Protection and Automation System of a HV/ MV Substation

Sami Andraos & Roy Moukarzel

MATELEC
PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION

Outline

Briefing of Matelec’s Substation Automation Evolution

Overview of Matelec’s Substation Protection and Automation Solution

Process Steps of S/S Protection & Automation System

Case study of key Project (Mobile Substation)

Why Matelec?

Application & real-time demonstration of a Mobile S/S
1987: Engineering & Contracting Division

The Engineering and Contracting division was established in 1987 in Ghorfine/Lebanon and is dedicated to the realization of complex HV, MV and LV projects.
PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION

**Briefing of Matelec’s Substation Automation Evolution**
*(From Conventional to complete automated system)*

**1987-1995**

The Substation automation Solution provided by Matelec was based on the following:

- Conventional Control System including push buttons and discrepancy switches
- Protection Panels using Electromechanical relays.
- Marshalling of signals to the dispatching through wiring.
- No Communication or SCADA Systems
Briefing of Matelec’s Substation Automation Evolution
(From Conventional to complete automated system)

1996-2000

According to Customer’s requirements Scada system is required in parallel with conventional system:

- Conventional Control System including push buttons and discrepancy switches
- Protection Panels Engineering & Manufacturing with Intelligent Devices.
- Scada system in partnership with other providers based on proprietary protocols and under the responsibility of the supplier.
Utilities became more focused on Scada system. Matelec invested in implementing a complete automated system:

- Bay Control Unit with/without a parallel Conventional Control System for full backup
- Protection Panels Engineering & Manufacturing with Intelligent Devices.
- Complete standard solution with in-house engineering and building of the SCADA systems.
## Outline

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing of Matelec’s Substation Automation Evolution</td>
<td></td>
</tr>
<tr>
<td>Overview of Matelec’s Substation Protection and Automation Solution</td>
<td></td>
</tr>
<tr>
<td>Process Steps of S/S Protection &amp; Automation System</td>
<td></td>
</tr>
<tr>
<td>Case study of key Project (Mobile Substation)</td>
<td></td>
</tr>
<tr>
<td>Why Matelec ?</td>
<td></td>
</tr>
<tr>
<td>Application &amp; real-time demonstration of a Mobile S/S</td>
<td></td>
</tr>
</tbody>
</table>
## Substation Automation Solution

### LEVEL 3 - Interface To Dispatch Center
- Telephone Modem, Radio Modem, Multiplexer, Power Line Carrier,......
- SCADA Protocol: IEC 60870-5-101/104, DNP 3.0, .......

### LEVEL 2 - Station Level
- Communication Network: Point to Point Fiber, Copper Ethernet......
- Hubs, Switches
- Communication Processor: PC, RTU, ...........
- HMI: PC with Graphic Screen or Touch Screen,...
- SCADA Protocol: IEC61850, IEC 60870-5-101/104, DNP 3.0, MODBUS.....

### LEVEL 1 - Bay Level
- IEDS: Protection Relays, Control Relays, Meters, ..........

### LEVEL 0 - Process Level
- Breakers, Disconnectors, Switches, Power Transformers, VTs, CTs, ......
Matelec’s flexible solution for a Substation Automation System

- Different Control
- Different Bays
- Voltage Levels
- Substation Type
- Busbar Topology
- Different Systems
- Different Protocols
- Relays Partners
- Scada Partners

MATELEC
Busbar Topology

- Single Busbar
- Single Bus with bus tie CB
- 1½ Breaker Stations
- Double Busbar
- Double Busbar with bus tie CB
Substation Type

Conventional SS

GIS SS

Mobile SS
Voltage Levels

Matelec Solution

From 10kV up to 400kV
PROTECTION AND AUTOMATION SYSTEM OF A HV/MV SUBSTATION

Different Bay Types

- Line Feeder
- Cable Feeder
- Transformer
- Busbar
- Coupler
- MV Switchgear
- Self
- Capacitor

Matelec Solution
Different Control Types

Local Substation Operator

Control Center

Gateway

Conventional Mimic

Bay Control Unit

Breaker

Disconnector
Our Main SCADA Partners

- MATELEC
- MICROSCADA PRO
- GE POWER
- SICAM PAS
- ZENON
- VIJEO CICTE
PROTECTION AND AUTOMATION SYSTEM OF A HV/MV SUBSTATION

Our Scada Equipments Provider

MATELEC

ADVANTECH

RUGGEDCOM

MEINBERG

VIEW SONIC, LG, HP,...
Different Scada Architectures (Simple System)
Different Scada Architectures (Redundant System)
Different Protocols Used

- MODBUS
- DNP
- LON
- PROFIBUS
- 60870-5-101
- 60870-5-101/4
- 60870-5-103
- 61850

 Functions:
- Central Functions
- Station Gateway
- HM I

Protocols:
- Protection 1
- Protection 2
- Protection & Control

Process interfaces:
- Process interface
### Advantages of the IEC61850 Protocol

<table>
<thead>
<tr>
<th>Interoperability</th>
<th>The ability for IED’s from one or several manufacturer to exchange information and to use that information for correct execution of specific functions.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When extensions are required, the protocol facilitate the integration of new relays within the existing system</td>
</tr>
<tr>
<td></td>
<td>Matelec have a big experience in integrating several IEDs from different manufacturers in any substation automation system</td>
</tr>
</tbody>
</table>

| Long term stability | The standard is for future proof, i.e. it is able to follow the progress in communication technology as well as evolving system requirements |

| Free configuration | Provides support of Engineering of the whole substation through standardized configuration language based on XML |
## Typical Reference List

### Conventional Control Solution:
- Lebanon: ARAMOUN 220/150/20kV GIS S/S
- Lebanon: Beirut Central District 220/66/20kV GIS S/S

### Combined (Conventional & Integrated) Control Solution:
- Syria: Kaboun 230/66/20kV GIS S/S
- Syria: Adra 230/66/20kV AIS S/S
- Syria: Banias 230/66/20kV GIS S/S

### Full Integrated Solution:
- Senegal: Kounoune 90/15kV AIS S/S
- Nigeria: Ganmo 330/132/33kV AIS S/S
- Algeria: Ahmer El Ain 220/60kV AIS S/S
- Algeria: Cheffia 400/220kV AIS S/S
- Algeria: Mekera 60/10kV GIS S/S
- Algeria: 60/30, 60/10 & 90-60/30kV Mobile S/S
# Outline

- Briefing of Matelec’s Substation Automation Evolution
- Overview of Matelec’s Substation Protection and Automation Solution
- Process Steps of S/S Protection & Automation System
- Case study of key Project (Mobile Substation)
- Why Matelec?
- Application & real-time demonstration of a Mobile S/S
Process Steps of S/S Protection & Automation System

Configuration & Parameterisation

Complete Test

Commissioning

Contract

Documents For Approval

Testing & Simulation

FT/FAT

ST/SAT

After Sales Support

MOM

Scada Architecture

MOM

Single Line Diagram
PROTECTION AND AUTOMATION SYSTEM OF A HV/MV SUBSTATION

Documents For Approval

- Single Line Diagram
- Scada Architecture
- Interlock
- Scada Specifications
- Scada Overview
- Scada I/O List

26
PROTECTION AND AUTOMATION SYSTEM OF A HV/MV SUBSTATION

Engineering

IED Configuration

System Testing

Scada Configuration

Configuration

Setting

Simulate

Database

HMI
**PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION**

**Engineering**

**IED CONFIGURATION**
- Complete customized configuration of the IED functionality based on the clients specific requirements and using the IED related software tool (PCM from ABB, DIGSI from Siemens...)
- Parameterization and basic configuration of the protection and control relays settings based on the clients standard requirements.

**SCADA CONFIGURATION**
- Database Engineering based on the clients approved documents (Specially the I/O List) and using the SCADA tools (SCL files for IEC61850, Modbus Table for Modbus relays...)
- Drawing and configuration of the Substation related HMI screens based on the approved documents, and according to the substation functionality.

**SYSTEM TESTING**
Simulation and validation of the system’s configuration through complete testing based on the “Testing Protocols” procedures, and using many testing tools ex:
- SIM600: Switching equipment simulator for switchgear operation
- OMICROM/ISA: For the injection of analogue signals and testing of protections and analogue readings.
- ETHEREAL: For monitoring of the network status and messages with LAN based protocols (Specially for IEC61850)
- COMPROTWARE Test tool: For the simulation and supervision of different substation protocols, mainly IEC101 simulation (Dispatching center)
Minutes of Meeting

PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION

COMMISSIONING & TESTING (FAT/ SAT)

IED COMMISSIONING

PROTECTION

BCU

Minutes of Meeting

SCADA COMMISSIONING

HMI

EVENT LIST
**IED COMMISSIONING**
- Complete test for BCU (Control, Interlocking, Measurement....)
- Complete test of Protections (Distance Protection, Transformer Differential Protection, Overcurrent...)

**SCADA COMMISSIONING**
- Complete testing of the SCADA System including Commands, Analogue reading, ..... 
- Events and Alarms generation, printouts on the Dot Matrix printer based on the I/O list document

- All the tests are implemented based on “Testing Protocols” procedures.
- The test is concluded by signing a Minutes Of Meeting with the client.
**Outline**

1. Briefing of Matelec’s Substation Automation Evolution
2. Overview of Matelec’s Substation Protection and Automation Solution
4. Case study of key Project (Mobile Substation)
5. Why Matelec?
6. Application & real-time demonstration of a Mobile S/S
Single Line Diagram
Scada Single Line Screen

Cabine Mobile 60/30 kV

MPOWERING Energy Conference
HV/MV Mobile Substation

SUPERVISION
SERVICE AUX CC
SERVICE AUX CA
MESURES
TENDANCES

2:44 AM 7/19/2011  Cabine Mobile 60/30kV
Scada Bays’ Screens

The 60/30kV Mobile substation consists of the following bays:

- 1x Line Bay 60kV
- 1x Transformer Bay 60/30kV
- 1x Incoming Switchgear 30kV
- 4x Outgoing Switchgears 30kV
Scada Supervision Screen
PROTECTION AND AUTOMATION SYSTEM OF A HV/MV SUBSTATION

PROTECTION & CONTROL PANEL - LINE 60kV

The Protection & Control Panel for 60kV Line Bay consists of:

- Bay Control Unit: GE-F650 (M,CTRL)
- Distance Protection: GE-D60 (21,51,27,79,67N)
- Back UP Protection: GE-MIFIIP (51,51N)
- Converter Modbus: RUGGED-RMC30
- Switch: RUGGED-RSG2100
PROTECTION PANEL - TR 60/30kV

The Protection Panel for Transformer 60/30kV Bay consists of:

- **TR Diff. Protection**: GE-T60 (87T)
- **Volt. Regulator**: MR-TAPCON260 (90)
- **Frequency Relay**: GE-F35 (81)
- **HV Phase O/C**: GE-MIFIIP (51,49)
- **MV Phase O/C**: GE-MIFIIP (51,49)
- **MV Neutral O/C**: GE-MIFIIN (51N)
- **Sensitive Earth Fault**: GE-MIFIIN (51N)
- **Tank Protection**: GE-MIFIIN (51N)
- **Converter Modbus**: RUGGED-RMC30
- **Switch**: RUGGED-RSG2100
PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION

30kV SWITCHGEARS

The 30kV Switchgears consists of:

- Bay Unit (Control & Protection): GE-F650 (BCU,M,51,51N,27,79,...)
The Common Bay consists of:

- **Bay Unit:** GE-F650
- **Central Unit:** GE-CCU1000
- **GPS:** Meinberg-M300
- **Modem:** Westermo-TD36
- **Switch:** RUGGED-RSG2100
The Scada Panel consists of:

- **Industrial PC:** Advantech-UNO
- **Dot Matrix Printer:** Epson-LQ300+
- **Industrial Screen:** Advantech-FPM
- **Modem:** Westermo-TD36
- **Output Module:** Advantech-ADAM
# Outline

- Briefing of Matelec’s Substation Automation Evolution
- Overview of Matelec’s Substation Protection and Automation Solution
- Process Steps of S/S Protection & Automation System
- Case study of key Project (Mobile Substation)
- Why Matelec?
- Application & real-time demonstration of a Mobile S/S
Why MATELEC

- A Complete System Solution Supplier
- Flexible & Customized Solution from Conventional to the latest, full integrated system based on IEC61850
- Experience Over A Broad Range of Applications and not limited to specific suppliers
- Complete system engineering in Matelec & Full real time factory test allowing to reduce duration of site intervention
- Site Testing & Commissioning is Plug & Play and limited to protection testing and parameters tuning according to the customer’s requirement
- Customer Training
- After Sales Support

Dedicated to bringing the best Automation solutions to our customers
Thank you for your attention!
## Outline

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing of Matelec’s Substation Automation Evolution</td>
</tr>
<tr>
<td>Overview of Matelec’s Substation Protection and Automation Solution</td>
</tr>
<tr>
<td>Process Steps of S/S Protection &amp; Automation System</td>
</tr>
<tr>
<td>Case study of key Project (Mobile Substation)</td>
</tr>
<tr>
<td>Why Matelec?</td>
</tr>
<tr>
<td>Application &amp; real-time demonstration of a Mobile S/S</td>
</tr>
</tbody>
</table>

PROTECTION AND AUTOMATION SYSTEM OF A HV/ MV SUBSTATION
Time for Application and real-time demonstration of a Mobile Substation!