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Lead System Architect

# **AZOGUES II – ECUADOR SUBSTATION PROJECT**

## ***1<sup>ST</sup> ECUADOR IEC 61850 PROJECT***

# Azogues II Substation

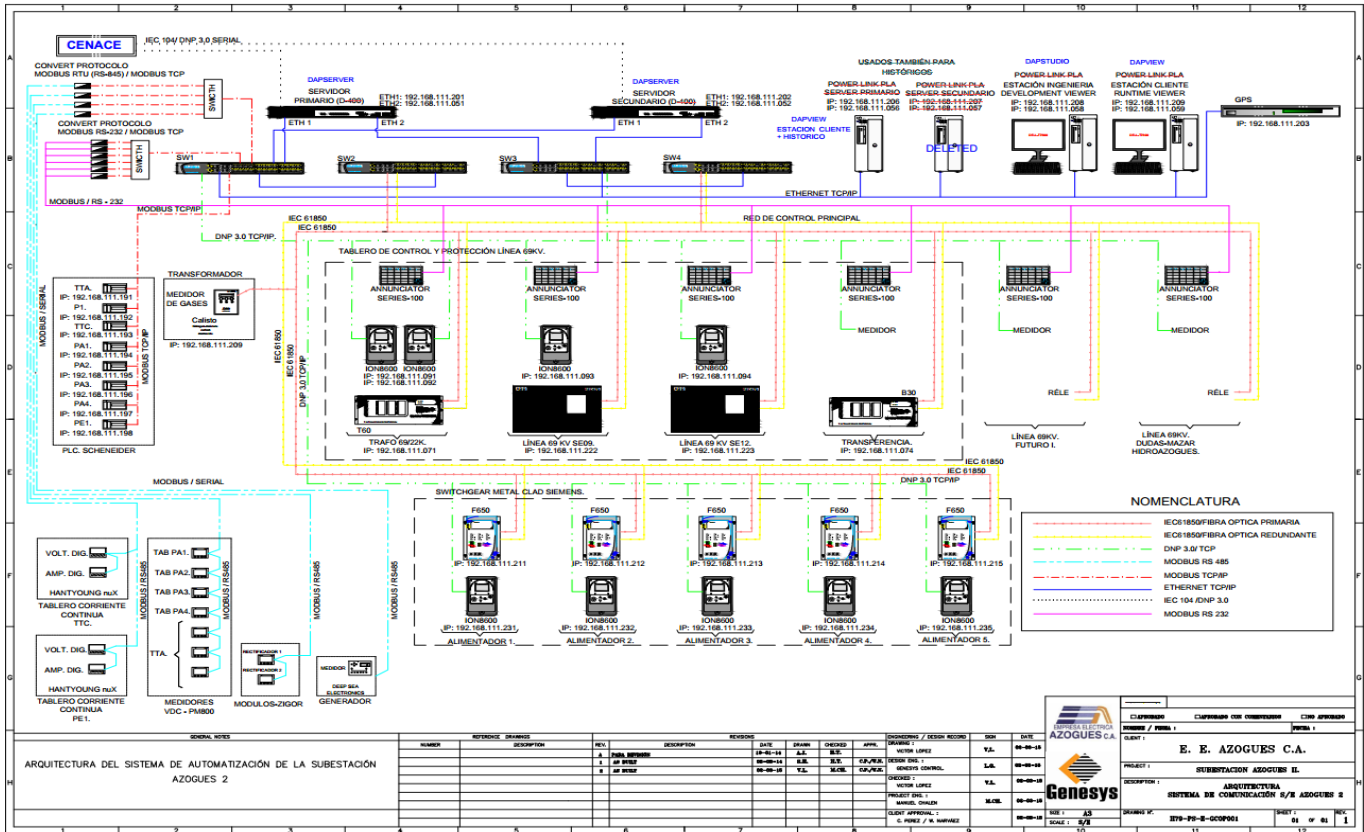
- Sub-transmission system
- 69/22 KV Substation
- 1 x 16/20 MVA power transformer
- 6 x 69 KV bays
- Transports power generated by the CELEC EP Alazán Hydro Plant
- Existing Substation Automation System
- Large variety of IEDs and protocols

# Project Challenges

- Multi-vendor & Multi-Protocol approach:
  - Devices: GE, ION, ABB, Hanyoung, Calisto Meters, Deep Sea Meters and Rochester Alarm Annunciators
  - Protocols: IEC 61850 MMS, DNP3 and Modbus
- Existing SAS Solution did not meet customer expectations
  - Interoperability issues with IEC 61850 MMS
  - Lack of a historian database and CSV export
  - Inconsistent behavior of redundancy solution
- First IEC 61850 Substation for The Electrica Azogues Company

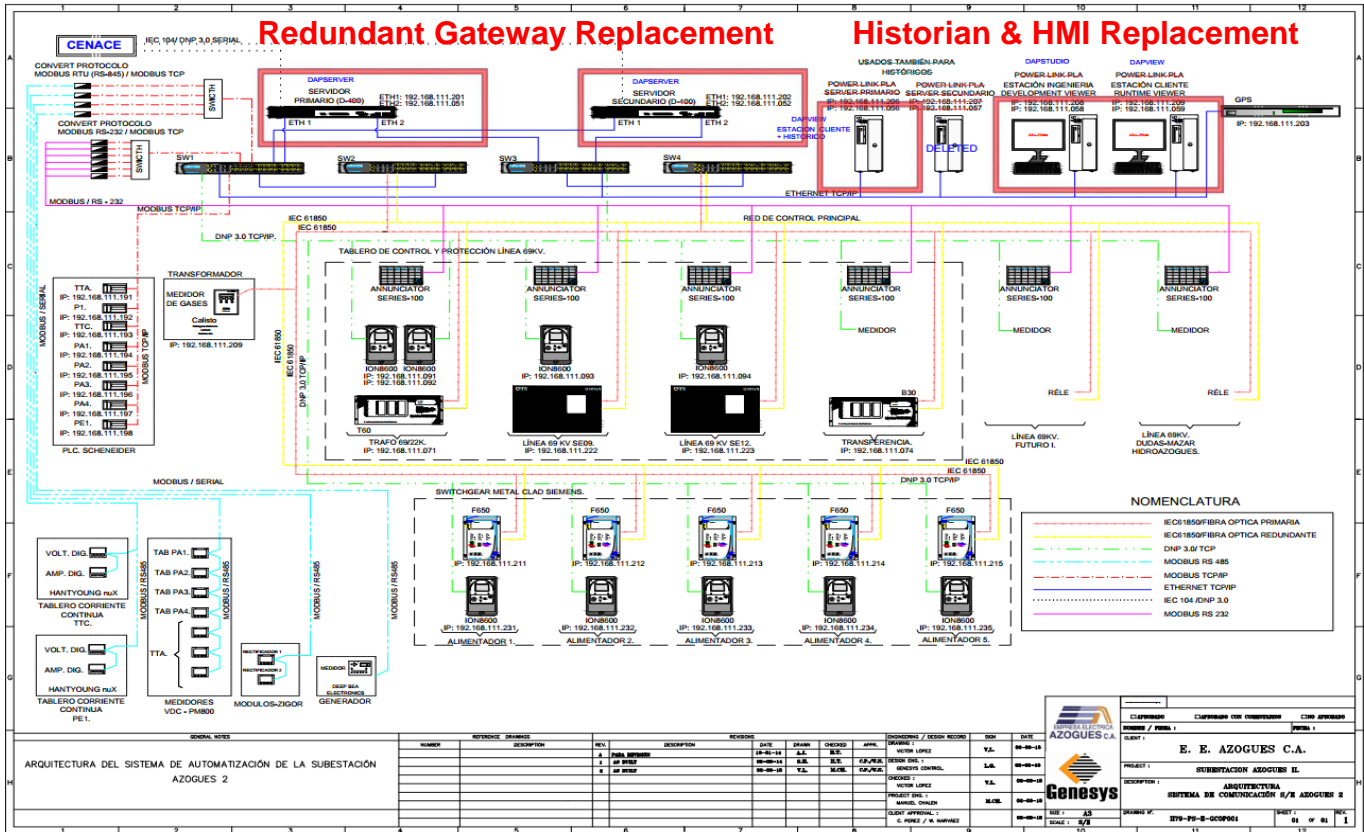
# AZOGUES 2 SYSTEM ARCHITECTURE

## - ORIGINAL -



# AZOGUES 2 SYSTEM ARCHITECTURE

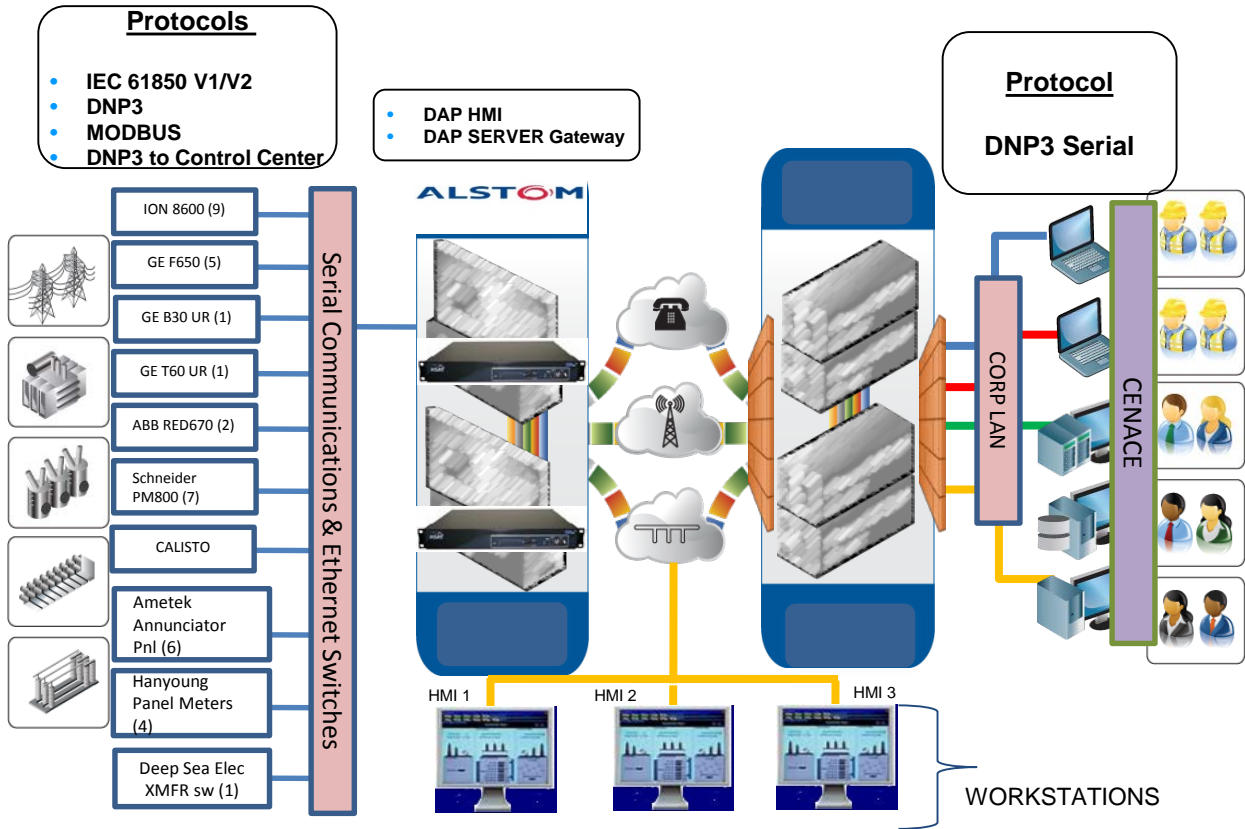
## - PROPOSED -



# AZOGUES DEVICE LIST

Device	Protocol
Schneider ION 8600 (9)	DNP3
GE F650 Bay Controller (5)	IEC 61850
GE T60 UR (1)	IEC 61850
GE B30 UR (1)	IEC 61850
ABB RED 670 (2)	IEC 61850
Schneider Power Meter PM800 (7)	Modbus TCP
Schneider PLC (8)	Modbus TCP
Ametek Annunciator panel (6)	Modbus TCP
Hanyoung panel mounted meter (4)	Modbus TCP
Deep Sea Electronics Generator Ctrl (1)	Modbus TCP
Zigor surge protectors (2)	Modbus TCP

# AZOGUES Substation Architecture - Before July 2015



# AZOGUES Substation Architecture – After June 2016

- Redundancy + Relational DB + Historical Trending -

## Protocols

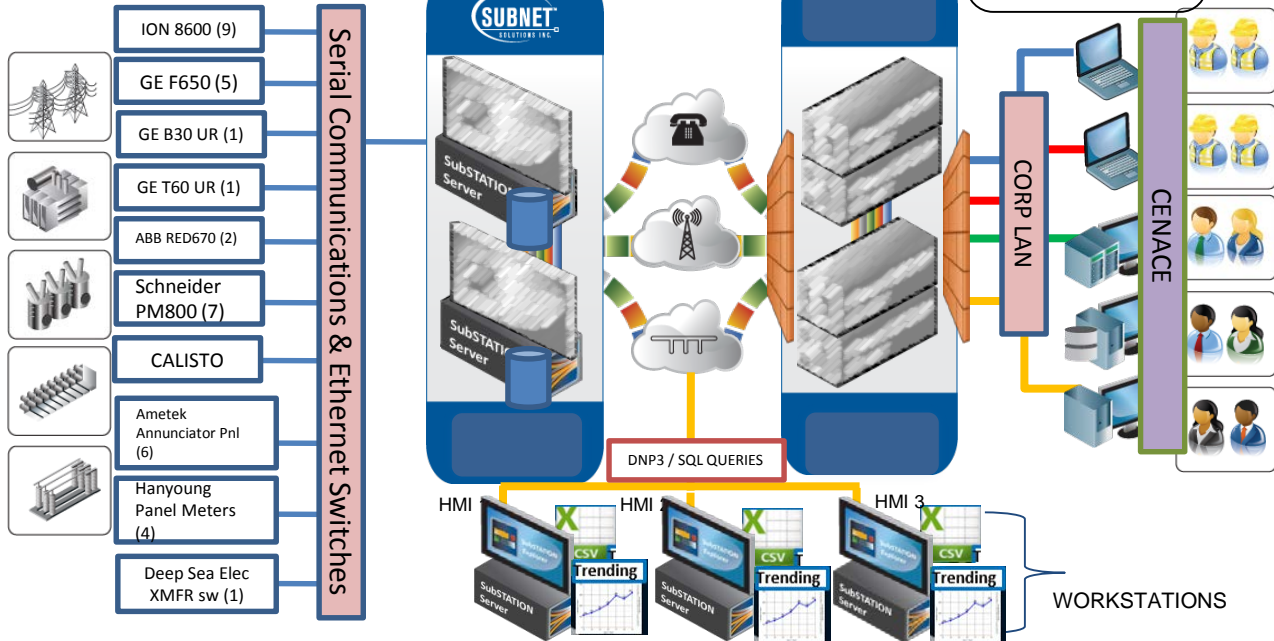
- IEC 61850 V1/V2
- DNP3
- MODBUS
- OLE DB Data Base Replication
- DNP3 Serial to Control Center

## DELL SERVERS

- Dell Power Edge Server R320
- Windows Server 2008 R2
- SSNET V2.16
- MS SQL Server 2014 Std
- SSNET Redundancy
- Mirroring SQL Data Base

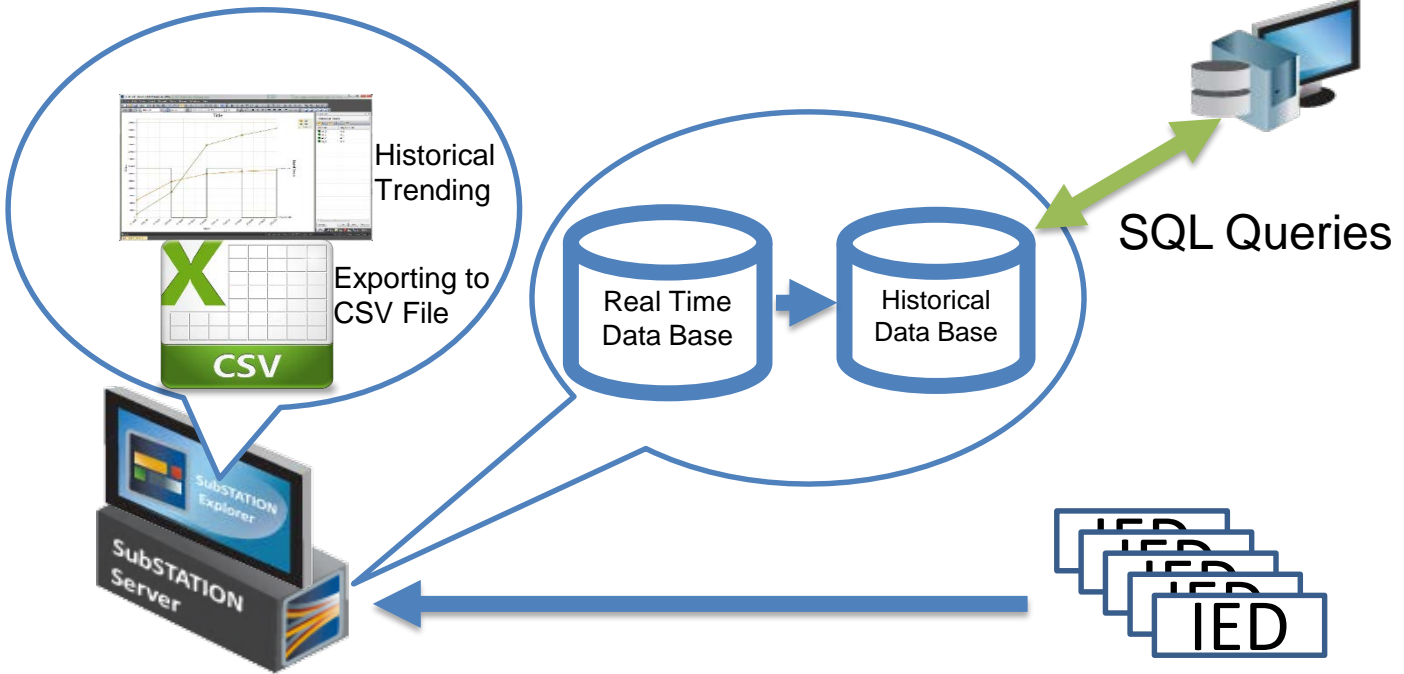
## Protocol

DNP3 Serial





# Real Time and Historical Data Base



# HMI DISPLAYS

AZOGUES-HMI Jan 2016.sub - SubSTATION Explorer 2015

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**SISTEMA DE CONTROL, PROTECCION Y  
CELDAS DE MEDIA TENSION PARA LA SUBSTACION AZOGUES 2**

SUBSTACION AZOGUES 2

**BIENVENIDO!**

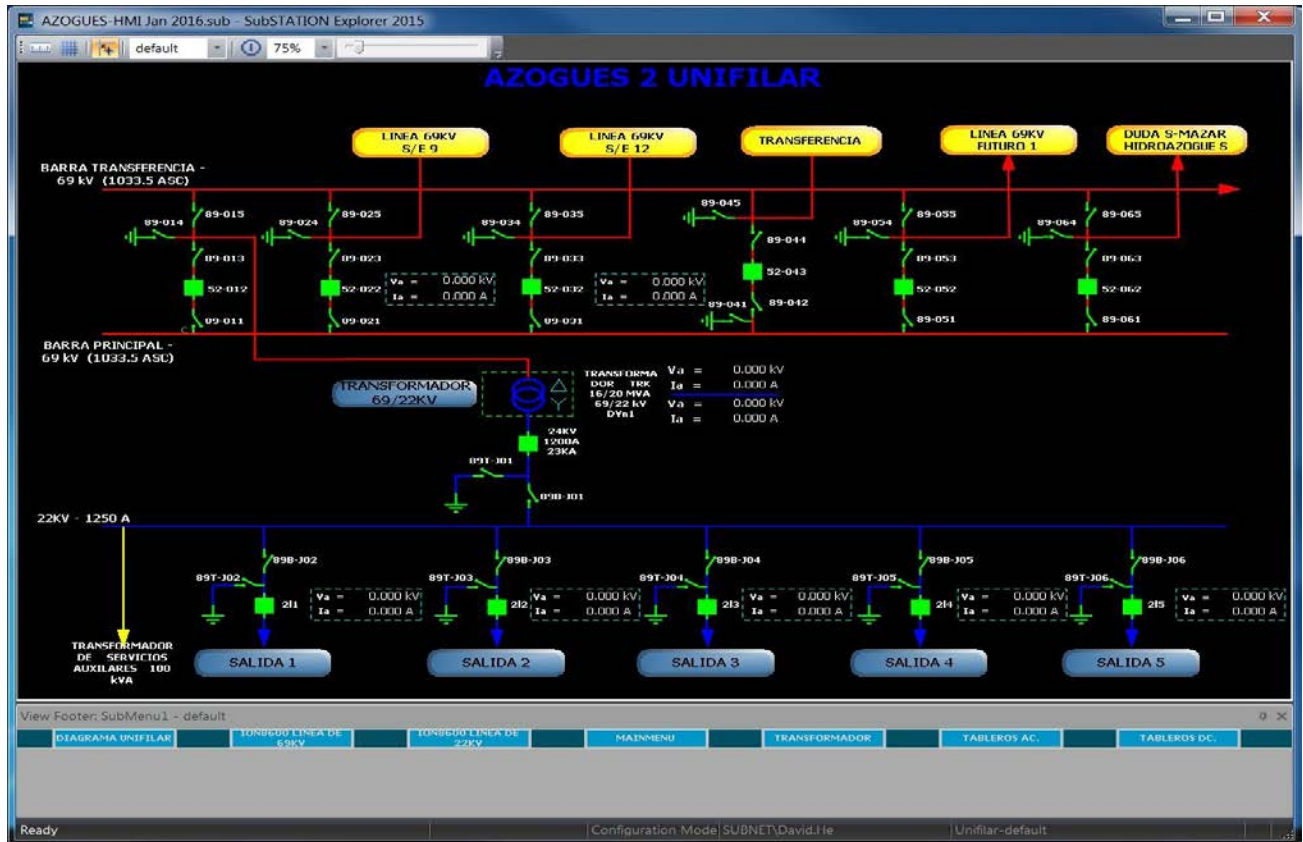
Genesisys  
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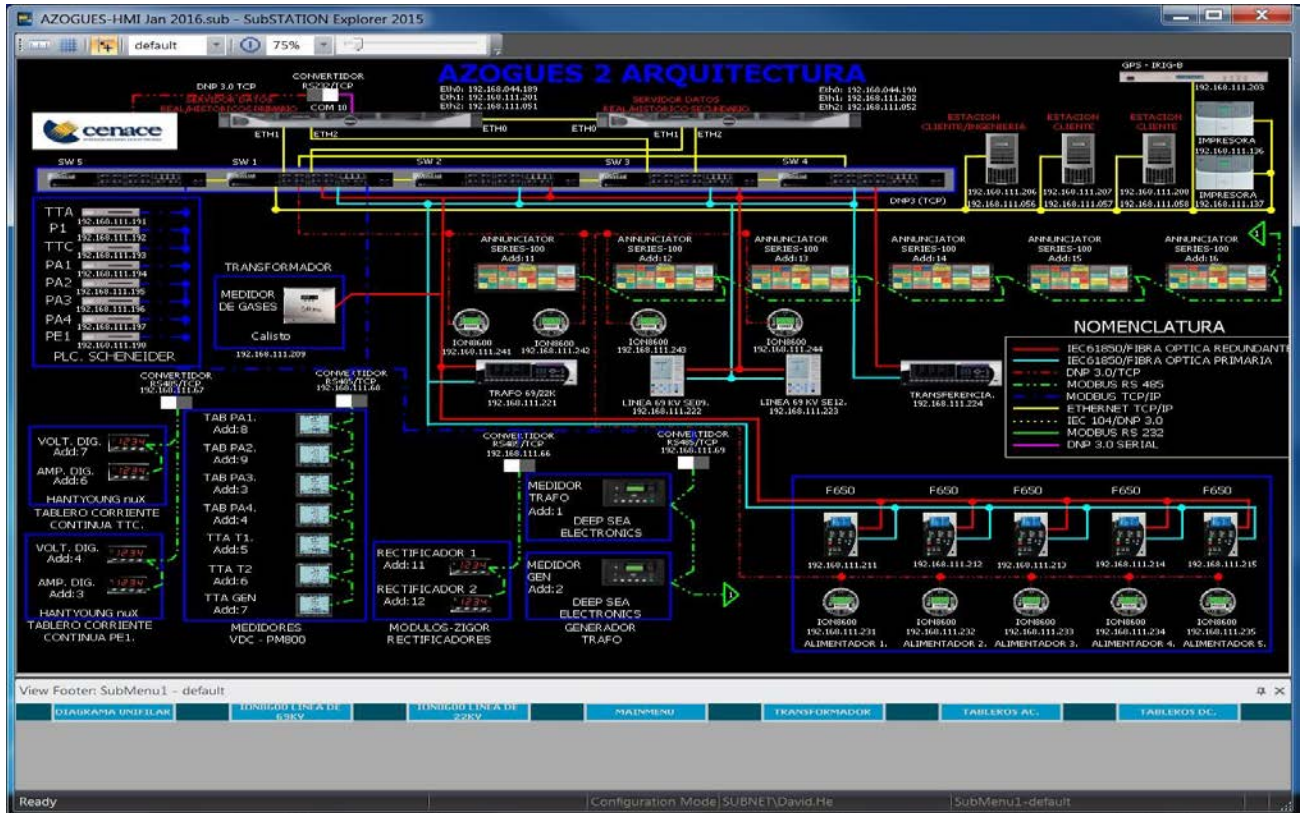
DIAGRAMA UNIFILAR | TORNEDO LINEA DE 6.9KV | TORNEDO LINEA DE 2.2KV | MATNMENU | TRANSFORMADOR | TABLEROS AC. | TABLEROS DC.

Ready | Configuration Model SUBNET\David.He | Acceso-default

# HMI DISPLAYS



# HMI DISPLAYS



# HMI DISPLAYS

AZOGUES-HMI Jan 2016.sub - SubSTATION Explorer 2015

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## TRANSFERENCIA GE-B30

Estado Rele: **Listo**

Modo Prueba: **Activo**

### BAHIA TRANSFERENCIA

TRANSFERENCIA

### LINEA DE 69 KV

#### TRANSFORMADOR 69/22KV

Ia: 0.00 A	Va: 0.00 V
Ia Angle: 0.00 °	Va Angle: 0.00 °
Ib: 0.00 A	Vb: 0.00 V
Ib Angle: 0.00 °	Vb Angle: 0.00 °
Ic: 0.00 A	Vc: 0.00 V
Ic Angle: 0.00 °	Vc Angle: 0.00 °

#### SUBESTACION 09

Ia: 0.00 A	Ib: 0.00 A	Ic: 0.00 A	Freq: 0.00 Hz
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#### SUBESTACION 12

Ia: 0.00 A	Ib: 0.00 A	Ic: 0.00 A	Freq: 0.00 Hz
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#### FUTURO 1

Ia: 0.00 A	Ib: 0.00 A	Ic: 0.00 A	Freq: 0.00 Hz
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#### DUDAS-MAZAR HIDROAZOGUES

Ia: 0.00 A	Ib: 0.00 A	Ic: 0.00 A	Freq: 0.00 Hz
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#### TRANSFO 69/22KV

Ia: 0.00 A	Ib: 0.00 A	Ic: 0.00 A	Freq: 0.00 Hz
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### SENALES DE ALARMAS Y DISPAROS

#### TABLERO 52-043

ALARMA POR SOBRECORRIENTE	ALARMA CIERRE POR BAJA DE GAS SF6
Normal UnAcked	Normal UnAcked
ALARMA CIERRE RESORTE SIN CARGA	ALARMA SF6 BAJA PRESION DE AIRE
Normal UnAcked	Normal UnAcked
FALLA DE ALIMENTACION DE CONTROL	FALLA ALIMENTACION DE CALEFACCION
Normal UnAcked	Normal UnAcked
FALLA DE ALIMENTACION DE MOTOR	SEÑAL DE OPERACION DEL MOTOR
Normal UnAcked	Normal UnAcked

#### RELE B30

DISPARO DE BARRA	Normal UnAcked
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#### TRIP 87 B

Normal UnAcked
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<h3 style="color: blue;">TRANSFERENCIA</h3> <p>TRAF0 DESHABILITADO SE09 DESHABILITADO SE12 DESHABILITADO FUTURO DESHABILITADO MAZAR DESHABILITADO</p>	<h3 style="color: blue;">INTERBLOQUEOS</h3> <p>89-041 INTERBLOQUEO 89-042 INTERBLOQUEO 89-044 INTERBLOQUEO 89-045 INTERBLOQUEO</p>
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**MAS DE UN SECCIONADOR DE TRANSFERENCIA CERRADO**

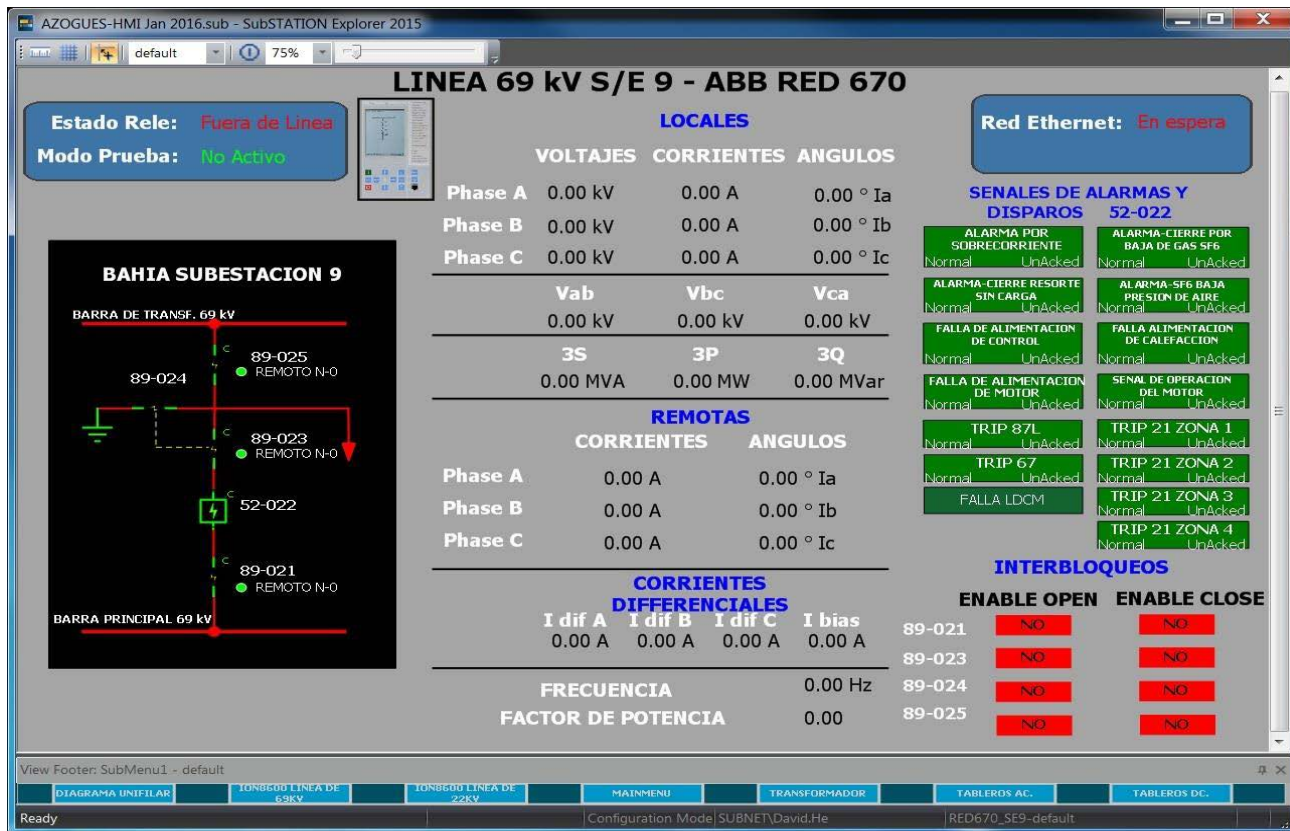
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DIAGRAMA UNIFILAR
TRANSFORMADOR 69/22KV
MAINMENU
TRANSFORMADOR
TABLEROS AC.
TABLEROS DC.

Ready Configuration Mode|SUBNET,David.He |B30\_Transferencias-default

# HMI DISPLAYS



# HMI DISPLAYS

AZOGUES-HMI Jan 2016.sub - SubSTATION Explorer 2015

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## TABLERO TRANSFORMADOR 69/22kv GE - T60

**Estado Rele:** Fuera de Línea  
**Modo Prueba:** Activo

**Red Ethernet Primaria:** En espera  
**Red Ethernet Secundaria:** Status

### 69KV

Ia: 0.00 A	Va: 0.00 kV
Ia Angle: 0.00 °	Va Angle: 0.00 °
Ib: 0.00 A	Vb: 0.00 kV
Ib Angle: 0.00 °	Vb Angle: 0.00 °
Ic: 0.00 A	Vc: 0.00 kV
Ic Angle: 0.00 °	Vc Angle: 0.00 °
Vab: 0.00 kV	Vbc: 0.00 kV
Vbc: 0.00 kV	Vca: 0.00 kV

### 22KV

Ia: 0.00 A	Va: 0.00 kV
Ia Angle: 0.00 °	Va Angle: 0.00 °
Ib: 0.00 A	Vb: 0.00 kV
Ib Angle: 0.00 °	Vb Angle: 0.00 °
Ic: 0.00 A	Vc: 0.00 kV
Ic Angle: 0.00 °	Vc Angle: 0.00 °
Vab: 0.00 kV	Vbc: 0.00 kV
Vbc: 0.00 kV	Vca: 0.00 kV

### SENALES DE ALARMAS Y DISPAROS

#### TABLERO 52-012

ALARMA PUR SOBRECORRIENTE Normal UnAcked	ALARMA LIBRE PUR BAJA DE GAS SF6 Normal UnAcked	TRIP 50 J201 Normal UnAcked
ALARMA CIERRE RESORTE SIN CARGA Normal UnAcked	ALARMA SF6 BAJA PRESION DE AIRE Normal UnAcked	TRIP 51 J201 Normal UnAcked
FALLA DE ALIMENTACION DE CONTROL Normal UnAcked	FALLA ALIMENTACION DE LA EFECTUACION Normal UnAcked	TRIP 87 J201 Normal UnAcked
FALLA DE ALIMENTACION DE MOTOR Normal UnAcked	SEÑAL DE OPERACION DEL MOTOR Normal UnAcked	TRIP 50 52-012 Normal UnAcked
SEÑAL 1 Normal UnAcked	SEÑAL 2 Normal UnAcked	TRIP 51 52-012 Normal UnAcked
SEÑAL 3 Normal UnAcked	SEÑAL 4 Normal UnAcked	TRIP 87 52-012 Normal UnAcked

### TRAFO 69 Kv/22kv

DISPARO RECIBE BUCHHILZ Normal UnAcked	DISPARO VALVULA SOBREPRESION Normal UnAcked	DISPARO VALVULA DE RETENCION Normal UnAcked	DISPARO INDICADOR TEMP. ACEITE Normal UnAcked
ALARMA RELA BUCHHILZ Normal UnAcked	ALARMA INDICADOR NIVEL ACEITE Normal UnAcked	ALARMA VAL VIE A DE RETENCION Normal UnAcked	ALARMA INDICADOR TEMP. ACEITE Normal UnAcked
FALLA INTERRUPTOR PRINCIPAL Normal UnAcked	FALLA CALIBRACION Y SERV. AUX. Normal UnAcked	FALLA CONTROL SIST. ENFRIAMIENTO Normal UnAcked	FALLA FUERZA SIST. ENFRIAMIENTO Normal UnAcked
FALLA ALIM. MONITOR TEMPERATURA Normal UnAcked	FALLA GUARDAMOTOR VENTILADOR 1 Normal UnAcked	FALLA GUARDAMOTOR VENTILADOR 2 Normal UnAcked	FALLA GUARDAMOTOR VENTILADOR 3 Normal UnAcked
FALLA GUARDAMOTOR VENTILADOR 4 Normal UnAcked	FALLA A VOLTAJE AC Normal UnAcked	FALLA VOLTAJE DC Normal UnAcked	FALLA GUARDAMOTOR VENTILADOR 3 ENCENDIDOS Normal UnAcked

### INTERBLOQUEOS

89-011	INTERBLOQUEADO
89-013	INTERBLOQUEADO
89-014	INTERBLOQUEADO
89-015	INTERBLOQUEADO

POTENCIA ACTIVA 3S:	0.00 kVA	
POTENCIA ACTIVA 3P:	0.00 kW	
POTENCIA REACTIVA 3Q:	0.00 kVAR	
F. POTENCIA	fp: 0.00	
FRECUENCIA	f: 0.00 Hz	

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DIAGRAMA UNIFILAR	TORNEO DE LINEA DE 69KV	TORNEO DE LINEA DE 22KV	MANTENIMI
TRANSFORMADOR	TABLERO'S AC.	TABLERO'S DC.	

Ready Configuration Mode | SUBNET\Ovidio.Hel 160\_Trafo - default

# HMI DISPLAYS

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## ALIMENTADOR 1

Estado Rele: **Fuera de Linea**

Red Ethernet: **En espera**

**ALIMENTADOR 1**

89B-J02

89T-J02

J02 ■ REMOTO

SALIDA 1

Voltajes		Corrientes	
Va :	0.000 kV	Ia :	0.000 A
Va Angle:	0.0 °	Ia Angle:	0.0 °
Vb :	0.000 kV	Ib :	0.000 A
Vb Angle:	0.0 °	Ia Angle:	0.0 °
Vc :	0.000 kV	Ic :	0.000 A
Vc Angle:	0.0 °	Ia Angle:	0.0 °

Vab :	0.000 kV
Vbc :	0.000 kV
Vca :	0.000 kV

REAL POTENCIA 3P:	0.000 W
REACTIVE POTENCIA 3Q:	0.000 VAR
APPARENT POTENCIA 3S:	0.000 VA
FACTOR DE POTENCIA fp:	0.000
FRECUENCIA f:	0.000 Hz

SENALES DE ALARMAS Y DISPAROS

TRIP 27 / 59	Normal	UnAcked
TRIP 50 / 51 FASE	Normal	UnAcked
TRIP 50 / 51 NEUTRO	Normal	UnAcked
ALARM-BAJA PRESION GAS 5HG	Normal	UnAcked

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DIAGRAMA UNIFILAR | TORRE DE LINEA DE 69KV | TORRE DE LINEA DE 22KV | MAIN MENU | TRANSFORMADOR | TABLEROS AC. | TABLEROS DC.

Ready | Configuration Mode | SUBNET\David.H... | SubMenu1 - default



# Achievements

- Various devices (GE, ABB, ION, Calisto, Hanyoung, etc.) were successfully integrated to the redundant gateway solution using three different protocols: IEC 61850 MMS, DNP3, and Modbus
- HMI Screens were recreated and successfully mapped
- Redundancy was achieved with the new redundant solution
- A SQL Based historian solution was installed which included historical data trending and CSV export
- Gateway switchover time was consistent using the new redundancy solution
- The Azogues II substation was completed working with an experienced IEC 61850 company

# Lessons Learnt

- IEC 61850 MMS Interoperability between IEDs and Gateway is possible with the right multi-vendor tool
- Wireshark was required to troubleshoot GOOSE interoperability between different vendor's devices
  - Some attributes are optional in the IEC 61850 standard but considered mandatory by one vendor
- IEDs were properly configured on the protection side, but, the MMS portion was incomplete
  - Customer had no previous experience with IEC 61850 MMS
- It was the first IEC 61850 substation implementation for The Azogues Company, hence they decided to work with an experienced integrator to complete the commissioning

# Q&A