Operator Training Simulation (NEMA)

Improve Staff Skills with Power System Digital Twin Simulation Training

EcoStruxure Power Digital Application

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EcoStruxure™ Power

Schneider Electric™

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Overview

Context of Application

Modern electrical systems are increasingly complex to operate in particular with the advent of renewable power sources. For operation and maintenance personnel, it is significantly more challenging to master all operational and maintenance tasks, especially when performed in stressful situations. Insufficient knowledge to perform certain operations or procedures can result in delayed restoration following an unintended event, or lead to safety consequences.

Problem to Solve

The facility, operations, and maintenance managers need to:

- Avoid unplanned outages and reduce safety risks due to operator missteps.
- Overcome skill shortages in operations and maintenance teams.
- Strengthen operator confidence and efficiency to perform complex operations (such as startup and shutdown).
- Enable operators to practice safely without affecting the live system.

Purpose of the Application

Provide an efficient and cost-effective training tool for operations and maintenance staff to help reduce safety risks

Use a highly-realistic model-driven power system simulator (Digital Twin) to:

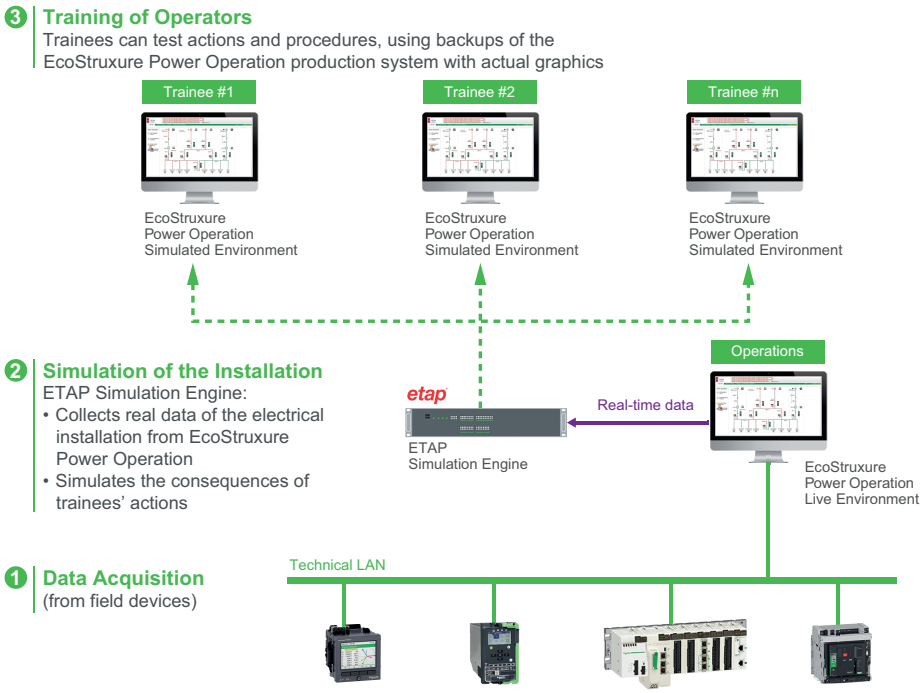
- Improve familiarity with day-to-day and/or complex operations in offline system (predefined scenarios).
- Track and review trainee actions and identify potential areas for staff skills improvement.
- Improve response time to critical events.

Operator Training Simulator

Application Outcomes

Real-Time Dynamic Simulation

Model-driven real-time simulator using a complete set of actual data of the entire electrical network to mimic a multitude of user-defined real-case scenarios and to train operators.



Schematic Diagram for Operator Training Simulation Application

Live Data Display

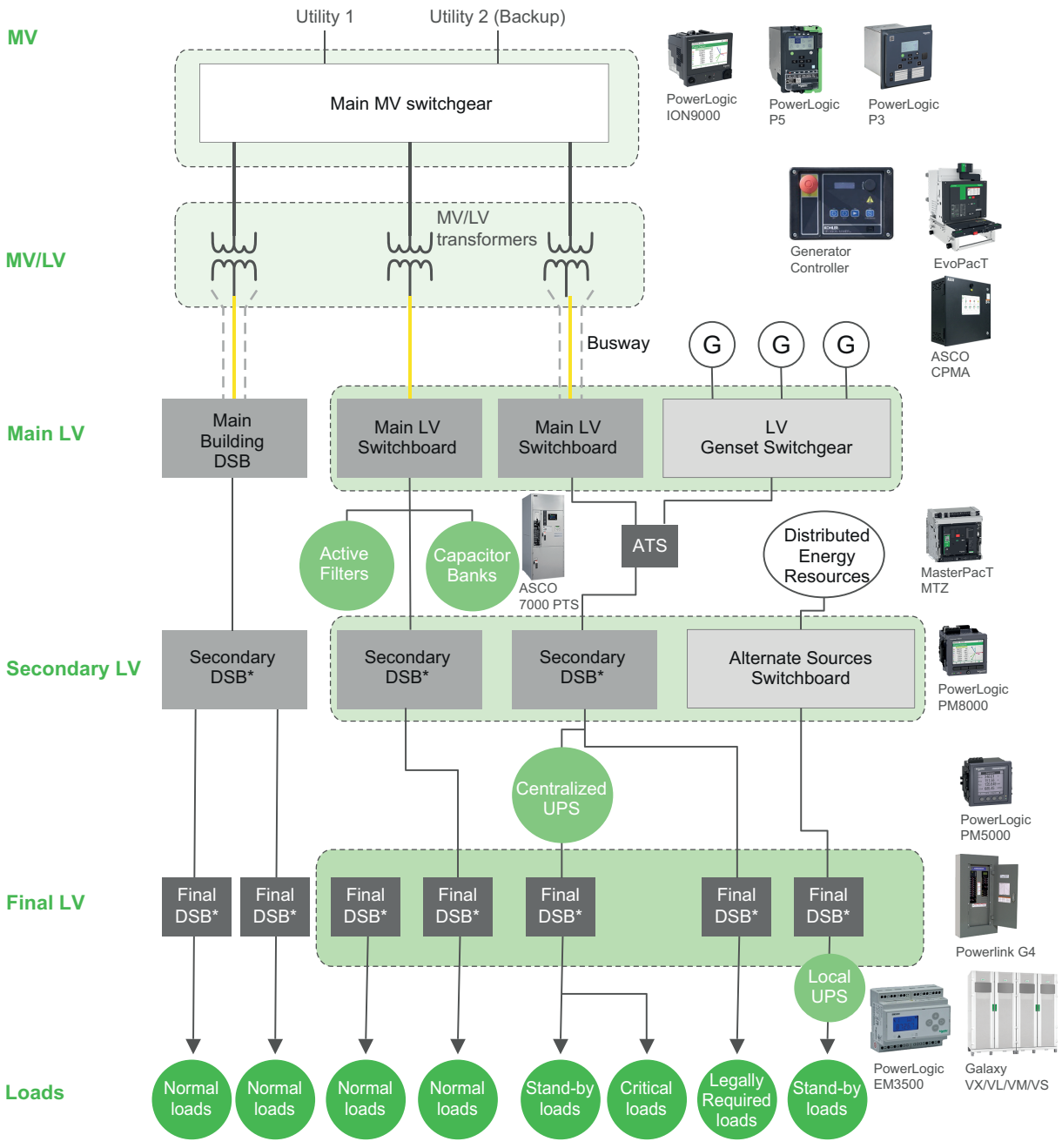
- Digital single-line diagrams with real-time animation of the status of the electrical network
- Real-time electrical data and equipment status

Reports

- Trainee reports: track and review trainee actions to identify potential areas for improvement.

Electrical Architecture

The following diagram details the areas of the architecture where the connected products should be installed in order to implement the Operator Training Simulation application:

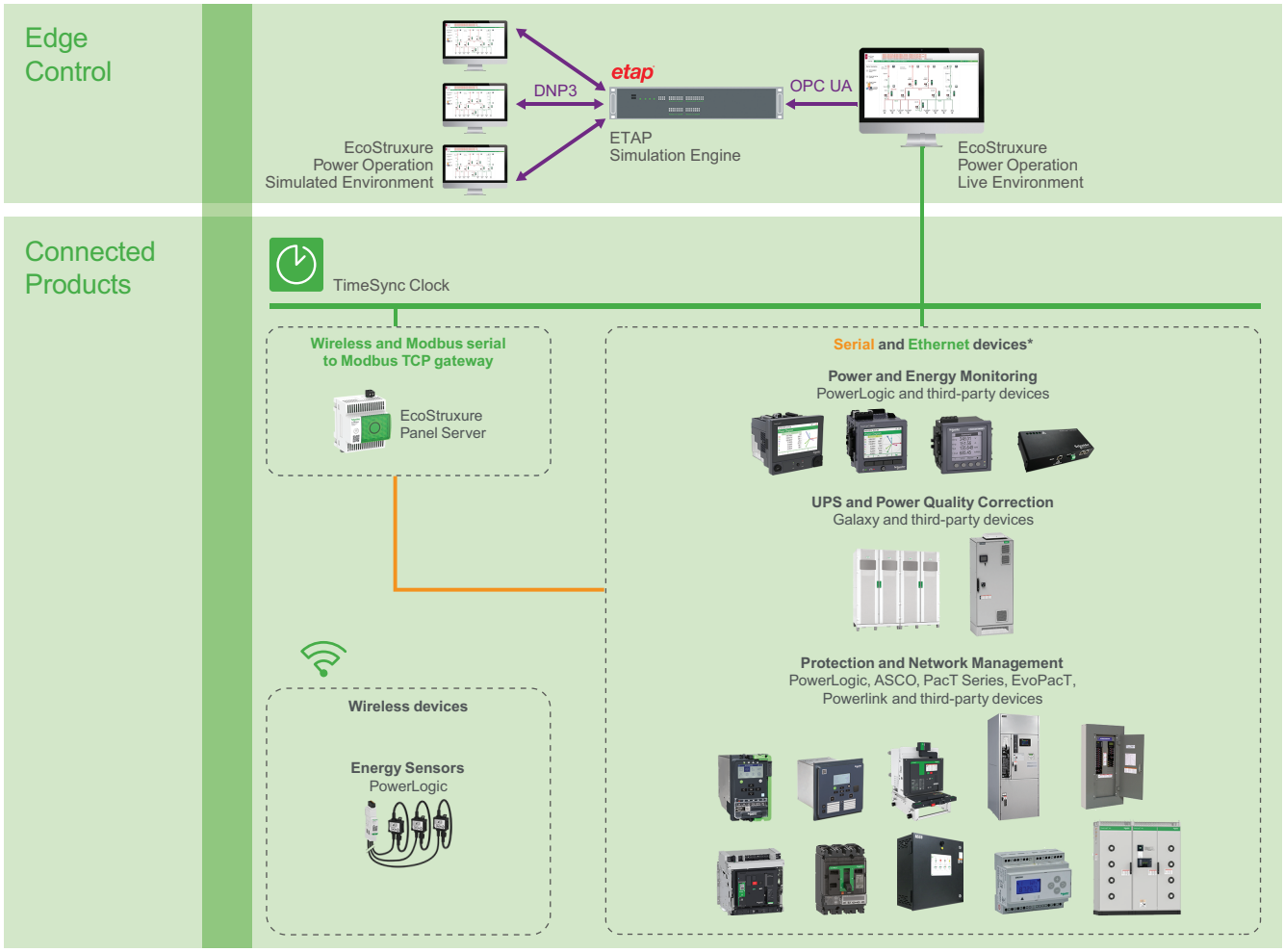


* DSB = Distribution Switchboard

Digital Architecture

The digital architecture of the Operator Training Simulation application involves collecting the input data from the different products, either directly over Ethernet or via gateways. This data is then processed by the Edge Control (EcoStruxure Power Operation) live environment and passed on to the ETAP Simulation Engine (using the OPC UA communication protocol) for training or simulations in simulated Edge Control environments.

The recommended digital architecture for the application is shown below:



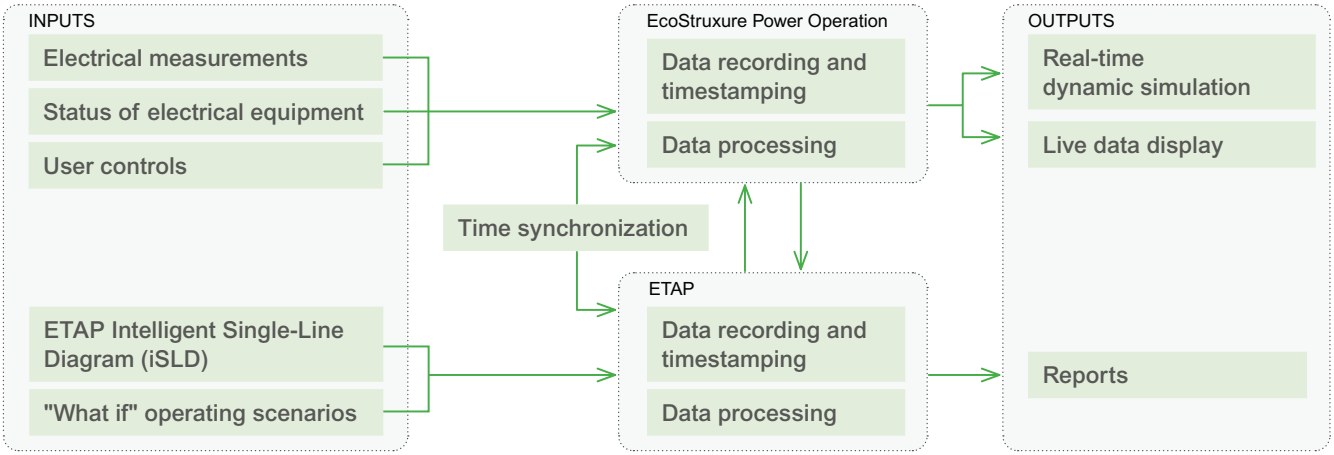
* Depending on the connected device chosen, communication protocols can be Ethernet or Serial

Ethernet - technical LAN
Serial
OPC / DNP3
Wireless - 2.4 GHz

System Description

Data Flow

The Operator Training Simulation application can be broken down as follows:



Inputs

The Operator Training Simulation application collects data in real time from the connected products of the electrical installation to generate a highly realistic model of the electrical system and enable operators to be trained on a digital twin of a site.

Electrical measurements and status information can be acquired from a wide range of connected products as well as third-party equipment through open communication protocols. Typical connected products include:

- **Energy/Power meters**, such as PowerLogic ION9000, PM8000, PM5000, HDPM6000, EM3500, Tag Rope


PowerLogic ION9000


PowerLogic PM8000


PowerLogic PM5000


PowerLogic HDPM6000


PowerLogic EM3500


PowerLogic Tag Rope

- **Protection devices**, such as PowerLogic P5/P3, EvoPacT, MasterPacT MTZ, PowerPacT H/J/L


PowerLogic P5


PowerLogic P3


EvoPacT


MasterPacT MTZ


PowerPacT H/J/L

- **Other equipment**, such as UPS (Galaxy VX/VL/VM/VS), ATS/PTS (ASCO 7000 Series PTS), ATS controller (PowerLogic T300), protective devices (ASCO SPD with ASM), power correction devices (PowerLogic PFC and AccuSine PCS+/PCSn/PFV+), Load Banks, Intelligent panelboard (PowerLink G4)


Galaxy VX/VL/VM/VS


ASCO 7000 Series PTS


PowerLogic T300


ASCO SPD with ASM


PowerLogic PFC


PowerLogic AccuSine PCS+/PCSn/ PFV+


Load Banks


PowerLink G4

Electrical Measurements

The following electrical measurements are collected from connected products (real-time values, the minimum, maximum and average value):

- Current and voltage
- Power (Active, Reactive, Apparent)
- Frequency
- Energy
- Harmonic distortion
- Voltage and current unbalance

Status of Electrical Equipment

Information is collected from intelligent electrical devices such as circuit breakers, power quality correction equipment, ATSs and other electrical distribution equipment:

- Circuit breaker position (open, closed, racked-in, racked-out, etc.)
- Circuit breaker trip status, protection status
- UPS status, motor status
- Other statuses, operating modes or conditions

User Controls

Trainees can interact with the digital twin and follow operational procedures by evaluating control strategies and emulate controls such as:

- Sequence of operations
- Load transfer switching
- Contingency plans

ETAP Intelligent Single-Line Diagram (iSLD)

ETAP's iSLD is a digital representation of the electrical system including all equipment characteristics and system behavior. It is designed to be the model of AC & DC networks based on real-time and estimated data.

"What If" Operating Scenarios

Some sequences of events must be predefined to train operators on sequences following critical operational situations such as:

- Utility outage
- Generator testing
- Motor starting
- Faults
- Contingency plans
- Sequence of operations to restore the power

Data Recording and Timestamping

For the Operator Training Simulation application:

- User actions are recorded and timestamped by EcoStruxure Power Operation.
- Status changes generated in response by the ETAP Simulation Engine are recorded and timestamped by the ETAP server.

This timestamped data is used to provide accurate sequence of events in the action summary report that can be produced after training sessions or after simulated actions.

To reach an optimal chronological correlation, a time accuracy of ±1 millisecond is recommended for both the trainee workstation (EcoStruxure Power Operation) and the ETAP Simulation Engine.

For a comprehensive overview of device recording and timestamping capabilities, refer to Data Recording and Time Synchronization Capabilities of EcoStruxure Power Connected Products.

ETAP
Simulation Engine

EcoStruxure
Power Operation

Time Synchronization

To be able to replay or analyze sequence of operations, time synchronization is required between the EcoStruxure Power Operation computers (server and user HMI) and the ETAP Simulation Engine.

This can be achieved by setting NTP or SNTP synchronization between computers.

TimeSync Clock

Data Processing

Real-time data from the electrical installation is provided by EcoStruxure Power Operation Edge Control using OPC UA communication protocol.

ETAP Simulation Engine additionally analyzes power system dynamics and transient disturbances, estimates the magnitudes and phase angles of bus voltages, currents, and performs analysis on arc flash hazards and incident energy.

This data is used by the ETAP Simulation Engine to generate highly-realistic equipment responses to a series of control actions by a user.

All user actions (user controls) are logged for traceability purposes.

ETAP
Simulation Engine

EcoStruxure
Power Operation

Outputs

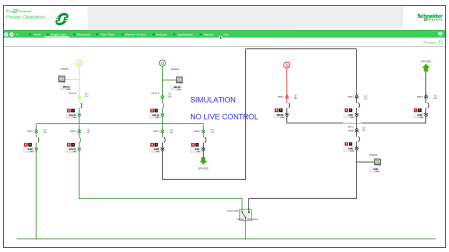
The outputs of the ETAP Simulation Engine are displayed in EcoStruxure Power Operation.

ETAP
Simulation Engine

EcoStruxure
Power Operation

Real-time Dynamic Simulation

Electrical SCADA utilizes data generated by ETAP Simulation Engine to mimic a multitude of user-defined real-case scenarios. It helps to provide an advanced and cost-effective training environment, that prepares operators to quickly respond to various power systems events and emergency situations.



Simulated Operator Training Environment

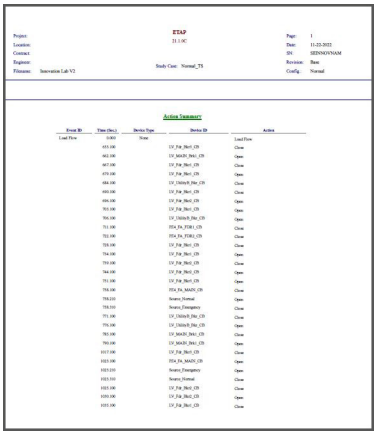
Live Data Display

The live status of the electrical distribution can be represented in the Edge Control software (EcoStruxure Power Operation) in various forms such as:

- Digital single-line diagrams, with real-time animation of the status of the electrical network
- Real-time electrical data and equipment status

Reports

In addition to specialized reports, action summary reports are generated to evaluate the steps taken by operators, and to assess and/or validate their competence level.


ETAP Action Summary Report

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