

Integrated Automation System for Smart Substations in Uruguay



Project Introduction

The National Administration of Power Plants and Power Transmissions (UTE) is a Uruguay state-owned enterprise which is engaged in the power generation, transmission, and distribution serving for one million two hundred thousand customers in the 176,215 km² of the country. This project owned by UTE is about 86 substations with the power voltage range from 150KV to 500KV. All the substations distributed in 19 provinces are belonging to 4 regional control centers, and the connection network is 4400km long. An integrated automation system for substations is created based on these 4 control centers by successfully implementing all the latest technologies including PRP, DHP/DRP, IEEE1588v2, and Goose Tunnel over IP network. The coexistence of multiple timing protocols and multiple service access solution realize an advanced solution while saving the system cost. All the advanced technologies and successful experience in this project will be introduced to international market by UTE regarding this project as a model project.

System Requirements

- IEEE1588 and IRIG-B multiple timing protocols coexistence and the precision accuracy of the system is less than 1 microsecond.
- System backup time server brings the timing into all integrated substation automation systems through E1 network.
- Network redundancy, zero packet for critical subsystems while network failover.
- Regional control centers should receive GOOSE packets from substations in its territory and realize the in-depth monitoring to substations.
- Multiple business such as serial and Ethernet data should be accessible in the unique communication network.
- IEC61850 compliant products
- Real time transmission of GOOSE/GSSE packets
- Resistant to harsh substation environments: strong EMI, extreme temperature variation, high surge.
- Flexible network structure and convenient network extension availability. Adding new nodes to the network should not have any impact to the communication of existing nodes.

Company: UTE (Uruguay National Administration of Power Plants and Power Transmissions)

Location: Uruguay

Kyland Solution

Kyland GPT series SICOM6028GPT, SICOM3028GPT and SICOM3424PT, together with SICOM3306PT, have been deployed to form the main substation communication network. DHP/DRP (IEC62439-6) redundancy protocols have been implemented in the network. Subsystem of relay protection equipment are connected through dual redundant networks and PRP (IEC62439-3) protocol ensures a zero packet loss while failover happens in the network. Substation integrated automation system realizes time synchronization according to IEEE1588v2 and the precision accuracy reaches $\pm 100\text{ns}$. The system meets Power Profile (C37.238) standards and realize a standard time synchronization solution for power system. Protocol conversion from IEEE1588 to IRIG-B is implemented through Kyland PTC1000 clock convertors which provide timing for all equipment which do not support IEEE1588.

Kyland SICOM6028GPT/SICOM3028GPT series modular industrial Ethernet switches perform as master clocks in the system by installing a GPS module. At the same time, a PTP over E1/T1 module can also be installed to provide a backup time source by getting the timing from E1 network. Since all the substations are connected to UTE's E1 network, timing from the atomic clock can be distributed to all substations through E1 network as the backup time source of the master clock.

TMS (Timing Management System) is deployed to realize the monitoring and management to the time synchronization status of multiple timing protocols (IEEE1588v2, IRIG-B, SNTP) within the system.

GOOSE Tunnel technology enables an upload tunnel for GOOSE message between substations and regional control centers and help regional control centers realize thorough monitoring and management to all substations.

A serial device server module with 4 selectable RS232 RS422 and RS485 serial ports is also supported by Kyland SICOM6028GPT/SICOM3028GPT series industrial Ethernet switches to access the serial data. Data mirroring and flow control enable an efficient monitoring and management to the serial data.

Optional IRIG-B output module for GPT series enables the conversion from PTP to IRIG-B clock and PPS (Pulse Per Second). This allows the IRIG-B format industrial devices to receive PTP high precision clock through GPT series conveniently.

Cyber security features, such as IEEE802.1X, Radius, SSH/SSL, SNMPv3, have been implemented in the whole system realizing the security of terminal access, data communication and network device management. Combining with the redundant firewalls between substations and regional control centers, the safety of network access and data communication of the whole system is fully secured.

Why Kyland?

Kyland provides a turnkey solution for the timing including master clock, timing distribution devices, and clock conversion devices which are fully compliant with IEEE1588v2, IRIG-B and Power Profile (C37.238). Telecom profile to Power Profile & Power Profile to Power Profile conversion are also supported. The precision accuracy of the whole system can reach $\pm 100\text{ns}$.

High performance redundancy protocol DRP/DHP enables a failover recovery time less than 20ms, flexible network structure and no disturbance network expansion.

PRP technology realize the zero pack loss and zero recovery time while failover happens within the substation integrated automation system.

PTP over E1 interface enables the timing distribution from atomic clock to all substations through E1 network which provide a backup clock source other than the master clock served by GPS.

TMS (Timing Management System) realizes the monitoring and management to the time synchronization status within the system.

Supports GOOSE Tunnel technology and realizes the transmission of GOOSE packet over IP network.

Modular platform of GPT series which support RS232/422/485, E1, Ethernet ports, and embedded industrial PC, realizes the access to the multiple business data with unified platform reducing the number of equipment and fault points in the system, leading to the saving of system cost.

Cyber security features ensure a safety of network and data access.

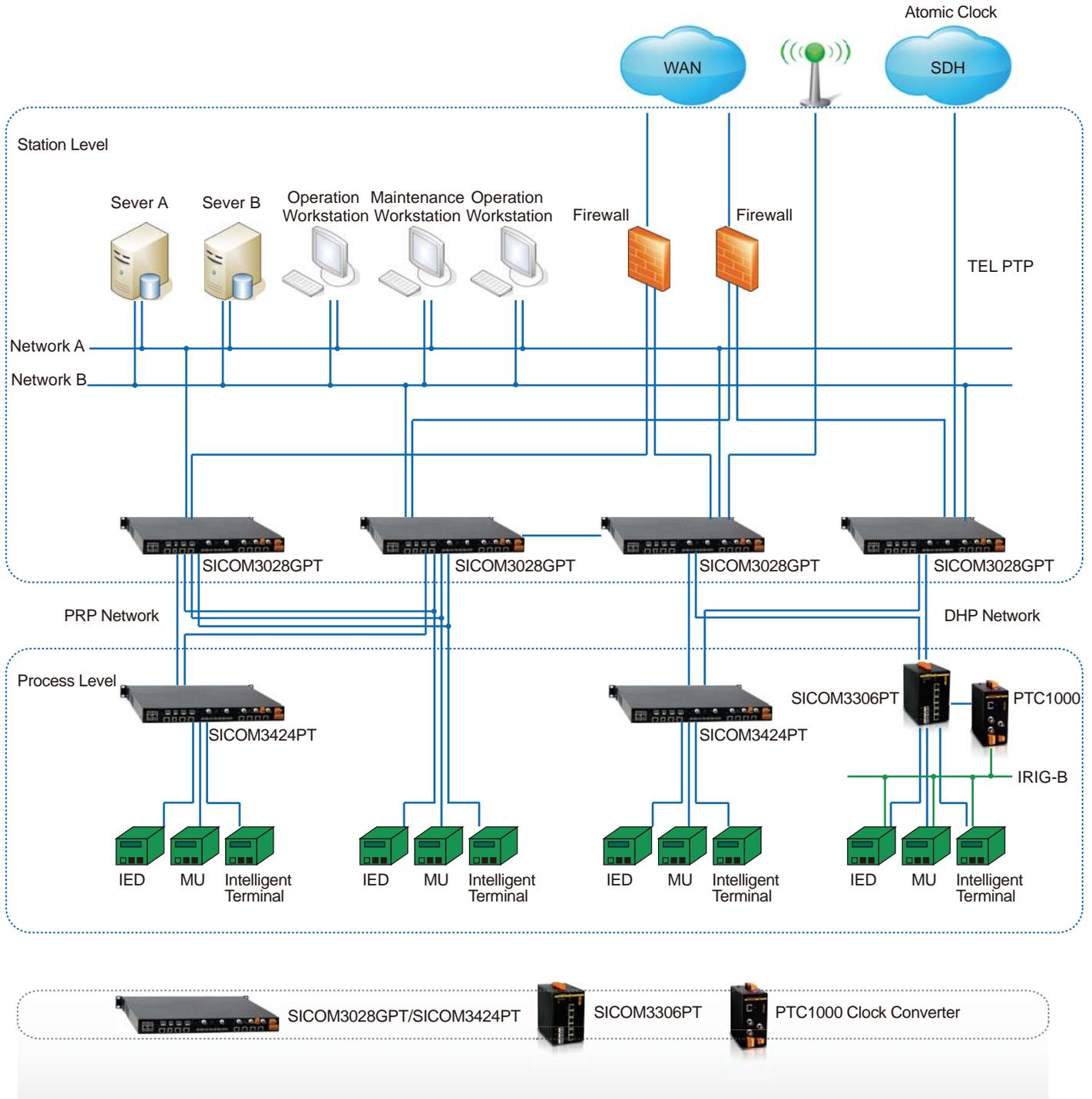
EMC level 4 fully compliant with IEC61850

Operating temperature of -40 to 85°C (-40 to 185°F)

► Please refer to www.kyland.com for more details

System Diagram

Integrated Automation System for Smart Substations in Uruguay



SICOM3028GPT/SICOM3424PT

- Supports IEEE1588v2, ITU-T. G. 8261/G. 8262 (SyncE)
- Complete support of Power Profile IEEE C37.238
- 1U modular design for easy expansion, and supports max 28 Gigabit ports or 4 Gigabit ports and 24 fast Ethernet ports
- Supports IEC62439-6, DT-Ring protocols and MSTP
- Extensible GPS and IRIG-B input/output modules
- Exceeds IEC61850-3 and IEEE1613



SICOM3306PT

- 3 100/1000Base-X SFP ports, 6 10/100Base-TX RJ45 ports
- Support IEEE1588v2, Support SyncE (ITU-T.G.8261/G.8262)
- Support IEC62439-6/DRP, DT-Ring, RSTP and MSTP ring protocols
- Support reset button for fast reboot or loading default settings
- Exceeds IEC61850-3 & IEEE1613



SICOM3306PT

PTC1000

PTC1000

- Support IEEE1588v2, the synchronization accuracy reaches $\pm 100\text{ns}$
- Support ITU-T.G.8261/G.8262 SyncE, the synchronization accuracy can reach $\pm 50\text{ns}$ with SyncE enabled
- Support 1 100Base-FX SC/ST/FC or 1 10/100Base-TX RJ45 IEEE1588 input
- Support max 4 10/100Base-TX RJ45 Ethernet ports
- Support PPS output, IRIG-B TTL outputs, and IRIG-B AM modulation
- Support both vertical and horizontal Din-Rail installation
- Exceeds IEC61850-3 & IEEE1613

GPT Modules

GPS module

1. 14 channels GPS C/A coding receiver
2. High precision stable crystal oscillator with excellent time keeping performance
3. One GPS signal input with BNC connector
4. One PPS +5V TTL level output with BNC connector

IRIG-B module

1. PTP to IRIG-B high precision clock converting
2. 2 IRIG-B (DC), 2 IRIB-B(AC), and 1 PPS outputs
3. Supports IRIB-B000, B002, B003, B123 output
4. Precision: Pulse 100ns, Analog, 1ms
5. Complete support of IEEE C37.238 Power Profile and IEEE C37.118 Synchrofasores

PRP/HSR module

1. Plug-in Redbox module for reliable industrial networking in GPT series
2. Full FPGA hardware solution with low switching latency
3. Compliant implementation of HSR (IEC62439-3-5) and PRP (IEC62439-3-4)

Serial device server module

1. 4 RS232/422/485 serial ports, one 100M interface (backplane)
2. Reset button for easy module reset without need to reboot the device
3. $\pm 15\text{kV}$ ESD protection circuit for each serial port
4. Compliant with EMC industrial level 4

MFA module

1. Plug-in module for GPT series
2. Industrial grade computing platform
3. Applications of security, control and monitor designed for power utilities

PTP over E1/T1 module

1. Plug-in interface module for time sync over SDH network
2. ITU-T compliant E1/T1 interface with balanced or unbalance connection
3. Less than $1\mu\text{s}$ synchronization accuracy

► Please refer to www.kyland.com for more details