Management System for Remote Substation Secondary Equipment

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AGENDA

- Who is Red Eléctrica
- Current situation
- New Project
  - Objectives
  - Characteristics
- Control Centre configuration SIGRES-CC
- Security
- Substation equipment SIGRES-NT
- Project milestones
- Conclusions
Who is Red Electrica?

- Leading Power Transmission Company in Spain
- Responsible for the management of the whole Spanish Transmission Grid
- Spanish System Operator
- Owns most of the Spanish Transmission Grid:
  - 27,000 Km of 400 kV, 220 kV and 132 kV Transmission Network
  - 1,746 Positions in more than 500 HV Substations
  - 26,966 MVA Transformation
- Operates the Ancillary Services Market
- Non regulated activities:
  - Consulting Services and Foreign Investment REI
  - Telecommunication Services ALBURA
Current Remote Maintenance System Architecture ALEF
Project Objectives

- Implement an Integrated Environment for Substation Secondary Equipment Management and Maintenance using and extending the IEC 61850
  - First step:
    - Protection relays
    - Local Control Systems
    - Battery Chargers
  - Further steps:
    - Any device with communication capabilities
    - Gracefully integration of “native” IEC 61850 IEDs

- Integrate the requirements of the New Substation of REE NSR, based on the same technologies
  - The IEC 61850 standard
  - IP protocol with Ethernet LAN access interfaces
Project Characteristics

- Standardised Services for maintenance and management of substation equipment:
  - Data and Operation consistency check
  - User’s contention when accessing system resources
  - Active and passive security control
  - Operation traceability
    - What has been done?
    - Who did it?
  - User-friendly working environment
  - Open and secure working environment

- Ubiquity Services

- Use mainstream technologies:
  - Java, Web Services, XML/SVG Graphics
System Architecture

REE Corporate LAN

REE Headquarters
Madrid

SIGRES-CC

Sigres-NT

IP WAN (Serv IP)

Substations

User

User

900 xxx xxx/ VPN

Internet

RTB/ADSL/ISDN

Remote User

SIGRES
SIGRES Working Environment

- ALEF
- IED 61850
- IED
- IED
- Legacy Protocols
- SIGRES NT-Terminal Node
- IEC 61850
- SIGRES CC-Control Centre
- Web Services
- https/HTML/XML
- EMS/SCADA
- APPLICATIONS
- USERS

SIGRES
SIGRES-CC Characteristics

- Fault-tolerant system
- Native management of 61850 IEDs
- Three-layer Architecture
- Oracle Data Base
- Communication with existing Management Centre (ALEF)
  - Integration of existing data in SIGRES-CC data base
- Standardised information model for data interchange (XML)
- Web Services “interface” with Applications (SCADA/EMS..)
- Web Browser based MMI Interface
- Specific Graphic Interfaces
  - Fault-recorders and PMUs
- Substation Configuration Tool based on IEC 61850 (Draft) SCL
- Intrinsic security based on international standards
Design & Project Principles

- Scalability and Modularity
- Hardware independence (Platform migration)
- IEC 61850 architecture adoption
- Based on existing or ongoing standards
  - No proprietary solutions whether HW or SW
- REE Ownership of the Design and Code
- Procedures to install the whole System from scratch
- REE has to be able to carry out the System Maintenance after Commissioning
Services

- Substation Remote supervision using RTUs or SAC
- RTUs and SAC Data Base Download
- System Management
- Historian and data logs
  - User’s reports:
    - Protection relay configuration and settings
    - Trips and commands
    - Chronological register
    - Operator’s commands and system utilization time
- Process Automation
  - Individual or Block Relay setting Configuration
- Security
- Substation equipment configuration
IEC-61850. A New Set of Possibilities

- IEC 61850 defines three basic aspects:
  - Communication protocols
    - IP and MMS
  - Substation devices modelling
  - Services

- IEC 61850 a unique working environment
  - Services and object models are harmonised
  - Services and object models are unique whether inside the substation or from the substation to the control centre
  - Object models and services are independent from communication protocols
SIGRES map to IEC 61850 Architecture

Station Level
- Technical Services
- AUXILIARY FUNCTIONS
- CCS
- PROT.
- CONTROL

Bay/Unit Level
- PROT.
- CONTROL

Process Level
- BAY

Levels:
- L0
- L1
- L2
- L3
SIGRES map to IEC 61850 Model (I)
SIGRES map to IEC 61850 Model (II)

LINK with SIGRES-CC Sample

SIGRES-CC (Gestor IEC-61850)
  IHMI

SIGRES-NT
  LD1 (Sigres-NT)
    LPHD
    IARC
  LNIO
  ITMI

  LD2 (Oscila)
  LD4 (Interruptor)
  LD3 (Protección)
  LDS (Trafo)
IEC 61850 Logic architecture
IEC 61850. A New Paradigm

CONTROL CENTRE

LOCAL CONTROL (SCI)

IED

PRIMARY EQUIPMENT

CIM

Mapping

IEC 61850

IP+MMS (OTHERS)

IP+ MMS

Ethernet

LN (OBJ)

SERVICES

MAPPING

COMMUNIC.
Logical Node Structure

- LOGICAL NODE
  - Common information Independent from the function of the LN
  - Status, process or function information
  - Settings Information needed to configure the LN
  - Measured Values
  - Controls
61850 Management and Maintenance Functions

- FULLY INTEGRATED
  - Management and maintenance services are built into the object models
  - Implemented using the services built into protection and control functions
- Management and maintenance functions cannot be isolated from 61850 services.
  - SIGRES has to be integrated in a 61850 environment
Migration from Legacy to 61850

- SIGRES-CC
- IP WAN
- SIGRES-NT
- IED
- IED
- Management of 61850 Devices
- 61850 MODELS & SERVICES
- LEGACY PROTOCOLS
SIGRES. A Step Forward

- IEC 61850 services become integrated in an open execution environment
- SIGRES evolves 61850 services
  - 61850 services will be available outside the substation
  - 61850 services can be used from a Web environment
    - Global view of the system
    - Direct control of IEDs without loosing the global view
- SIGRES complements 61850 services
  - Standardised user’s interface
  - Distributed services
  - Auxiliary services configured from 61850 services
SIGRES. A Distributed Application Environment

- Users can be distributed
  - An IP network provides connectivity

- Applications can be distributed
  - An IP network provides communication between applications

- The internal process can be distributed
  - A network provides connectivity between objects

- EVERYTHING CAN BE DISTRIBUTED
  - A Middleware architecture provides an access environment to the services
Web Services

A Web service is a software application identified by a URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artifacts. A Web service supports direct interactions with other software agents using XML based messages exchanged via internet-based protocols.

- Based on Agents
  - Service requestor
  - Service provider
  - Discovery agency
    - Service publishing
    - Service finding
Service Oriented Architecture
Protocol Architecture

DESCRIPTION
- UML
- WSDL
- XML
- SOAP

TRANSPORT
- HTTP
- TCP/IP

UDDI
LDAP
User’s Interface
Hardware Architecture (I)

*Fault-tolerant environment designed to support the Three-Layered architecture*

- Data base Server
  - Redundant cluster
- Application Server
  - Redundant cluster
- Printer Server
- Development platform
  - Small size version of DB and application servers
- System management terminals
- Security
  - Redundant Firewalls
  - Redundant RADIUS servers for remote access control
Hardware Architecture (II)
Security Architecture

- Secure Zone. Access through a Firewall
  - No access allowed for users
    - Data base Server
    - Management sites
    - Printer Server
- DMZ. Access through a Firewall
  - Access to enabled users
    - Application Server
    - Development platform
    - Remote users authentication server
SECURITY

Key Issues in a Secure System

- Authentication  Who is the user?
- Authorization   What can the user do?
- Auditing       What has the user done?
SIGRES Security Performance

- Prevention form internal or external attacks
- Standardised public key architecture (PKI)
  - ITU-T X.509 rec.
- Every data interchange is carry out in secure mode
  - Authentication and Ciphering
- Security is applied to every kind of access
  - Corporate LAN
  - ServIP (Corporate IP WAN)
  - Remote access through public network using a dedicated RADIUS server
- Wide variety of user profile configurations
- Security auditing
SUBSTATION EQUIPMENT SIGRES-NT

- Interfaces legacy substation equipment with the new 61850 environment
- Supports the services offered by SIGRES-CC
- Automatic configuration from SIGRES-CC
  - Application Software
  - Object models
- Rugged design able to work in hazardous environment like bay control cabinets
  - Equipped to fulfil bay requirements
    - 1 Ethernet port
    - 6 serial ports
- Helps in the integration of legacy devices into the new substation architecture
Specific Characteristics

- Remote supervision and BD download functions supported
- Auto-checking
- Event time-stamping with 1 mseg resolution
  - GPS Synchronization
- Built-in IEC 61850 Server
  - Communication with SIGRES-CC using 61850
  - Conversion of legacy IEDs to 61850 objects
- Supports all the maintenance and management protocols used by REE
- Chronological registers acquisition
- Open Software. Hardware platform independent
  - IEC 61850 KEMA certification required
Substation Communication Architecture

IP WAN

Router

Switch

F.O.

HUB

IED 61850

SIGRES-NT

IED 61850

IED 61850

IED 61850

IED 61850

IED 61850
The selected supplier is a Spanish company named ELIOP with international projection and experience in Substation Automation and Control Centres development, and also strongly committed to the IEC 61850.

- **MS 1. Functional specification**  November 2002
- **MS 2. System Supplier Selection**  May 2002
- **MS 2. Project Start**  June 2003
- **MS 3. Project Development & FAT**  December 2003
- **MS 3. Project SAT**  February 2004
CONCLUSIONS

- Powerful complement of the new substation architecture NSR
- Single working environment for all the services
- Standard working platform
  - Unified
  - Flexible
  - Secure
  - Ubiquity
  - Integrated in the new standard IEC 61850
- Operational cost reduction
  - Lower number of equipment required
  - Wiring simplified
  - Maintenance simplified
Questions ?