standard for the Transmission of IP datagrams over Ethernet Networks; IETF, available at <http://www.ietf.org>*

RFC 919, *Broadcasting Internet Datagrams; IETF, available at <http://www.ietf.org>*

RFC 1006 *ISO transport services on top of TCP: Version 3; IETF, available at <http://www.ietf.org>*

RFC 1112, *Host Extensions for IP Multicasting; IETF, available at <http://www.ietf.org>*

INTERNATIONAL STANDARD

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Communication networks and systems in substations –

Part 10: Conformance testing

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 10: Conformance testing

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61850-10 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this standard is based on the following documents:

FDIS	Report on voting
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Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*:

Part 1: Introduction and overview

Part 2: Glossary

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models

Part 6: Configuration description language for communication in electrical substations related to IEDs

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3

Part 10: Conformance testing

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual edition of this standard may be issued at a later date.

INTRODUCTION

This part of IEC 61850 is part of a set of specifications which details a layered substation communication architecture.

This part of IEC 61850 defines:

- the methods and abstract test cases for conformance testing of devices used in substation automation systems, and
- the metrics to be measured within devices according to the requirements defined in IEC 61850-5.

The intended readers are test system developers.

NOTE 1 Tests regarding EMC requirements and environmental conditions are subject to IEC 61850-3 and not included in this part of IEC 61850.

NOTE 2 It is recommended that IEC 61850-5 and IEC 61850-7-1 be read first in conjunction with IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

NOTE 3 Abbreviations used in IEC 61850-10 are listed in Clause 4 or may be found in other parts of IEC 61850 that are relevant for conformance testing.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 10: Conformance testing

1 Scope

This part of IEC 61850 specifies standard techniques for testing of conformance of implementations, as well as specific measurement techniques to be applied when declaring performance parameters. The use of these techniques will enhance the ability of the system integrator to integrate IEDs easily, operate IEDs correctly, and support the applications as intended.

NOTE 1 The role of the test facilities for conformance testing and certifying the results are beyond the scope of this part of IEC 61850.

NOTE 2 The test approach and test system design to test a client device is likely to be different across the broad range of clients. There are many possibilities to test clients. The client tests are beyond the scope of this part of IEC 61850. It is intended to define client test requirements during the maintenance of this part.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-4, *Communication networks and systems in substations – Part 4: System and project management*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems in substations – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

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IEC 61850-9-1, *Communication networks and systems in substations – Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link*

IEC 61850-9-2, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

ISO/IEC 9646-1, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts*

ISO/IEC 9646-2, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract test suite specification*

ISO/IEC 9646-4, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 4: Test realization*

ISO/IEC 9646-5, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 5: Requirements on test laboratories and clients for the conformance assessment process*

ISO/IEC 9646-6, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 6: Protocol profile test specification*

TÉRMINOS USUALES

Este anexo presenta la interpretación de los términos usuales relacionados al tema y que son utilizados en el informe.

1. **IEDs**. cualquier dispositivo electrónico utilizado en Subestaciones Eléctricas que incorpora uno o mas procesadores con la capacidad de intercambiar datos y efectuar secuencias de control desde o hacia una fuente externa. Ejemplos : Reles de Proteccion, medidores , Equipos de Monitoreo de transformadores e interruptores.
2. **LAN** . es la interconexión de varios IEDs , ordenadores, Switches, Routers. (LAN es la abreviatura inglesa de Local Area Network o 'red de área local'). Su extensión esta limitada físicamente a una Subestación o a un entorno de pocos kilómetros. Su aplicación más extendida es la interconexión de ordenadores personales y estaciones de trabajo en oficinas, fábricas, etc., para compartir recursos e intercambiar datos y aplicaciones. En definitiva, permite que dos o más equipos se comuniquen
3. **VPN** . La Red Privada Virtual (RPV), en inglés Virtual Private Network (VPN), es una tecnología de red que permite una extensión de la red local sobre una red pública o no controlada, como por ejemplo Internet. Ejemplos comunes son, la posibilidad de conectar dos o más sucursales de una empresa utilizando como vínculo Internet, permitir a los miembros del equipo de soporte técnico la conexión desde su casa al centro de cómputo, o que un usuario pueda acceder a su equipo doméstico desde un sitio remoto, como por ejemplo un hotel. Todo ello utilizando la infraestructura de Internet.
4. **TCP/IP**. Es la familia de protocolos de internet . Es un conjunto de protocolos de red en la que se basa Internet y que permiten la transmisión de datos entre redes de computadoras. En ocasiones se la denomina conjunto de protocolos TCP/IP, en referencia a los dos protocolos más importantes que la componen: Protocolo de Control de Transmisión (TCP) y Protocolo de Internet (IP), que fueron los dos primeros en definirse, y que son los más utilizados de la familia. Existen tantos protocolos en este conjunto que llegan a ser más de 100 diferentes, entre ellos se encuentra el popular HTTP (HyperText Transfer Protocol), que es el que se utiliza para acceder a las páginas web, además de otros como el ARP (Address

Resolution Protocol) para la resolución de direcciones, el FTP (File Transfer Protocol) para transferencia de archivos, y el SMTP (Simple Mail Transfer Protocol) y el POP (Post Office Protocol) para correo electrónico, TELNET para acceder a equipos remotos, entre otros.

5. **IPV4, IPV6**. IPv4 es la versión 4 del Protocolo IP (Internet Protocol). Esta fue la primera versión del protocolo que se implementó extensamente, y forma la base de Internet. IPv4 usa direcciones de 32 bits, limitándola a 232 = 4.294.967.296 direcciones únicas, muchas de las cuales están dedicadas a redes locales (LANs). Por el crecimiento enorme que ha tenido del Internet (mucho más de lo que esperaba, cuando se diseñó IPv4), combinado con el hecho de que hay desperdicio de direcciones en muchos casos (ver abajo), ya hace varios años se vio que escaseaban las direcciones IPv4. Esta limitación ayudó a estimular el impulso hacia IPv6, que esta actualmente en las primeras fases de implementación, y se espera que termine reemplazando a IPv4
6. **Ethernet**. es el nombre de una tecnología de redes de computadoras de área local (LANs) basada en tramas de datos. El nombre viene del concepto físico de ether. Ethernet define las características de cableado y señalización de nivel físico y los formatos de trama del nivel de enlace de datos del modelo OSI. Ethernet se refiere a las redes de área local y dispositivos bajo el estándar IEEE 802.3 que define el protocolo CSMA/CD
7. **DNP3**. es un protocolo de adquisición de datos utilizado por las compañías eléctricas, gas y agua con el fin de leer información de sus IEDs. Es diseñado como un abierto, interoperable y simple protocolos para Sistemas Scada . Usa la interrogación Maestra/Esclava para enviar y recibir información de IEDs.
8. **UCVA 2.0**. El Electric Power Research Institute (EPRI) desarrolló la suite de protocolos conocida como "Utilities Communications Architecture versión 2" (UCA 2.0) . Este protocolo de adquisición de datos de IEDs es basado en la utilización de Ethernet e incorpora la utilización de TCP/IP y MMS para las capas de aplicación.
9. **ICCP**. También conocido como IEC 60870-6/TASE.2 . Es un protocolo de intercambio de datos entre Centros de Control.
10. **RTU**. También conocido como UTR - Unidad Terminal Remota es un acrónimo que define a un dispositivo basados en microprocesadores, el cual permite obtener señales independientes de los procesos y enviar la información a un sitio remoto donde se procese. Generalmente este sitio remoto es una sala de control donde se encuentra un sistema central SCADA el cual permite visualizar las

variables enviadas por la UTR

11. **Switch** . en castellano "conmutador", es un dispositivo electrónico de interconexión de redes de ordenadores que opera en la capa 2 (nivel de enlace de datos) del modelo OSI (Open Systems Interconnection). Un conmutador interconecta dos o más segmentos de red, funcionando de manera similar a los puentes (bridges), pasando datos de un segmento a otro, de acuerdo con la dirección MAC de destino de los datagramas en la red.
12. **Router** . en español enrutador, ruteador o encaminador es un dispositivo de hardware para interconexión de redes de ordenadores que opera en la capa tres (nivel de red). Un router es un dispositivo que permite asegurar el enrutamiento de paquetes entre redes o determinar la ruta que debe tomar el paquete de datos.
13. **Fibra Óptica**. es un conductor de ondas en forma de filamento, generalmente de vidrio, aunque también puede ser de materiales plásticos. La fibra óptica es capaz de dirigir la luz a lo largo de su longitud usando la reflexión total interna. Normalmente la luz es emitida por un láser o un LED. Las fibras son ampliamente utilizadas en telecomunicaciones, ya que permiten enviar gran cantidad de datos a gran velocidad, mayor que las comunicaciones de radio y cable. También se utilizan para redes locales. Son el medio de transmisión inmune a las interferencias por excelencia
14. **ICD**. También llamado IED Configuration Description , Es el archivo que contiene las características de implementación del protocolo IEC 61850 en un IED.
15. **SCD**. Es el archivo que contiene la descripción de las comunicaciones lógicas entre IEDs bajo el estándar IEC 61850.
16. **GOOSE**. es un acrónimo de Generic Object Orintated System Wide Events . Esta reemplaza el convencional Cableado para que los IEDs intercambien información entre ellos. En el momento que se detecta un evento (cambio de estado de un Interruptor en un IED por ejemplo) , el IED usa una comunicación del tipo Multicast (envío de información a múltiples destinos) para notificar a los otros IEDs que se encuentran en el mismo BUS que ha ocurrido un evento

BIBLIOGRAFÍA

[1] Kema Inc, "Substation Communications : Enabler of Automation" , United Telecom Council – USA - Washington DC, 2006

[2] Electric Power Research Institute (EPRI), "Guidelines for implementing Substation Automation Using IEC 61850, the International Power System Information Modeling Standard", EPRI – California – USA, 2004

[3] John D. McDonald, " Electric Power Substations Enginnering" , Florida – USA , 2003.

[4] Douglas Proudfoot, " UCA and 61850 for Dummies" , Siemens Power Transmision and Distribution , USA , 2002.

[5] Cobus Strauss , " Electrical Network automation and Communication Systems" , London , England , 2003.

[6] FIEE -UNI, " Curso Internacional – Sistemas Scada en Centros de Control de Energia y Automatizacion de Subestaciones Electricas" , Lima , Peru , 2001.

[7] IEE1613 Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations , USA , 2002.

[8] IEEE , Recommended Practice for Master/Remote Supervisory Control and Data Adquisition (SCADA) Communications, USA , 1993.

[9] Ruggedcom , IEC 61850 Seminar : Ruggedcom The Communication Backbone for IEC 61850, Toronto , Canada , 2005.

[10] ABB, IEC 61850 el Nuevo Estandard en Automatizacion de Subestaciones, Santiago de Chile , 2005.