

Case Study in Improving Protection System Reliability With Automatic NERC PRC-005 Inspection, Testing, Reporting, and Auditing

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What Is NERC PRC-005?

- Ensures all transmission and generation protection systems affecting reliability of the BES are maintained
- Applies to
 - ◆ Protection systems
 - ◆ Underfrequency and undervoltage load-shedding systems
 - ◆ Special protection systems

What Does a PRC-005 Protection System Include?

- Protective relays
- Communications systems necessary for correct operation of protective devices
- Voltage- and current-sensing inputs and circuits to protective relays
- DC control circuitry
- Station dc supply

PRC-005 Requires a Protection System Maintenance Program (PSMP)

- Ensure working order of protection system critical components
- Leverage installed protection IEDs to reduce resources required to maintain protection system



PRC-005 Level 1, 2, and 3 Monitoring

- Time-based maintenance (unmonitored)
- Condition-based maintenance (partially monitored)
- Performance-based maintenance (fully monitored)



CDWR State Water Project



Oroville-Thermalito Dam Complex



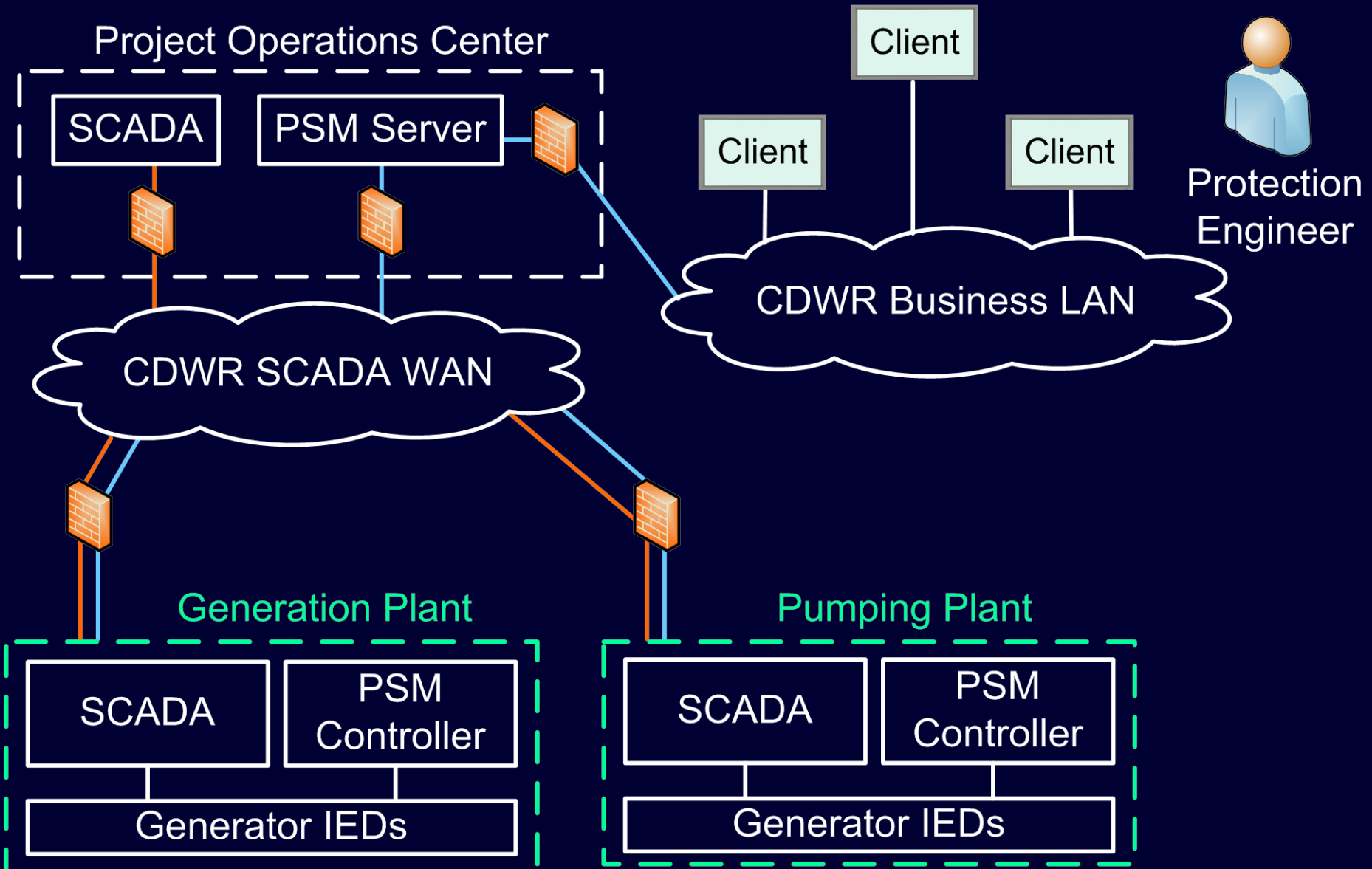
Thermalito Power Plant



Protection System Monitoring (PSM) Design

- Perform real-time evaluation and validation of critical protection system components
- Automatically report results to a centralized server
- Improve CDWR protection system awareness through daily reports
- Support PRC-005 testing and documentation requirements

CDWR PSM System Architecture



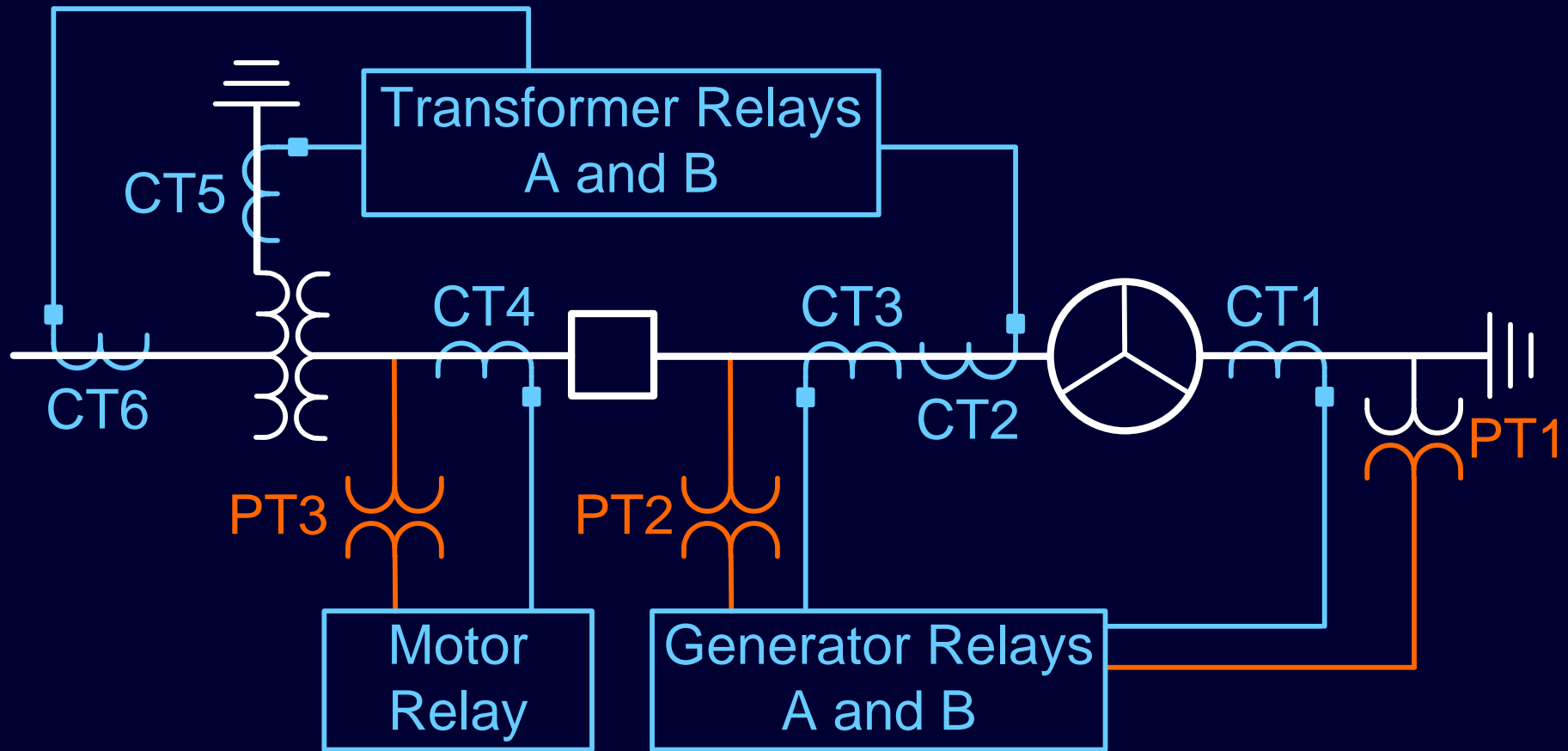
CDWR PSM and Event Retrieval System

- Supplement time-based (unmonitored) maintenance program
- Include validation and reporting
 - ◆ IED internal diagnostics
 - ◆ Relay A/D converter
 - ◆ CT- and PT-sensing devices and circuits
 - ◆ Installed IED firmware and settings
 - ◆ Relay event reports

Separate Isolated System

- PSM controller IED connections are isolated from SCADA and engineering access
- System operation, changes, and updates do not require outage management
- System only monitors IEDs
- CIP has no remote access

CDWR Generation Protection



PSM Controller Evaluates and Validates Using Measured Values

- Compares measured values from five relays
- Verifies all values are within analog dead band
- Verifies time and data quality
- Validates relay A/D converter and sensing device and circuit

Implementing CT Validation Logic

Compare
magnitude,
data quality,
and time
stamp

Verify relay
A/D converter
and
CT-sensing
device and
circuit

Generator Relay A	Generator Relay B
IA_Instmag.value	IA_Instmag.value
IA_Instmag.quality	IA_Instmag.quality
IA_Instmag.time	IA_Instmag.time
IB_Instmag.value	IB_Instmag.value
IB_Instmag.quality	IB_Instmag.quality
IB_Instmag.time	IB_Instmag.time

PSM Controller

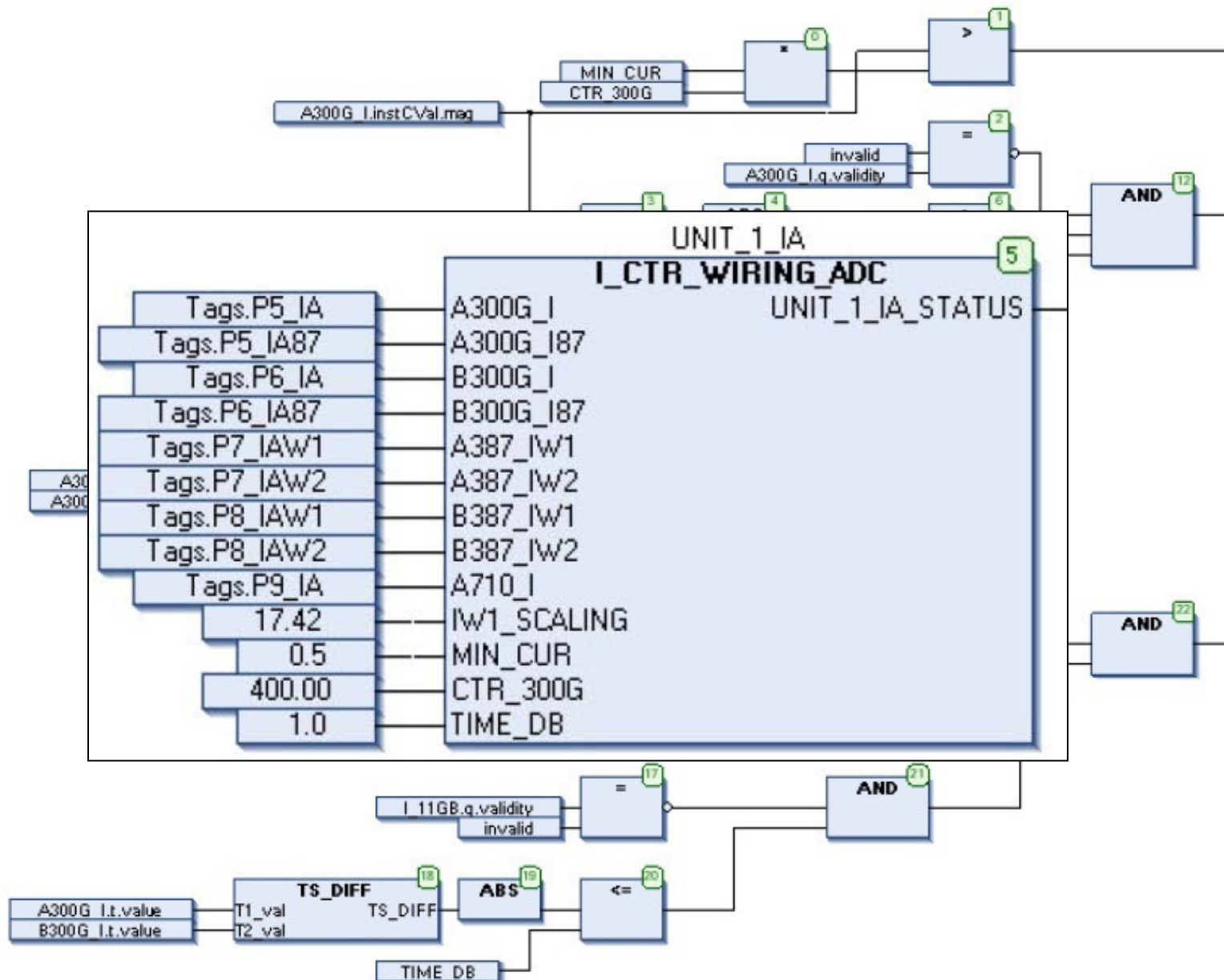
Generator
Relay A

Generator
Relay B

Quantity	Attribute
IA	IA_Instmag
IA	IA_Instmag.q
IA	IA_Instmag.t
IB	IB_Instmag
IB	IB_Instmag.q
IB	IB_Instmag.t

Quantity	Attribute
IA	IA_Instmag
IA	IA_Instmag.q
IA	IA_Instmag.t
IB	IB_Instmag
IB	IB_Instmag.q
IB	IB_Instmag.t

IEC 61131 Logic



Applying PSM System to Protect Critical Assets

Edmonston Pumping Plant



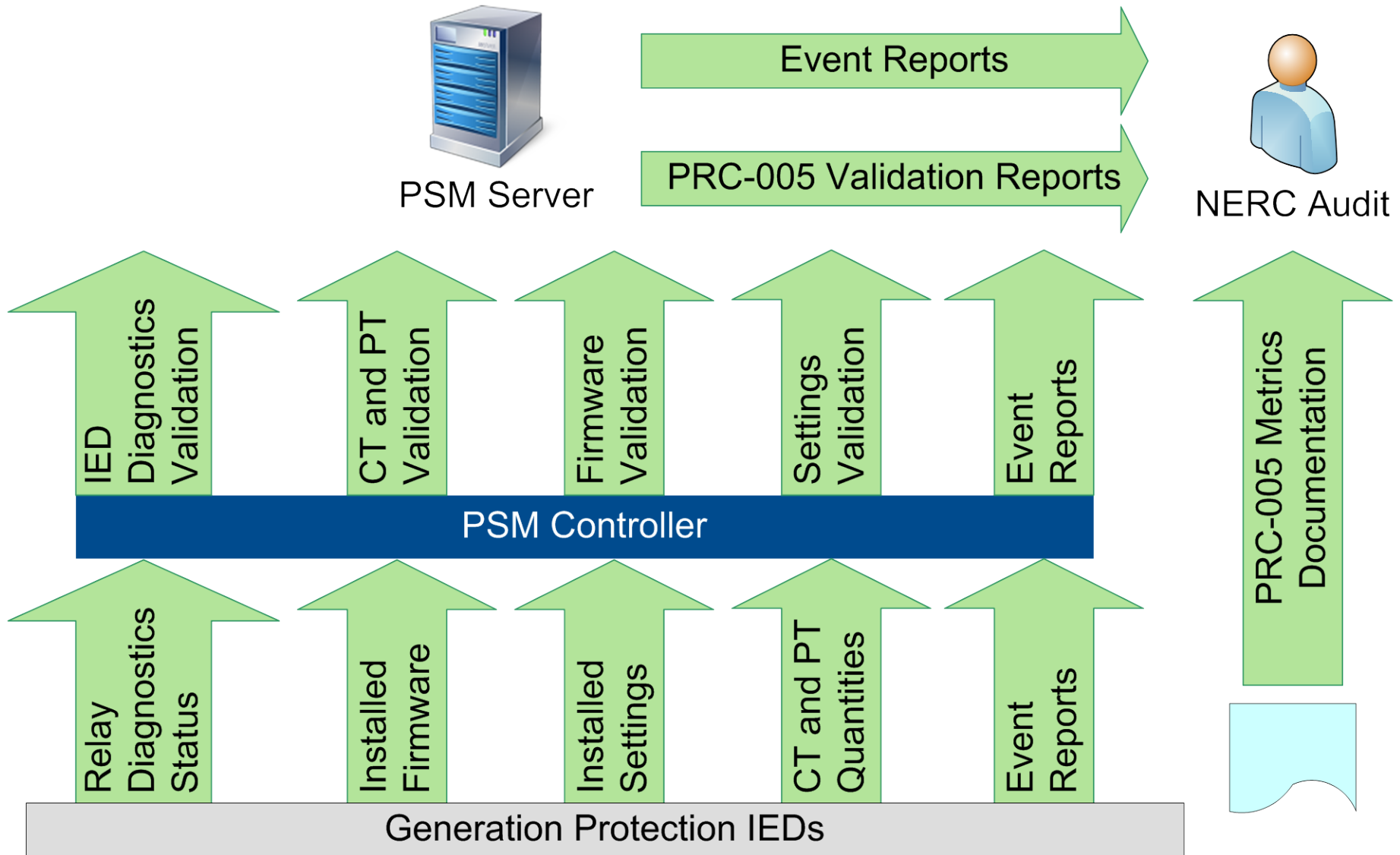
Edmonston Pumping Plant Outage

Events Have Economic Impact

- PSM system could have prevented outage due to a CT failure
- Total cost of outage was about \$90,000
- CDWR may extend PSM system by installing PSM monitors next to legacy devices



PSM Report Data Flow



PRC-005 Unit Validation Report

PRC-005 Report Unit 1

Valid

Relay Diagnostics

Valid

Relay A to D

Report Date

02-17-2011

Valid

CT Sensing Devices

Valid

CT Circuits

Acknowledge

Ack

Valid

PT Sensing Devices

Valid

PT Circuits

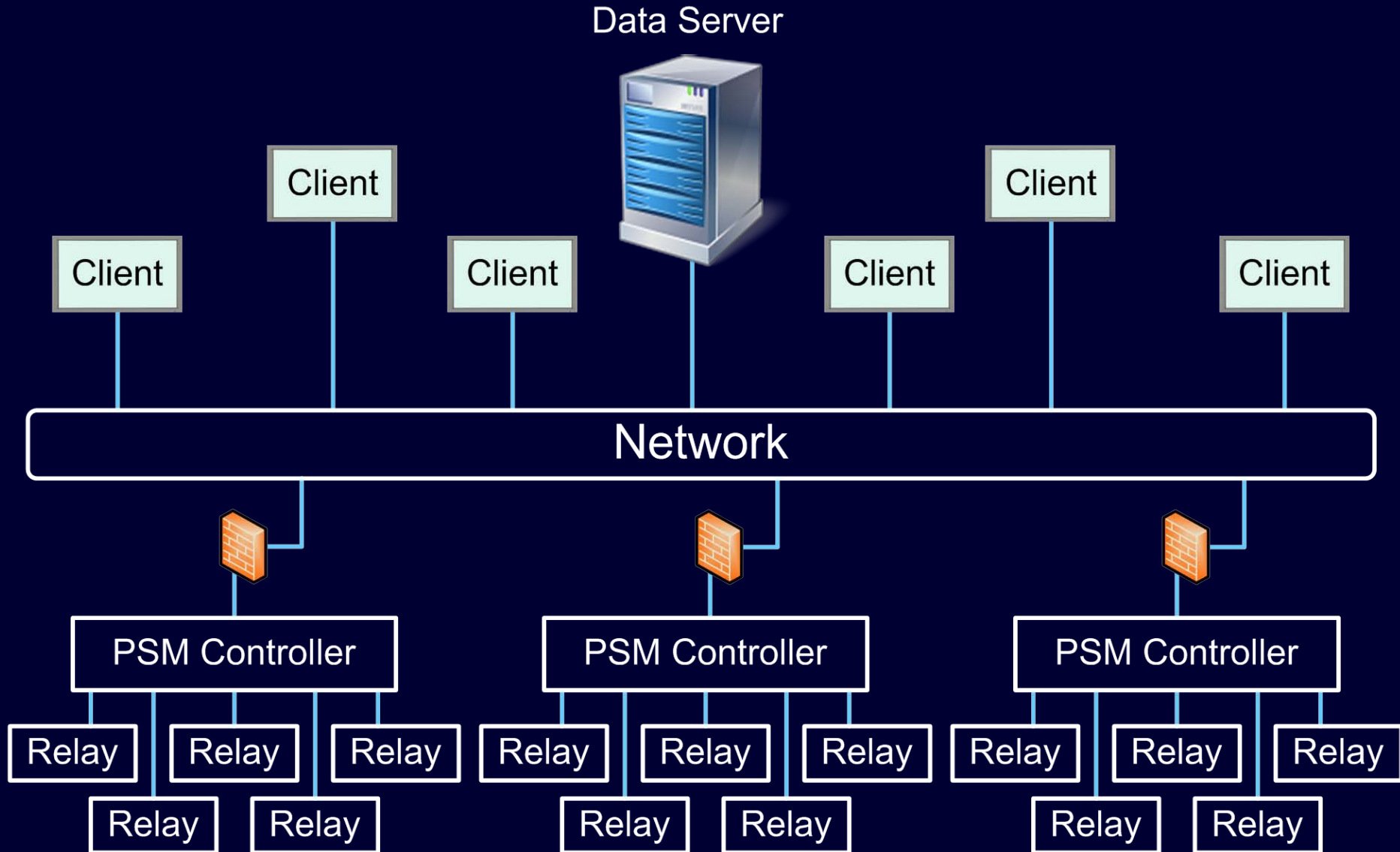
Valid

Relay Firmware

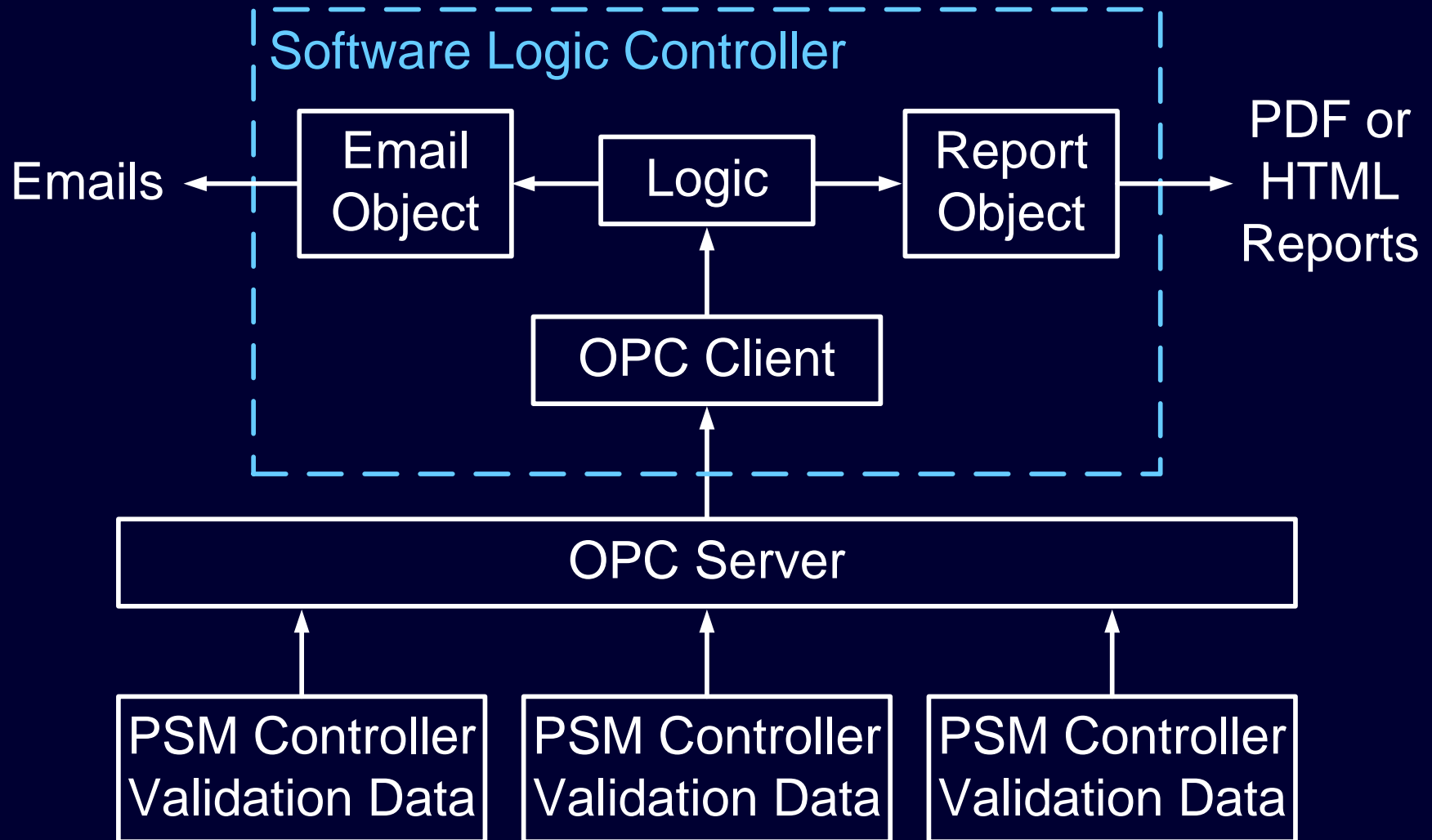
Valid

Relay Settings

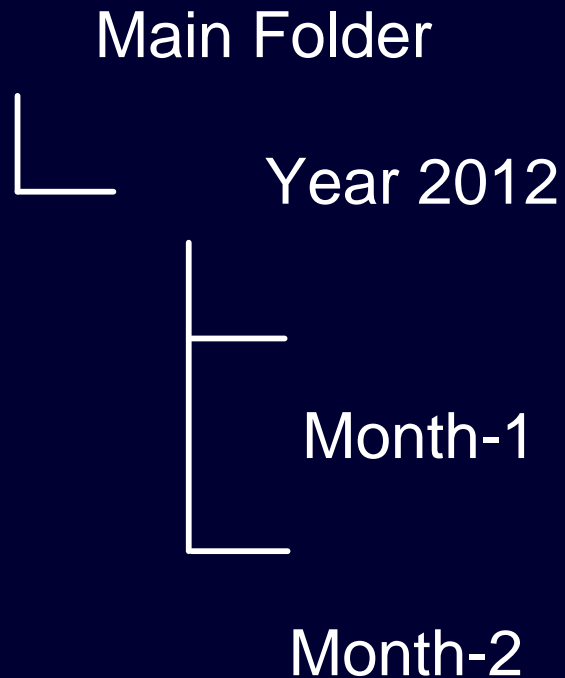
PSM Report Topology



PRC-005 Report Software



PRC-005 Report Folder Structure



Month-1

G_Report

G_THM1-01-01-2012

G_THM2-01-01-2012

G_THM3-01-01-2012

NG_Report

NG_THM1-01-01-2012

NG_THM2-01-01-2012

NG_THM3-01-01-2012

OL_Report

OL_THM1-01-01-2012

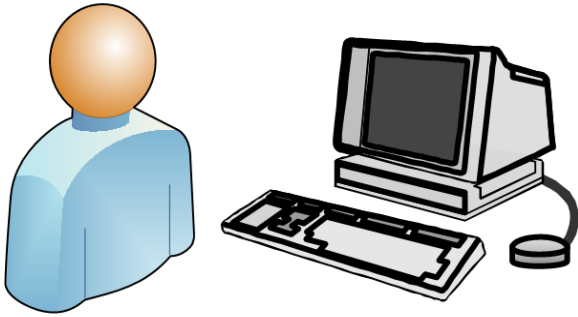
OL_THM2-01-01-2012

OL_THM3-01-01-2012

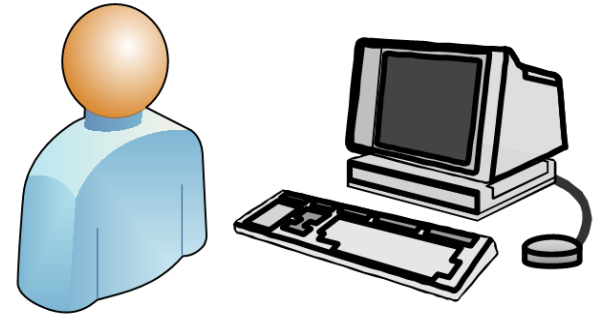
Report and Archive Protection System Events

- Automatically retrieve events from generator IEDs
- Store new events in PSM controller database
- Push new events to PSM central server

Protection Engineer



Protection Engineer



PSM
Server

Plant PSM Controller

PSM Controller



Plant PSM Controller

PSM Controller



Conclusion

- PSM application is designed to enhance CDWR protection system awareness and support PRC-005 PSMP
- This is accomplished by
 - ◆ Performing continuous component evaluation
 - ◆ Reporting the results
 - ◆ Documenting the validation and event reports

Conclusion

- CDWR may adopt PSM system at pumping plants to monitor critical assets via predictive alarming
- Installing IEDs next to legacy devices will help
 - ◆ Communicate critical data to PSM system
 - ◆ Keep critical assets online
 - ◆ Avoid expensive downtime

Questions?

