



RED ELÉCTRICA DE ESPAÑA



**Management System for  
Remote Substation  
Secondary Equipment**

**KEMA SEMINAR June 17, 2003 Amsterdam**



## **AGENDA**

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

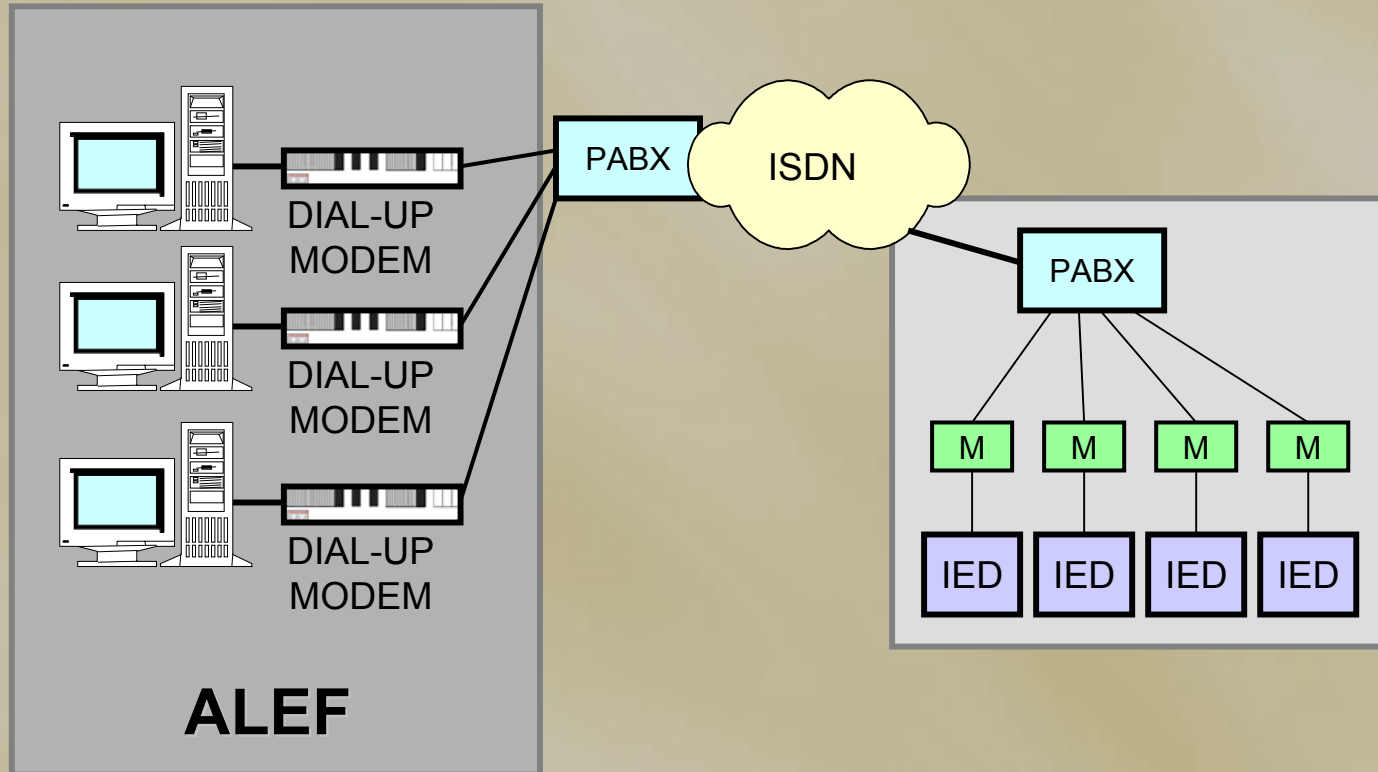


## Who is Red Electrica ?

- **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**
  - **1746 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**

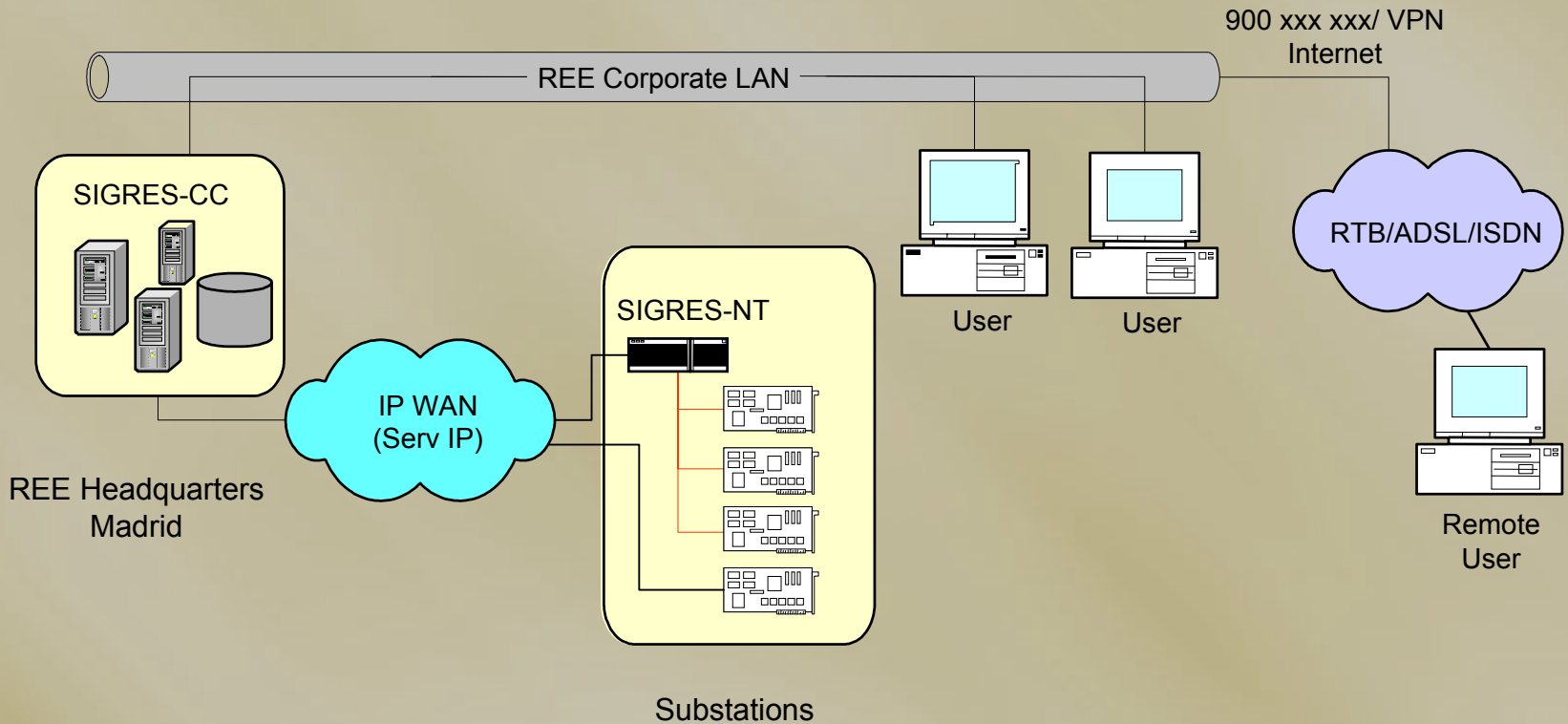


## Project Characteristics

- **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

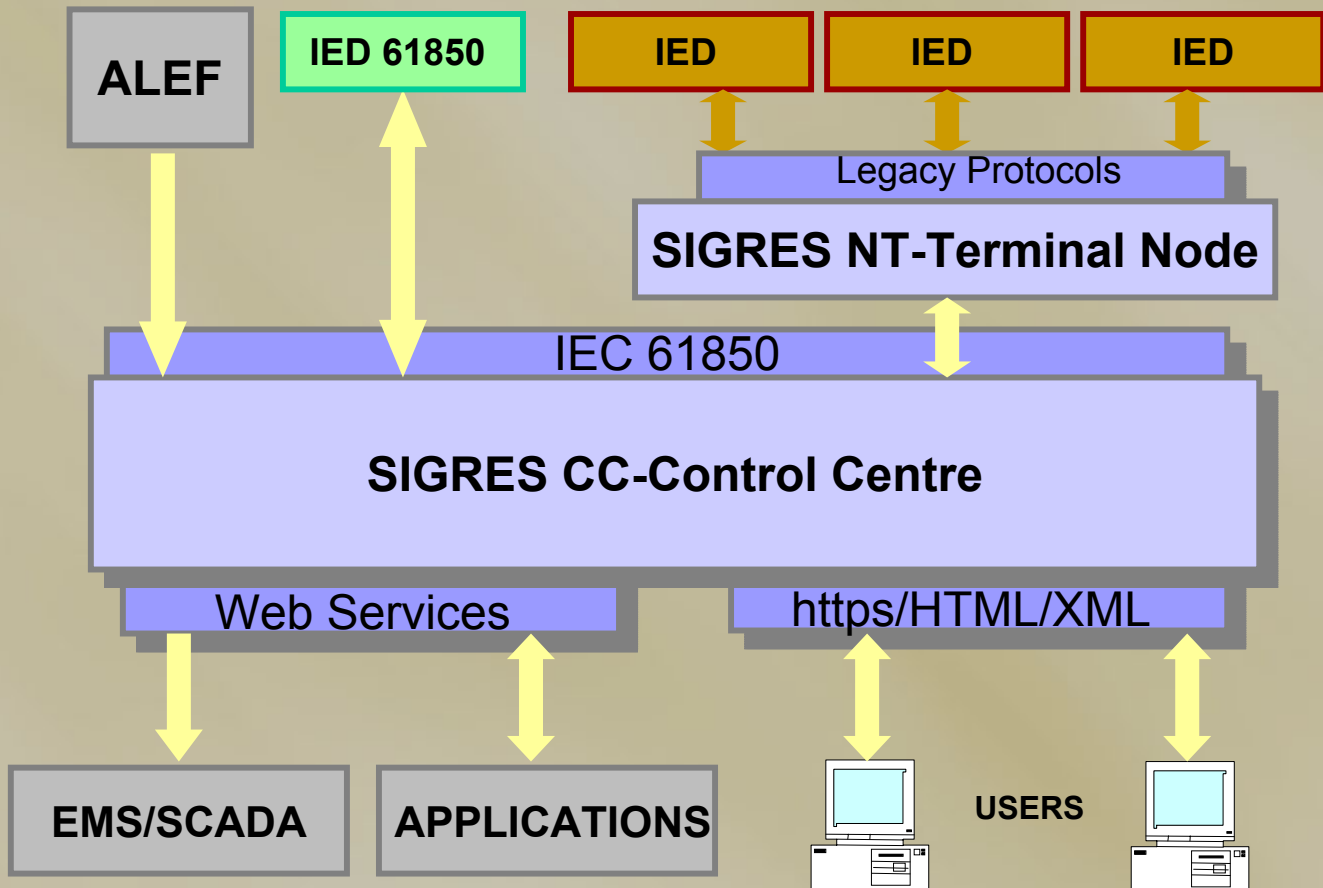


# System Architecture





# SIGRES Working Environment





## **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

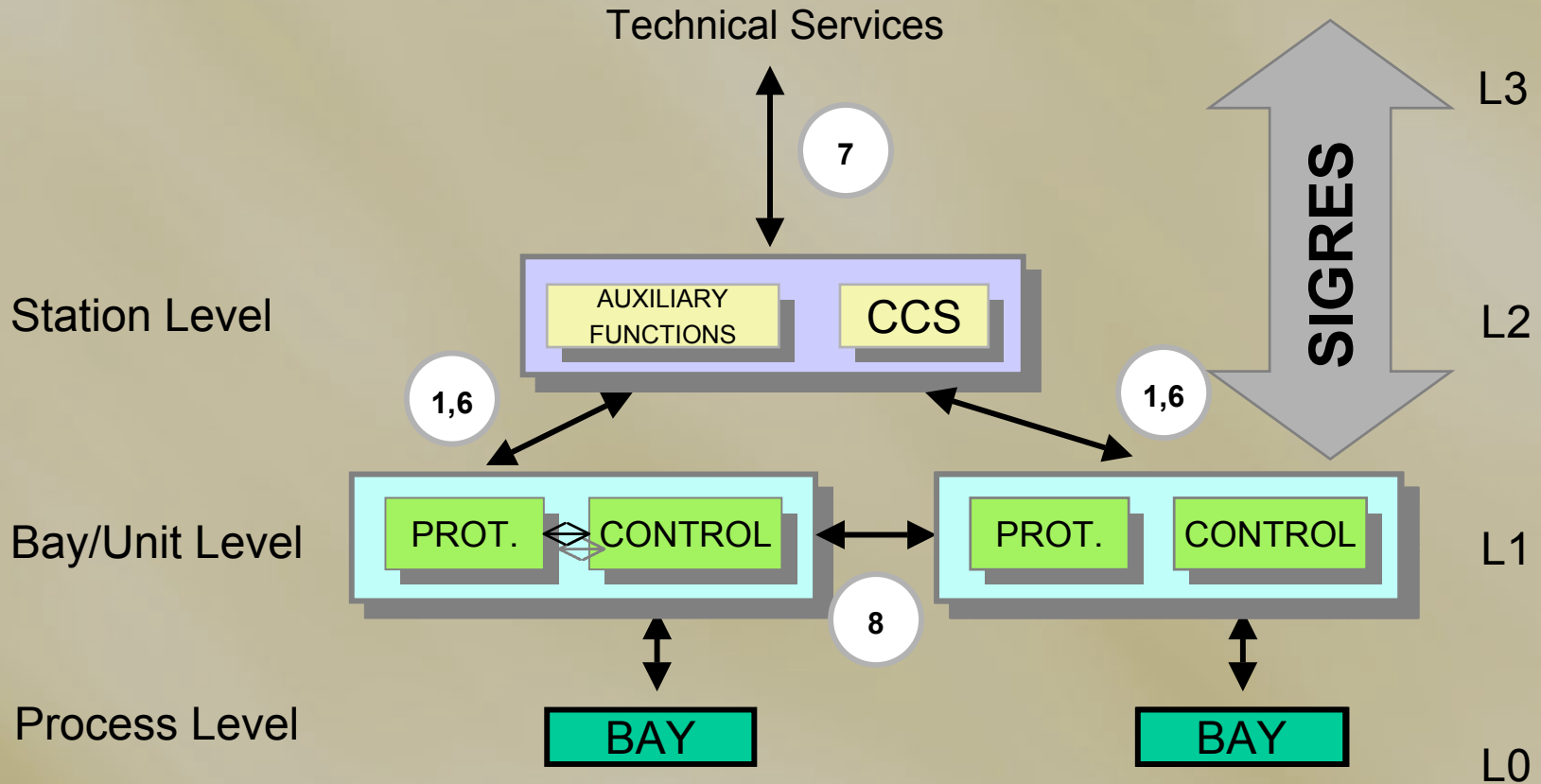


## **IEC-61850. A New Set of Possibilities**

- **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**

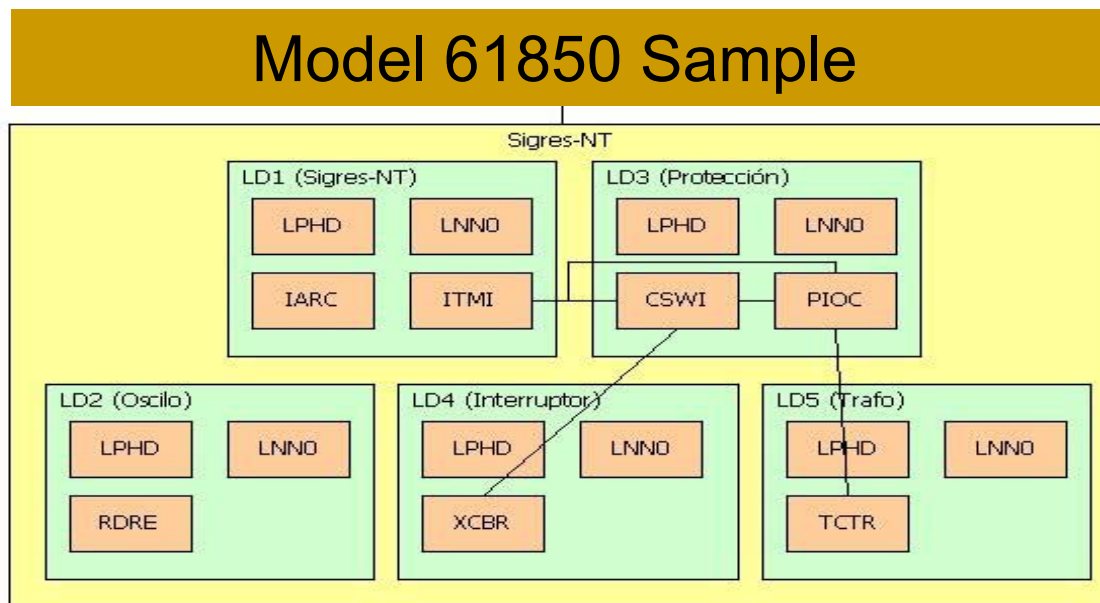


# SIGRES map to IEC 61850 Architecture





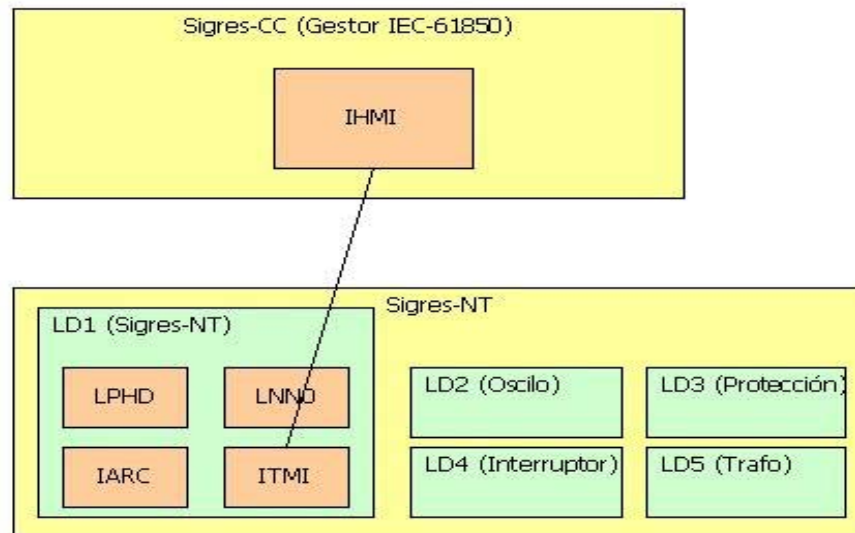
# SIGRES map to IEC 61850 Model (I)





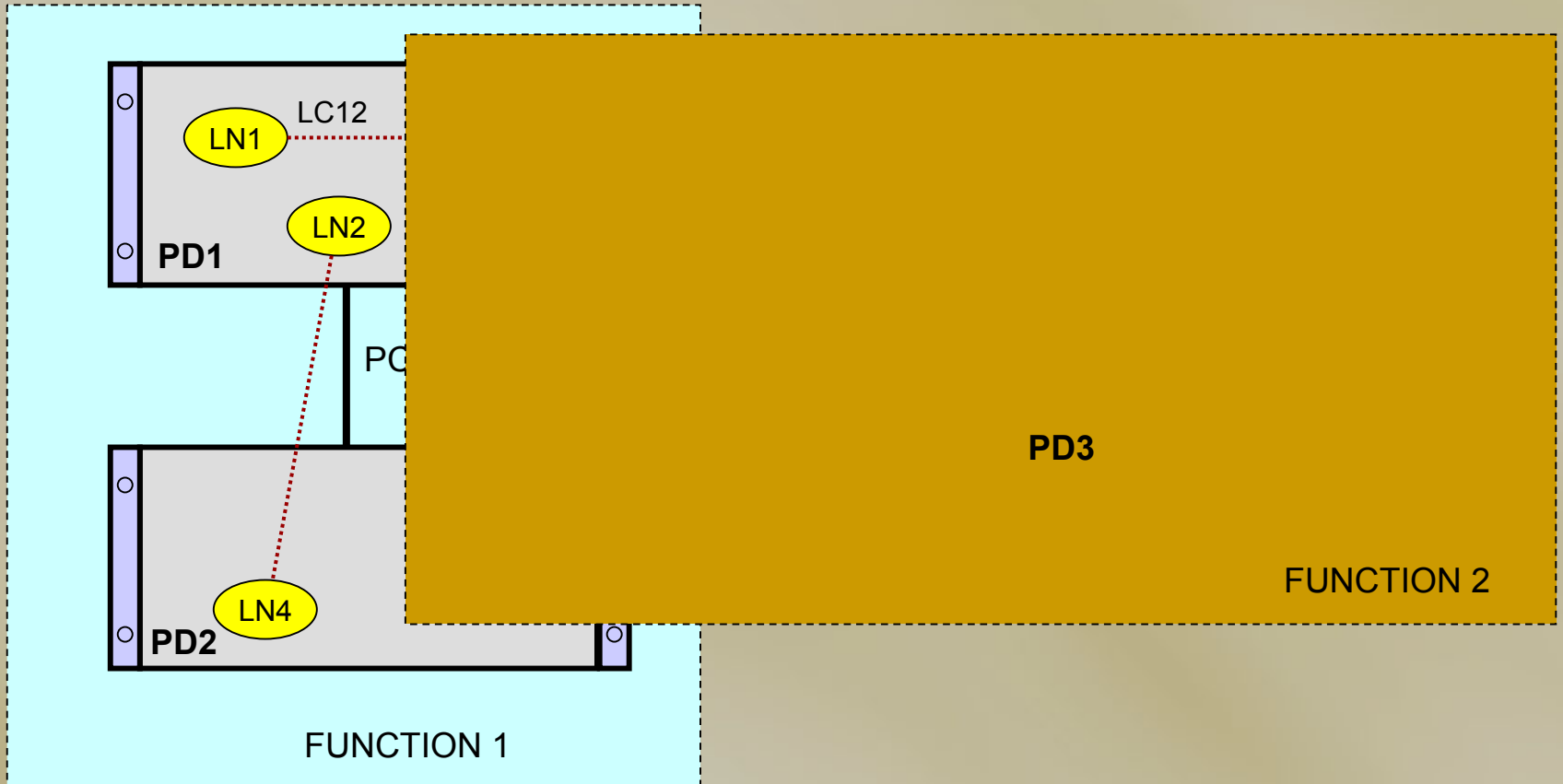
## SIGRES map to IEC 61850 Model (II)

### LINK with SIGRES-CC Sample



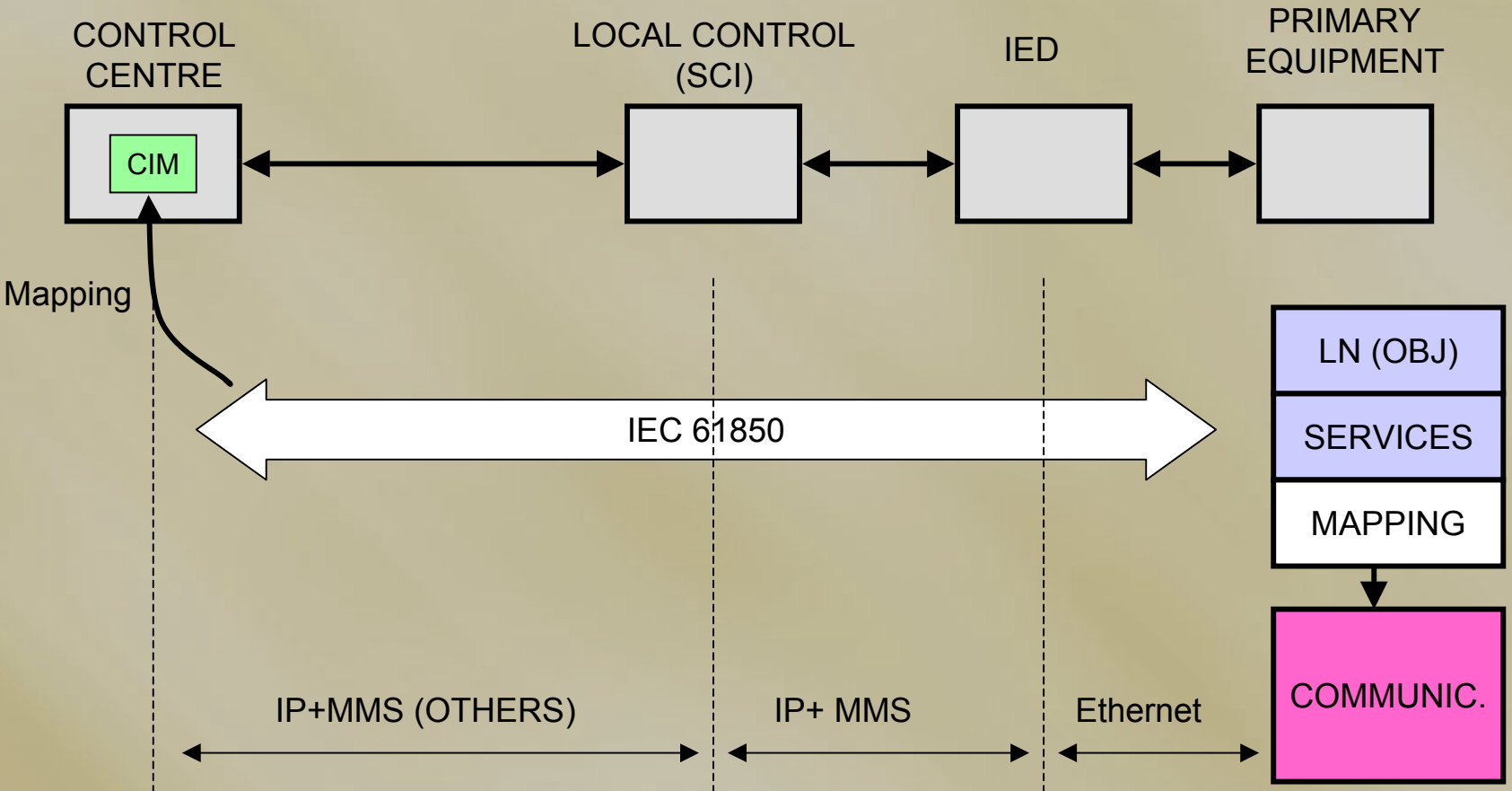


# IEC 61850 Logic architecture



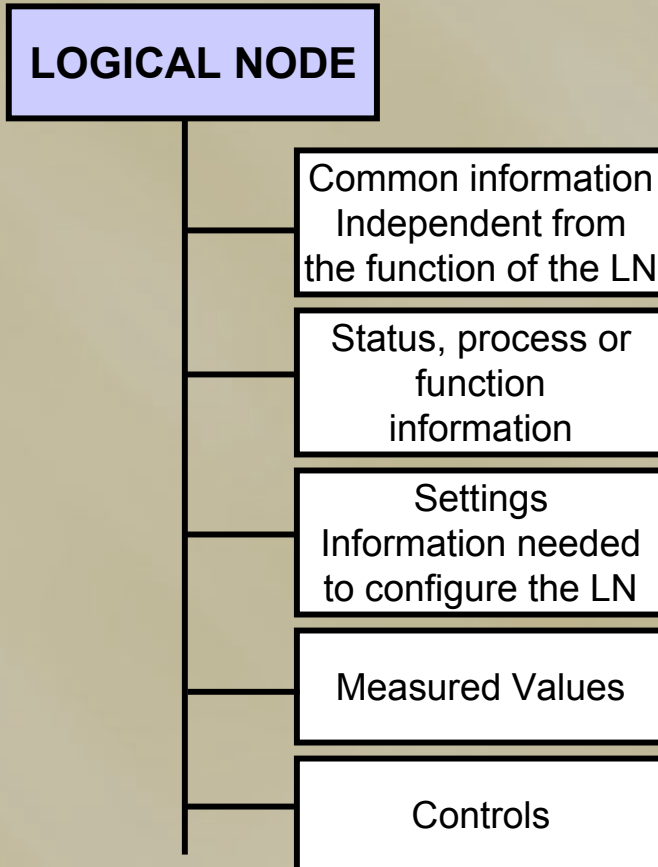


# IEC 61850. A New Paradigm





## Logical Node Structure



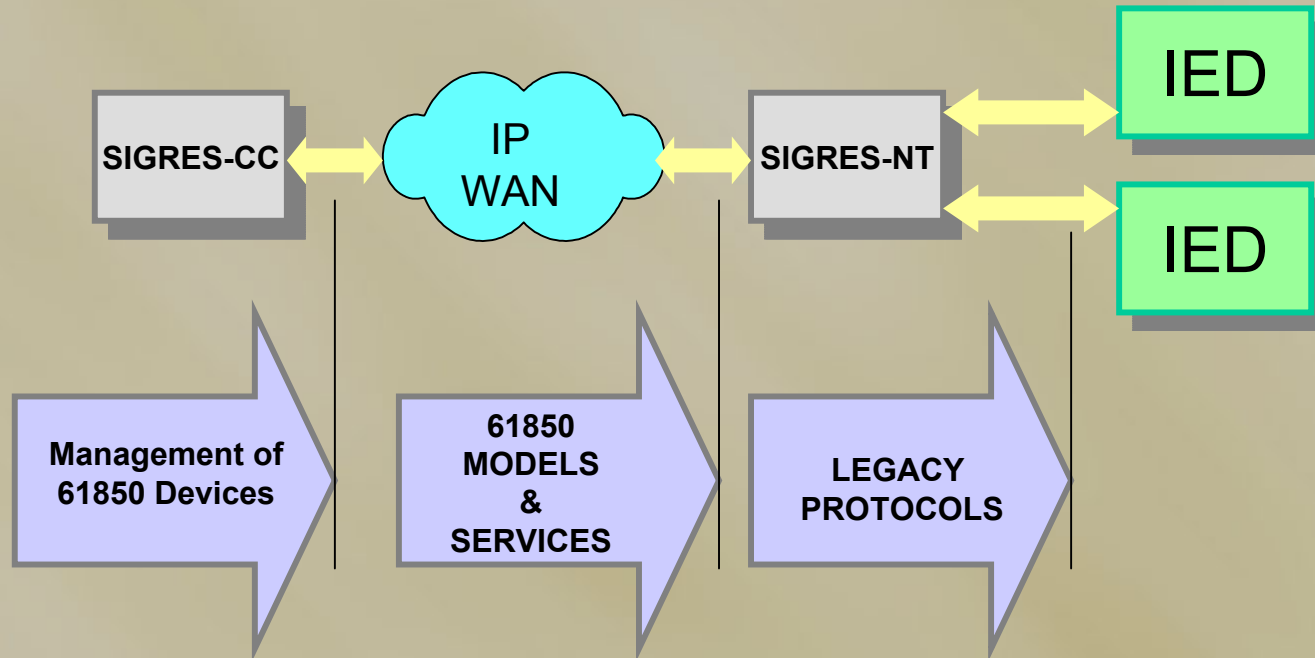


## 61850 Management and Maintenance Functions

- **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. 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 losing 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



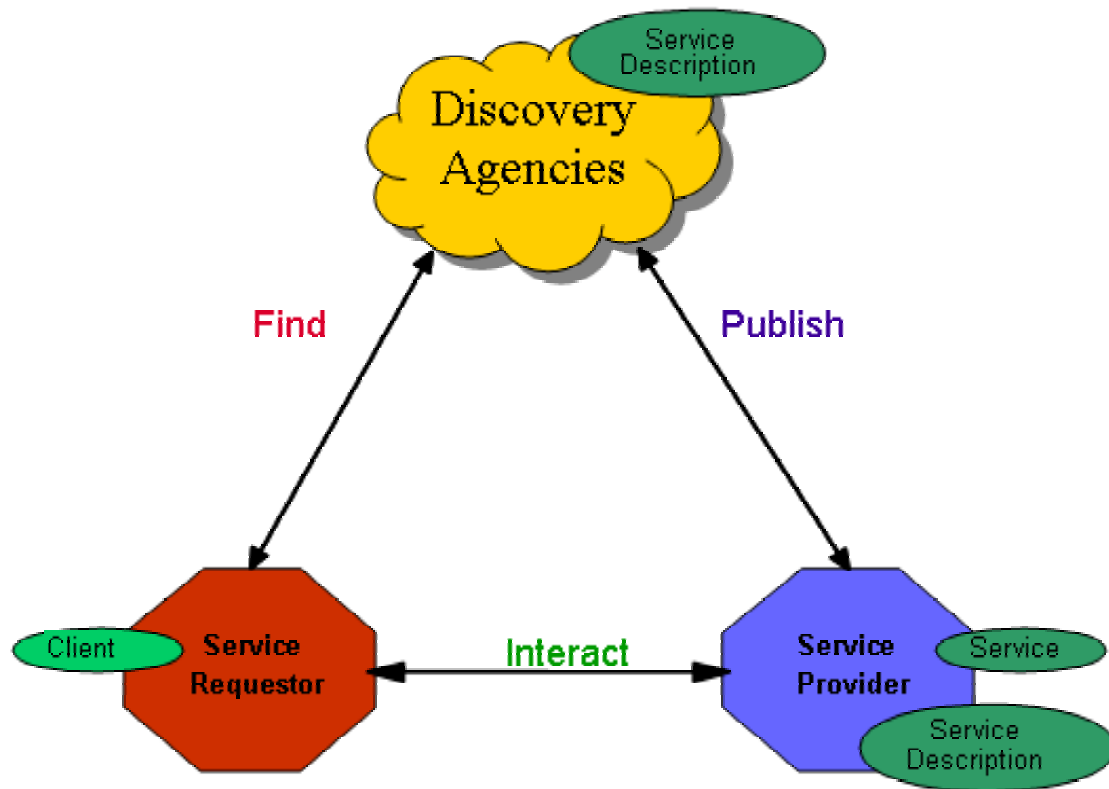
## Web Services

*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**

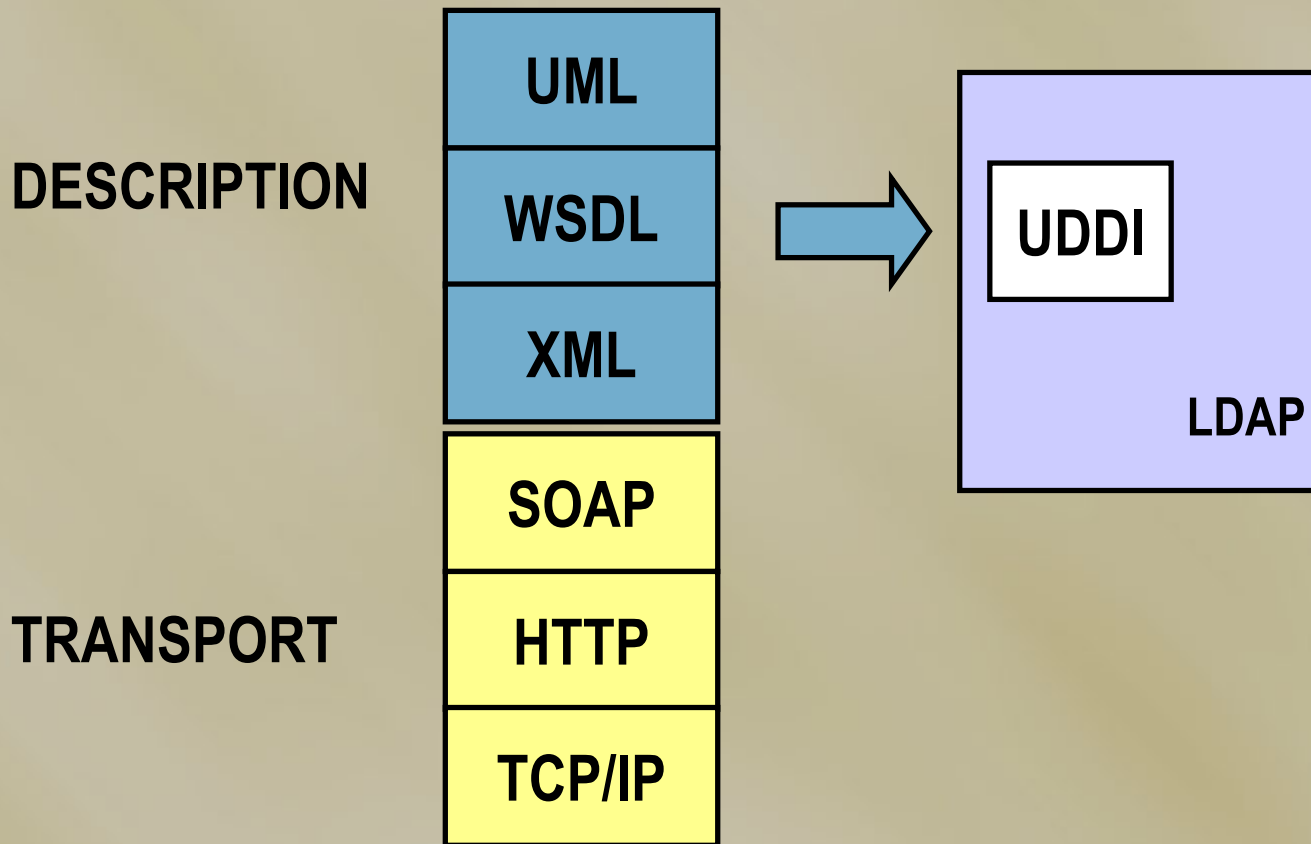


# Service Oriented Architecture



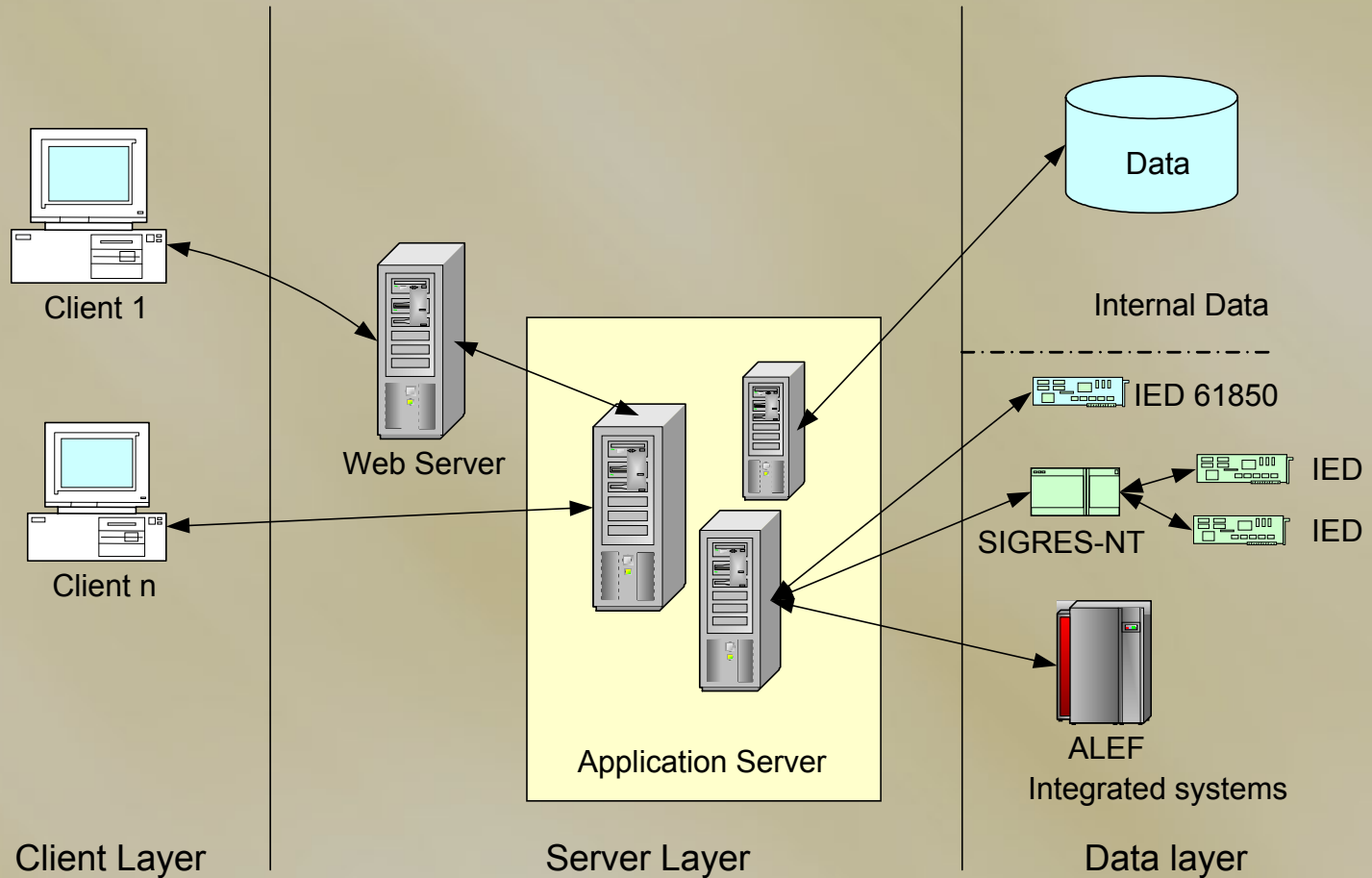


## Protocol Architecture



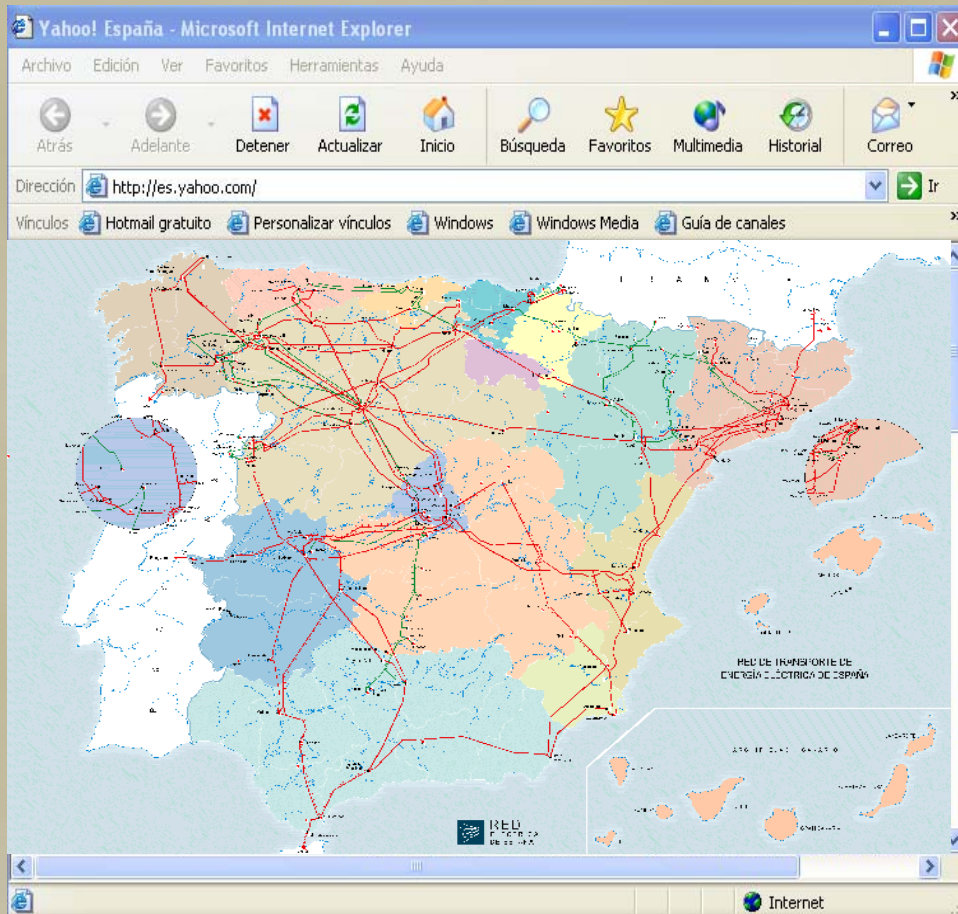


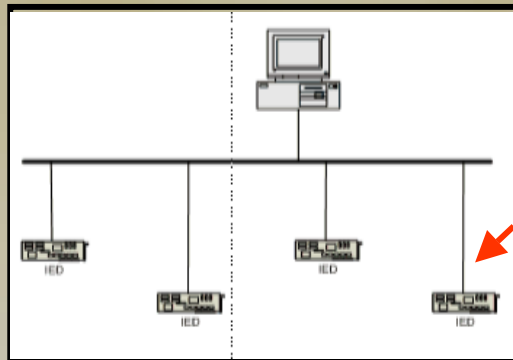
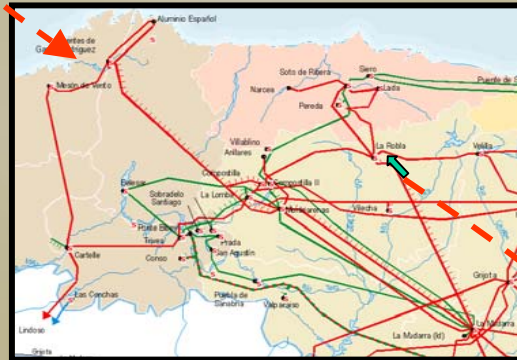
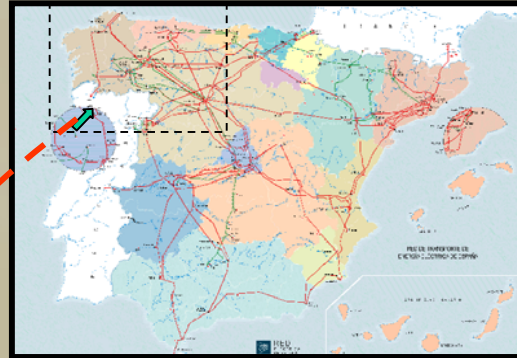
# Three-Layered Architecture





# User's Interface







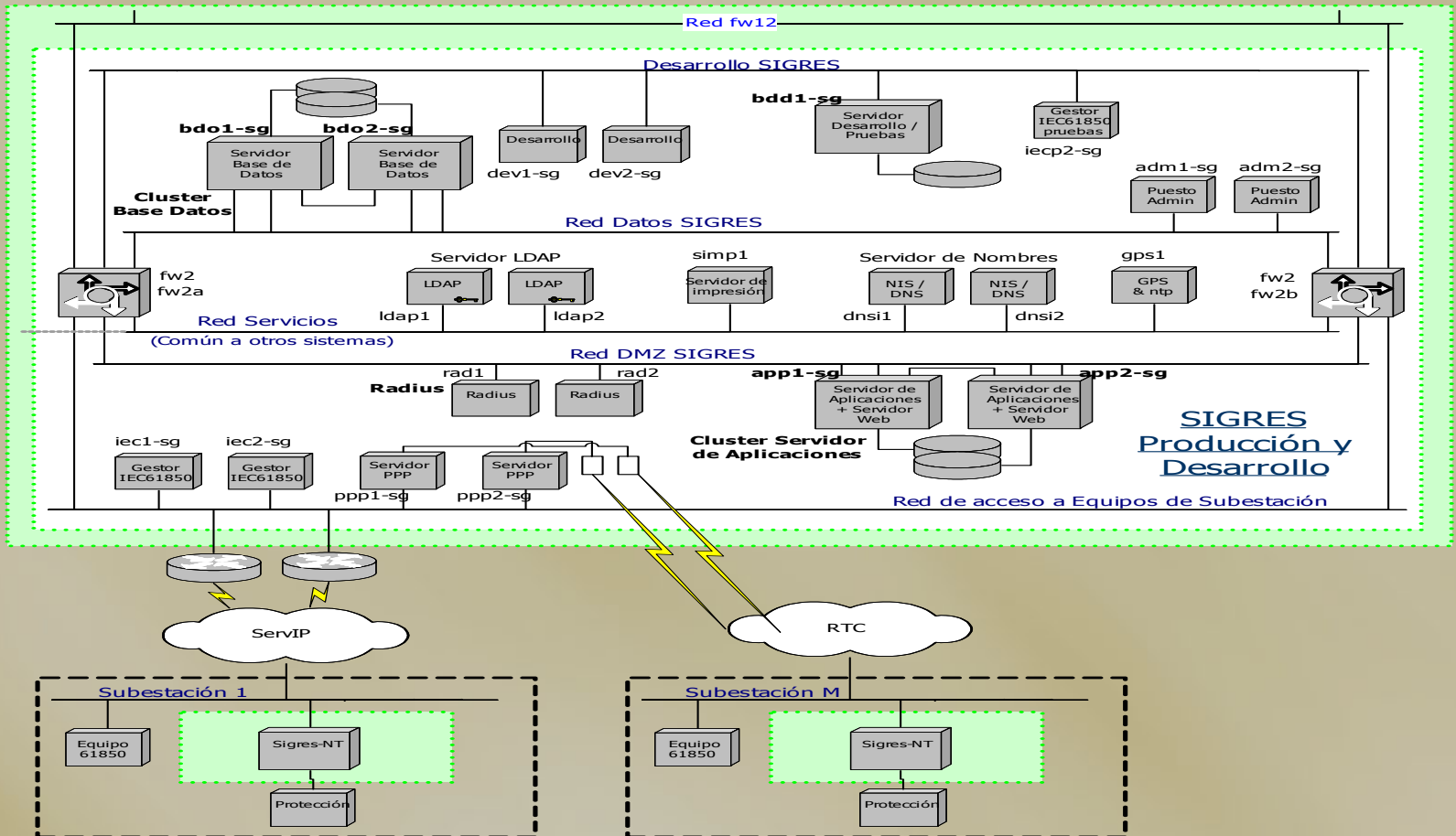
## Hardware Architecture (I)

*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**

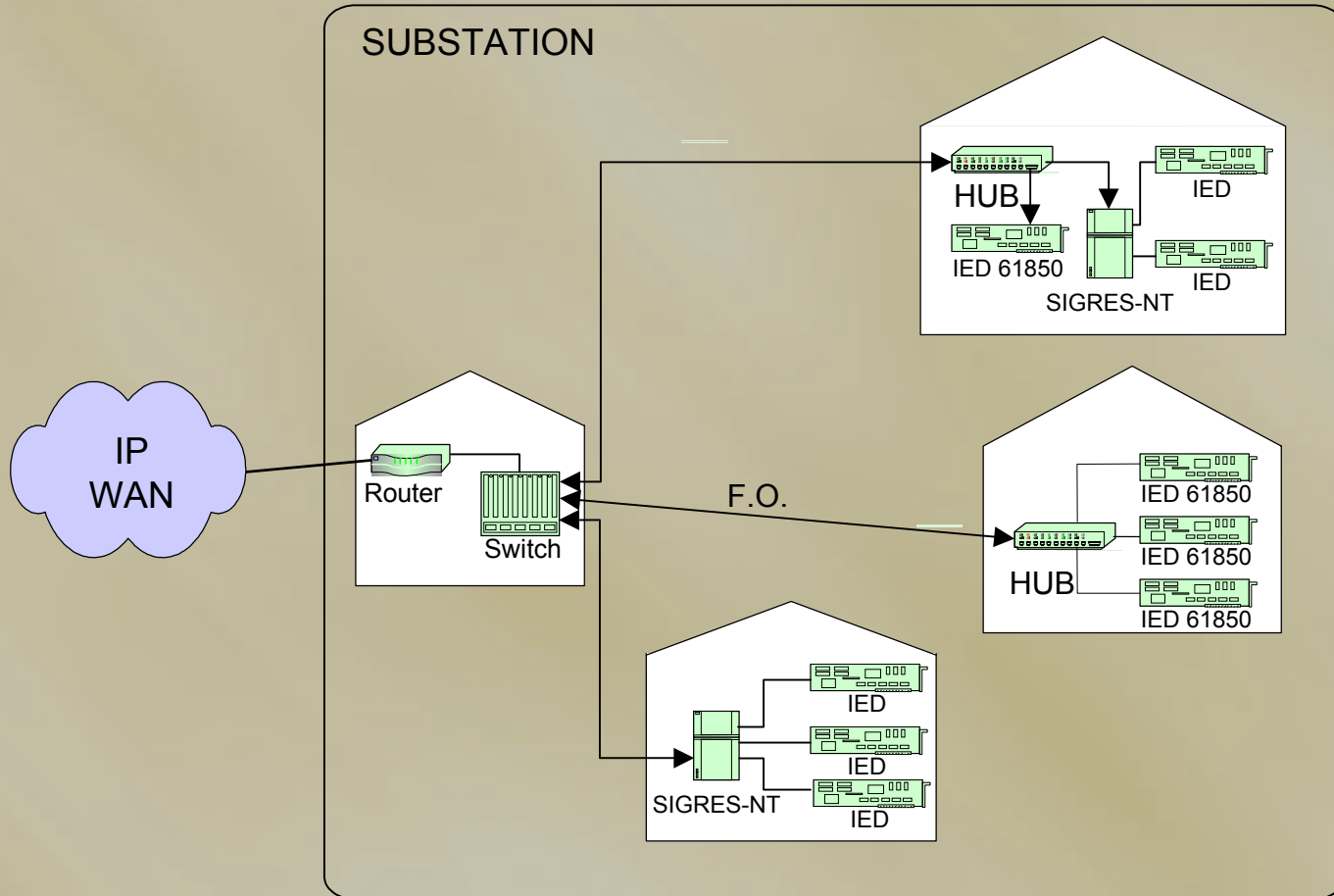


## Specific Characteristics

- 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





## PROJECT MILESTONES

- 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
- MS 4. System Deployment.                      2004/2006



## 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 ?