EcoStruxure™ Innovation At Every Level Power

How to Optimize Time-Synchronization and Data Recording for EcoStruxure™ Power Digital Applications

Technical Guide

11/2019

se.com/ww/ecostruxure-power

Life Is On | Schneider Electric

Purpose of the Document

Target Audience

This technical guide is intended for EcoXperts, System Integrators, Application Engineers, and other qualified personnel who are responsible for the design and configuration of EcoStruxure™ Power projects.

Objective

The objective of this document is to support the EcoStruxure™ Power Digital Application Design Guide, in which we introduce the digital applications and describe their implementation for large buildings and critical facilities.

All the digital applications embedded in EcoStruxure™ Power Edge Control Software need to collect data from the electrical installation to enable applications such as Cost Allocation, Energy Usage Analysis, Power Event Analysis, etc., as well as to perform general trending or diagnostics.

The data must be timestamped and the required accuracy of the timestamp depends on the digital applications selected.

This technical guide details how to define the digital architecture to ensure proper timestamping of the collected data depending on the selected digital applications.

It provides a special focus on the various methods used to time synchronize the internal clocks of advanced devices such as power meters, trip units, protective relays, PLCs, UPS controllers, Harmonic Filters, etc.

Digital Applications for Large Buildings and Critical Facilities
IEC EcoStruxure™
Power Design Guide
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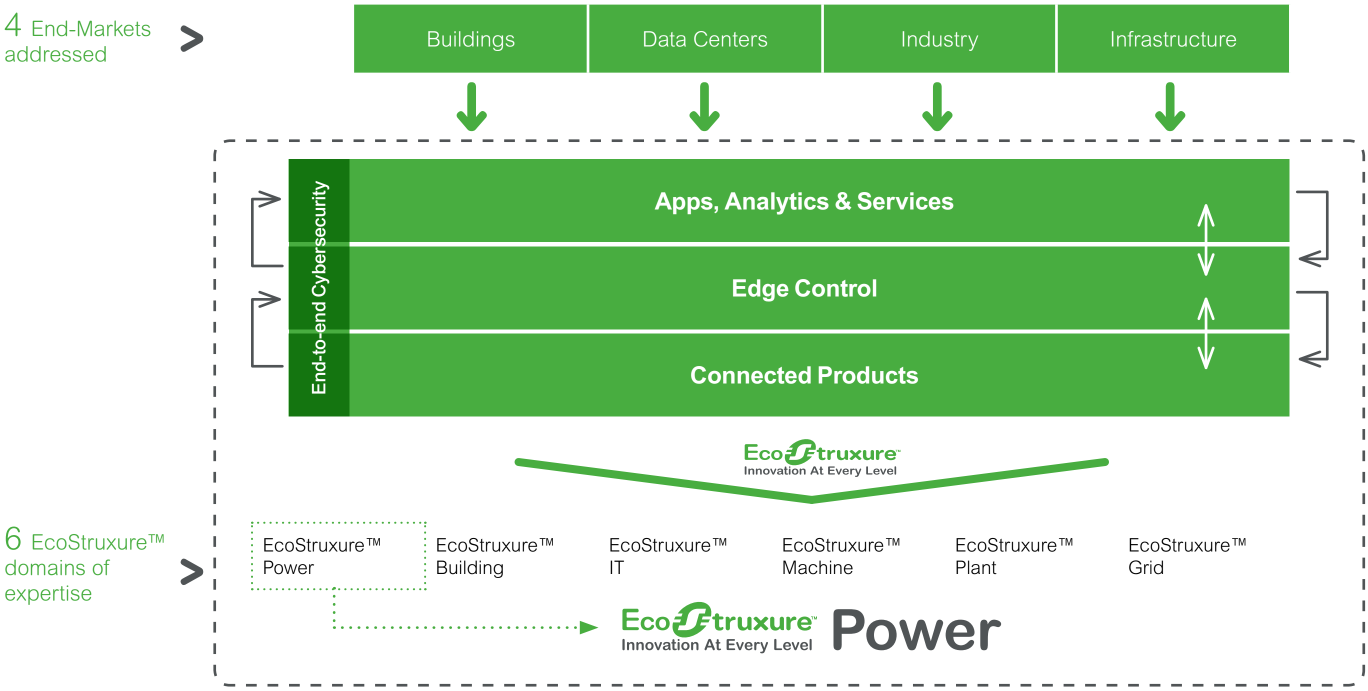
Overview of EcoStruxure™ Power (1/2)

Introduction

As shown in the diagram below, and indicated by the green arrows, EcoStruxure™ Power is one of the six domains of EcoStruxure™, our IoT-enabled architecture and platform.

EcoStruxure™ Power plays a key role in all four End-Markets (Building, Data Center, Industry and Infrastructure). This involves bringing the world of electrical distribution to those End-Markets.



EcoStruxure™'s integrated architecture serves four end markets with its six domains of expertise.

OUR VISION OF A NEW ELECTRIC WORLD

The world is becoming more electric and digital, and power is becoming more distributed, more complex to manage, and more integrated into our everyday lives. We envision a New Electric World where building staff and occupants are safer, with zero electrical safety incidents. Where power is 100% available, with zero unplanned downtime. Where energy and operations are more efficient, with zero energy waste. And where operational systems are resilient, with zero cyber intrusions.

We strive to make this vision a reality with our IoT-enabled EcoStruxure™ architecture and platform, which we deliver through our connected energy management ecosystem – a collective of partners and industry experts who are openly collaborating with us to push innovation, enhance productivity, reduce risk, and unlock new growth opportunities.

Overview of EcoStruxure™ Power (2/2)

EcoStruxure™ Power

- **EcoStruxure™ Power digitizes and simplifies low and medium voltage electrical distribution systems.** It provides essential data to aid the decisions that help protect people, safeguard assets, maximize operational efficiency and business continuity, and maintain regulatory compliance.

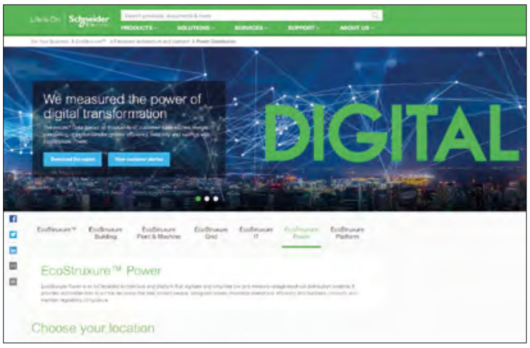
- **EcoStruxure™ Power is an open architecture and platform** designed with the intention of making it easy to add, upgrade, and swap components. The world is full of electrical distribution systems in various stages of maturity; from a variety of manufacturers. Interoperability with EcoStruxure™ Power is essential to making these power distributions systems future ready. The added benefit of a holistic Schneider Electric system is the plug-and-play connectivity to achieve faster and lower risk integration and commissioning.

- **EcoStruxure™ Power architectures are cost-optimized** to deploy, using only the right technology to deliver the desired business outcomes for our customers – no more, no less. However, customer needs or demands change over time.

- **The EcoStruxure™ Power system is scalable** from light commercial and industrial buildings to critical facilities such as hospitals data centers or infrastructure like airports, rail and oil and gas. Scalability of EcoStruxure™ Power also extends to growing and evolving with changing needs or demands through its modular architecture.

- **EcoStruxure™ Power architectures are fully flexible power distribution systems** with the ability to adapt to dynamic and ever-changing conditions, such as balancing supply and demand by the hour or minute or adding and then scaling on-site renewable generation capabilities over time. Connecting IT and OT systems into a single, easy-to-manage Ethernet IP network is at the heart of our digitization story. With EcoStruxure™ Power, facility managers can use the data they collect to make real-time decisions to maximize business continuity and optimize operations.

More about EcoStruxure™ Power
https://www.schneider-electric.com/en/work/campaign/innovation/power-distribution.jsp



About the Guide (1/3)

General Methodology for Optimizing Time-Synchronization and Data Recording/Timestamping

Like a common thread, the below methodology will help you understand the steps to optimize time-synchronization and data recording/timestamping for EcoStruxure™ Power digital applications, and efficiently use this guide.

PREREQUISITES – Define Your Electrical Installation and Select the Associated EcoStruxure™ Power Digital Applications

Once your electrical architecture has been designed, use the Digital Application Design Guide for Large Buildings & Critical Facilities to:

- select the appropriate digital applications for your electrical installation,
- understand how to implement them,
- define the connected products, software and services that need to be embedded.

>

See the:
Digital Applications for Large Buildings and Critical Facilities
IEC EcoStruxure™ Power Design Guide
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STEP 1 – Define the Required Time Criticality for Your EcoStruxure™ Power Applications

Most of the digital applications use connected product data which needs to be recorded and timestamped.

>

See Section 1, p. 11 to understand why data timestamping is useful and to learn about time accuracy and time-synchronization

Depending on the purpose of the applications, the required accuracy of the timestamps differs: Three time criticalities have been defined to describe digital applications (Low/Medium/High).

>

See Section 1, Table 1 p. 12 which defines time criticality

In table 2, EcoStruxure™ Power applications have been sorted by "Time Criticality".

Use this table to define the required Time Criticality for the different parts of your digital installation.

>

See Section 1, Table 2 p. 13 to find the time criticality of the EcoStruxure™ Power digital applications

STEP 2 - Select the Data Timestamping/Recording and Time-Synchronization Solution for Your Products

There are three main families of solutions for timestamping and recording data:

- using a time-synchronized connected product (Solution 1)
- using Edge Control software (Solution 2)
- using an external time-synchronized connected product (Solution 3).

>

See Section 2, p. 17 to learn about the three main timestamping solutions

About the Guide (2/3)

General Methodology for Optimizing Time-Synchronization and Data Recording/Timestamping (cont.)

STEP 2 (cont.) - Select the Data Timestamping/Recording and Time-Synchronization Solution for Your Products

The choice of family for any given connected product depends on:
- the product category (Basic, Standard, Advanced)
- the required time criticality (Low, Medium, High).

> **See Section 2, p. 18 to learn about the different categories of products**

Use Table 3 to understand the selection principles.

> **See Table 3, p. 19 which shows the timestamping solution versus connected product category and time accuracy requirements**

For advanced products which can be time synchronized, use Table 4 to select the most appropriate protocol from amongst the compatible time-synchronization protocols.

> **See Section 2, Table 4 p. 20 for time-synchronization protocol selection criteria**

Use Table 5 to assess the time-synchronization capabilities of your EcoStruxure™ products.

> **See Section 2, Table 5 p. 21 for the detailed time-synchronization capabilities of main EcoStruxure™ products**

STEP 3 – Implement the Technical Solutions which will Enable the Required Time Criticality

Implement the selected data timestamping and recording solutions.

> **See Section 3 for detailed information about the three families of solutions and their implementation**

Get inspired by the implementation examples shown in Section 4.

> **See Section 4 for example architectures for different installation time criticalities.**

Get information about connected products.

> **See Appendix for descriptions of connected products**

About the Guide (3/3)

Structure of the Document

Section 1 explains why **data timestamping accuracy** is important while designing an EcoStruxure™ Power digital architecture and introduces the notion of digital application **time criticality**.

Section 2 presents the three **main families of timestamping solutions** as well as the main **time-synchronization protocols** and the **selection criteria**.

Section 3 provides **deeper information about the technical solutions** for timestamping data and time-synchronizing connected products as well as explains how to **implement** them.

Section 4 suggests **implementation examples** for digital applications with different time criticalities.

The **Appendix** provides a brief description of the **connected products and Edge Control software** stated in this guide.

The **Bibliography** quotes the **sources** of the information embedded in this guide and provides links to **useful documentation**.

SECTION 1

Defining the Required Time Criticality for Your EcoStruxure™ Power Applications

Introduction

Why Read this Section?

The objective of this section is to introduce the notion of digital application time criticality, which is fundamental when implementing EcoStruxure™ Power Applications.

Contents of this Section

First, we explain the importance of time accuracy when timestamping data, which can sometimes require time-synchronizing connected products.

Then, to facilitate understanding, we define the notion of digital application time criticality, how it correlates with time accuracy, and we will classify EcoStruxure™ Power digital applications according to this time criticality (Low, Medium, High).

Finally, to illustrate why applications require different levels of time criticality, we will review three sample applications.

Why Is Time Accuracy Important When Timestamping Data for a Digital Application?

Introducing Time Accuracy

In a digital electrical installation, a lot of data is collected and recorded by connected products or by the Edge Control software. It can be recorded:

- at regular intervals (for example every 15 min)
- or when an event occurs (circuit breaker trip, voltage sag, transient, etc.)

To enable analysis, diagnostics and operational decisions, this data must be timestamped (onboard connected products or remotely). In particular when timestamped data needs to be sorted chronologically, the **accuracy of the timestamps** relative to a single time reference must be sufficient with respect to the usage of the data.

Definition of Relative and Absolute Time Accuracies

There are two kinds:

Relative Time Accuracy

is the time accuracy of connected products within a system in relation to one another. As an example, a 1 ms relative time accuracy implies that all relevant device clocks in the system are within 1 ms of each other.

Absolute Time Accuracy

is the accuracy with respect to the most accurate cesium atomic clock in the world.

Comment: Time Accuracy must not be confused with the resolution of a timestamp which reflects the number of decimal places. For example, the following timestamp has 1 ms precision or resolution: 3/2/2018 13:37:34.577.

Choosing Between Relative and Absolute Time Accuracy

Within a single system like EcoStruxure™ Power, we do not consider absolute time accuracy necessary for data recording and timestamping: relative time accuracy is sufficient.

However, when the EcoStruxure™ Power system is connected to other EcoStruxure™ or 3rd party systems, absolute time accuracy may be required.

Need for Time-Synchronization

When data is recorded and timestamped on board connected products, it is important to ensure that their internal clocks are accurate in relation to other devices and local time. The setting of all the connected products to a single time reference is called time-synchronization.

Time-synchronization can be implemented using several solutions as described in Section 2, p. 20.

Time-synchronization solutions using time servers such as Global Navigation Satellite Systems, which are aligned with the absolute clock, provide absolute time accuracy.

What Is the Time Criticality of a Digital Application?

Introducing Time Criticality

The time accuracy required depends on data usage, and therefore on the digital application to be implemented.

For ease of understanding and to simplify selection of the timestamping solution(s) for EcoStruxure™ Power digital applications, the notion of time criticality has been defined.

The time criticality of a digital application reflects the level of time accuracy required for data logged by connected products to enable proper operation of the application.

Three Time Criticality Levels

In this document, we distinguish between three levels of time criticality amongst EcoStruxure™ Power applications:

Digital Application Time Criticality	Time Accuracy Upper Limit	Time Accuracy Lower Limit
High	+/-1 ms	+/-10 ms
Medium	+/-10 ms	+/-1 s
Low	+/-1 s	+/-10 s

Table 1: Time criticality definition

Time Criticality and Timestamping/ Time-Synchronization Solution

When building an efficient digital architecture, the challenge is to ensure that the solution used for data timestamping and recording is compatible with the overall time accuracy required by the selected EcoStruxure™ Power digital applications.

If the achieved time accuracy is not sufficient, due to an inappropriate timestamping solution, the application may not work properly and it may not be possible to take appropriate decisions

As will be explained in Section 2, p. 20, accurate timestamping implies, at one level or another, the implementation of time-synchronized advanced products.

Please note that the time-synchronization technologies available today are in alignment with the accuracies given in the table above.

How to Determine the Time Criticality of EcoStruxure™ Power Digital Applications

Learn About EcoStruxure™ Power Digital Applications

Understanding the details of the digital applications is necessary to classify their time criticality as Low, Medium, or High.

You can find all information in the Digital Applications for Large Buildings & Critical Facilities IEC Design Guide

Digital Applications for Large Buildings and Critical Facilities
IEC EcoStruxure™ Power Design Guide
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Detailed Breakdown of Applications Relative to Their Time Criticality

The following table shows application classifications as well as the recommended and minimum required time accuracies for each EcoStruxure™ Power application:

Application	Time Criticality	Recommended Time Accuracy [+/-]	Minimum Required Time Accuracy [+/-]
Continuous Thermal Monitoring	Low	1 min*	5 min*
Insulation Monitoring	Low	1 s	10 s
Electrical Distribution Monitoring & Alarming	Medium	10 ms	1 s
Capacity Management	Low	1 s	10 s
Backup Power Testing	Medium	10 ms	100 ms
Breaker Settings Monitoring	Low	1 s	10 s
Power Events Analysis	High	1 ms	10 ms
Source and Network Control	Medium	10 ms	100 ms
Power Quality Monitoring	Medium	10 ms	100 ms
Power Quality Correction	Low	1 s	10 s
Utility Bill Verification	Low	1 s	10 s
Energy Benchmarking	Low	1 s	10 s
Cost Allocation	Low	1 s	10 s
Energy Usage Analysis	Low	1 s	10 s
Energy Performance Analysis & Verification	Low	1 s	10 s
Power Factor Correction	Low	1 s	10 s
Asset Performance	Low	1 s	10 s
Energy Efficiency Compliance	Low	1 s	10 s
Greenhouse Gas Reporting	Low	1 s	10 s
Power Quality Compliance	Low	1 s	10 s
Regulatory Compliance	Medium	10 ms	100 ms

* For the continuous thermal monitoring application, considering the time constant of the physical phenomena observed (temperature rise of electrical conductors), time accuracy in the range of a minute is acceptable.

Table 2: Time criticality, minimum required and recommended time accuracies by EcoStruxure™ Power digital application.

Comparison of Applications with Different Levels of Time Criticality

Introduction

To illustrate why applications require different levels of time criticality, we will review three sample applications:

- Power Event Analysis
- Electrical Distribution Monitoring & Alarming
- Cost Allocation.

High Time Criticality: Power Event Analysis

This application compares multiple events often captured by multiple connected products to determine the cause and effect of a power-related incident.

When a power incident occurs in an electrical distribution system (such as transients, voltage sags...), a number of resulting events appear within a very short time frame.

In this case, it is important to have tight time correlation between devices to make sure that we can diagnose the origin of an event and the exact sequence in which the incident propagated through the electrical network. With poor time accuracy, the order of the events may be wrong and may lead to inappropriate conclusions.

Therefore we recommend **a minimum time accuracy of 10 ms, but preferably 1 ms** for this application.

Medium Time Criticality: Electrical Distribution Monitoring and Alarming

In the case of this application, we need to make sure we accurately keep track of and record any power system status changes and control actions. Any resulting critical alarms and events are then forwarded to the user/operator who needs to understand their timing. For this purpose, **a time accuracy of 1 s is typically sufficient**.

However, if a control action needs to be tightly correlated to power events for cause and effect analysis, refer to "Power Event Analysis" in the paragraph above.

Low Time Criticality: Cost Allocation

For Cost Allocation, where we try to assign energy costs to different areas, load types, departments, etc. within a facility, time accuracy is less important, and **a time accuracy of 10 s is sufficient**.

Choosing the Right Accuracy for Different Areas of Your Facility

It is important to recognize that time accuracy is a compromise between individual applications. A decision must be made as to which application dictates the accuracy within each area of the electrical distribution system. For example, for critical loads and areas close to the incomer, the Power Event Analysis application may drive the time accuracy, whereas for non-critical loads, the Cost Allocation application could be the main accuracy driver.

SECTION 2

Selecting the Data Timestamping/ Recording and Time-Synchronization Solution for Your Products

Introduction

Why Read this Section?

In **Section 1**, the notion of time criticality level was introduced and was used to classify EcoStruxure™ Power digital applications.

The objective of Section 2 is to present the families of timestamping and data recording solutions which can be deployed to achieve the time criticality level requested by the selected digital applications. It also suggests criteria for selecting the most suitable solution.

Contents of this Section

This section starts with the presentation of the three timestamping and data recording solution families:

- **Solution 1:** timestamping and data recording by the time-synchronized connected product itself, with a presentation of the main time-synchronization protocols
- **Solution 2:** timestamping and data recording by the Edge Control Software,
- **Solution 3:** timestamping and data recording by an external time-synchronized connected product.

We then define the connected product categories (Basic, Standard, Advanced).

Along with the time criticality of the application, these are a criterion for selecting the most suitable timestamping solution.

Keys for selection are presented and summarized in a selection table.

Finally, selection criteria for time-synchronization protocols used in Solution 1 are suggested and summarized in a cost/performance selection table. The capabilities of the main EcoStruxure™ power connected products, with regard to time-synchronization protocols, are also detailed in a table.

What Are the Timestamping and Data Recording Solutions?

Three Main Families

There are three main families of solutions for timestamping and recording data. They are presented briefly below and will be detailed later in this chapter.

SOLUTION 1: Timestamping and Data Recording Using a Time-Synchronized Connected Product

Some connected products that can record data in their onboard memory and that have an internal clock are able to timestamp each recorded data point.

To use their data in a system like EcoStruxure™ Power, the internal clocks on those devices must be regularly synchronized to an external reference.

Section 3 presents several protocols that can be implemented:

- Most of them, for example PTP, NTP, IRIG-B, etc., provide medium to high time accuracy.
- Time-synchronization over Modbus or ION is commonly used. In this case, the time server is the Edge Control software. Time accuracy with this methodology would be lower (typically in the range of +/-1 s) but still valid for non-critical applications.

Wireless technologies (using the Zigbee protocol) tend to be more and more commonly deployed in LV and MV equipment, especially for applications involving energy or environmental monitoring. However, the overall time accuracy capabilities for Zigbee-based architectures are very limited (can be up to +/-10-20 s depending on the architecture used).

See Section 3 p. 25 for the implementation of time-synchronization protocols.

SOLUTION 2: Timestampingand Data Recording Using the Edge Control Software

This is commonly referred to as “PC logging”: the Edge Control application retrieves a real-time reading from the connected product and then records and timestamps this reading in the Edge Control database.

See Section 3, p. 36 for the implementation of PC logging.

SOLUTION 3: Timestamping and Data Recording Using an External Time-Synchronized Connected Product

This solution is used when the connected product does not have an internal clock or cannot be time synchronized with sufficient accuracy. Data recording using an external time-synchronized connected product is most effective for recording statuses such as:

- LV and MV circuit breaker status changes
- Automatic Transfer Switch (ATS) status changes
- Control scheme status changes
- Uninterrupted Power Supply (UPS) status changes
- Generator status changes

See Section 3, p. 37 for the implementation of an external time-synchronized connected product.

How do you select the timestamping and data recording solution for your needs? This is detailed on the next page.

Selecting the Timestamping and Data Recording Solution (1/2)

Selection Parameters

The choice of possible timestamping solution for any given connected product depends on:

- the required time accuracy (linked to the time criticality of the application to be implemented as seen in Section 2)
- the category (defined below) of the product which provides the data.

Three Categories of Connected Products

We can generally divide connected products into three categories, depending on their capability to manage the data they produce:

Basic Connected Products which only provide real-time data.

Example:

Easergy
TH110
Wireless Thermal Sensor

Standard Connected Products which only provide real-time data, energy counters and min/max/average registers.

Example:

Acti9
iEM3000
Energy Meter

PowerLogic
PM3000
Power Meter

Advanced Connected Products with the ability to provide real-time data, energy counters, min/max/average registers and onboard data recording.

Example:

PowerLogic
PM8000/ION9000
Power Meters

MasterPact
MTZ
Circuit Breaker

Not all connected products can perform accurate data timestamping. Therefore, it is important to understand which timestamping solution is suitable for which product category.

Timestamping Solution Based on Product Category

Solutions for Advanced Connected Products

Advanced connected products are capable of recording data in their onboard memory and have an internal clock. The connected product timestamps the recorded data itself.

When high time accuracy is not required, time-synchronization over Modbus is sufficient.

When high time accuracy is required, a high-accuracy time-synchronization protocol must be implemented.

However, some advanced products have limited time-synchronization capabilities and can only support certain time-synchronization protocols.

If higher time accuracy is required, it is possible to hardwire these to an advanced connected product with higher capabilities. The accuracy of the timestamp is then dictated by the capabilities of the most accurate advanced product.

Selecting the Timestamping and Data Recording Solution (2/2)

Timestamping Solution Based on Product Category (cont.)

Solution for Basic and Standard Connected Products

The selection criteria are similar for basic and standard products as neither can be time synchronized:

Basic connected products are not able to record any data and do not have an internal clock that could be time synchronized.They simply display or send the last measured value via their communications interface.

Standard connected products may have an internal clock that provides a time reference for computing energy values, but do not have a time reference that could be used to timestamp data.
As such, they typically also do not require time-synchronization.

for basic transducers and standard connected products with no time-synchronization capabilities, timestamping is performed:

- Either by the Edge Control software by leveraging what is commonly referred to as "PC logging" if high time accuracy is not required (the Edge Control application retrieves a real-time reading from the product and then records this reading in its database)
- Or by connecting digital inputs to an advanced product which is time-synchronized with high-accuracy. In this case, the accuracy of the timestamp is defined by the capabilities of the advanced product.

Summary Table

The below table summarizes the information about timestamping solutions:

		Connected Product Category		
		Basic & Standard	Advanced	
		No Time-Synchronization Capabilities	Limited Time-Synchronization Capabilities	High Time-Synchronization Capabilities
Time Accuracy Requirements	**High-Medium time accuracy (+/-1 ms to 10 ms)**	Hardwired connection to an advanced time-synchronized device **> Solution 3**	Hardwired connection to an advanced time-synchronized device **> Solution 3**	Time-synchronization with high-accuracy protocols **> Solution 1**
	Low time accuracy (+/-1 s to +/-10 s)	PC Logging with Edge Control software **> Solution 2**	Time-synchronization with SNTP protocol or over Modbus **> Solution 1**	Time-synchronization over Modbus **> Solution 1**

Table 3: Selecting the timestamping solution

See Section 3 for solution implementation.

See Table 5, p. 21 later in Section 2 for the detailed time-synchronization capabilities of the main Schneider Electric products used in EcoStruxure™ Power.

Comment: Please note that some products can only be connected to another product with communication connection. In those cases, time accuracy cannot be improved.

Selecting the Time-Synchronization Protocol for Solution 1 (1/2)

Two Main Time-Synchronization Protocol Families

The time-synchronization protocols used in Solution 1 can be sorted into two main families:

- **Ethernet-Based Protocols** (using an existing Ethernet network)
  - Precision Time Protocol (PTP)
  - Network Time Protocol (NTP) / Simple Network Time Protocol (SNTP)
  - Modbus or ION Communication Protocols
- **Non Ethernet-Based Protocols** (which require specific serial line wiring like IRIG-B)

These protocols will be detailed in Section 3.

1

Selection Criteria

2

Protocol Selection versus Performance and Cost

The choice of time-synchronization protocol is a compromise between achievable time accuracy and implementation costs.

- Some of the most expensive, but most accurate time-synchronization technologies rely on non-Ethernet protocols (for example IRIG-B, DCF77) tied to a GPS antenna, a GPS receiver and a clock.
- Ethernet-based protocols provide more economical solutions. The most cost-effective but less accurate approach is achieved with Modbus-based (or ION-based) time-synchronization over an Ethernet or serial communications network.
- Protocols such as NTP/SNTP are now commonly supported by a wide range of connected products and can provide sufficient performance for non-critical applications, typically in the range of 1 s down to 10 ms, at an affordable cost (at most a dedicated physical time server).
- A recent Ethernet-based protocol called PTP (defined in IEEE 1588 and IEC 61588) can achieve even more accurate time-synchronization, offering a strong alternative to non-Ethernet-based protocols. In order to reach the highest levels of accuracy with this protocol, specific hardware implementation is required in connected products and communication products (switches).

3
4

Selection Table

As explained in Section 1, the digital application with the greatest constraints determines the time criticality of the different parts of the installation and thus, the required time-synchronization accuracy.

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The table below outlines the most suitable time-synchronization protocols according to their time criticality, as well as an estimation of associated costs.

Application Time Criticality	Typical Time Accuracy	Protocol Media	Protocol	Typical Cost
High	+/-1 ms	Ethernet	PTP (IEEE1588)	$$
High	+/-1 ms	Serial	IRIG-B	$$$
Medium	+/-10 ms to 100 ms(1)	Ethernet	NTP	$
Medium	+/-100 ms	Serial	DCF77	$$
Low	+/-1 s	Ethernet	SNTP	$
Low	+/-1 s	Ethernet	Over Modbus / ION from Edge Control	$
Low	+/-1 s	Serial	1per10	$$

(1) Achievable accuracy depends on connected product capability.

Table 4: Time-synchronization protocol selection criteria

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Selecting the Time-Synchronization Protocol for Solution 1 (2/2)

Time-Synchronization Capabilities for Common EcoStruxure™ Power Connected Products?

Summary Table

As explained in this section, not all connected products have the same time-synchronization capabilities.

The following table summarizes these capabilities for the main Schneider Electric Products embedded in EcoStruxure™ Power digital architectures:

Device	Product Category (as per Section 2)	Logging Capabilities(1)		Maximum Achievable Time-Synchronization Accuracy/ Compatible Time-Synchronization Protocols(1) (2)							
		Event Log	Measurement Log	1 ms		10 ms / 100 ms	100 ms	1 s			
				PTP	IRIG-B	NTP	DCF 77	SNTP	1per10	Over Modbus	Over ION
MasterPact MTZ (with IFE/eIFE)	Advanced Limited	●				●		●		●	
MasterPact NT / NW (with IFE)	Advanced Limited	●				●		●		●	
ComPact NS (with IFE)	Advanced Limited	●				●		●		●	
ComPact NSX (with IFE)	Advanced Limited	●				●		●		●	
Acti9 Powertag Link	Advanced Limited	●						●		●	
Acti9 Smartlink SI B	Advanced Limited	●						●		●	
PowerTag Energy	Basic										
Vigilohm IM20H	Standard	●									
Vigilohm IFL12H	Standard	●									
Easergy P3	Advanced High	●			●			●		●	
Easergy P5	Advanced High	●			●			●		●	
Easergy Sepam 20 Series	Advanced Limited	●							●	●	
Easergy Sepam 40 Series	Advanced Limited	●							●	●	
Easergy Sepam 80 Series	Advanced Limited	●						●	●	●	
PowerLogic Vamp 321	Advanced High	●			●			●		●	
PowerLogic Vamp 121	Standard										
PowerLogic Vamp 125	Standard										
Easergy T300	Advanced High	●		●				●		●	
SMD (Modicon M251)	Advanced Limited	●						●		●	
Easergy TH110 / CL110	Basic										
Modicon M580	Advanced Limited	●				●		●		●	
Modicon M580 with ERT module	Advanced High	●			●	●	●	●		●	
Modicon M340	Advanced Limited	●				●		●		●	
PowerLogic ION9000	Advanced High	●	●	●	●	●		●		●	●
PowerLogic PM8000	Advanced High	●	●	●	●	●		●		●	●
PowerLogic PM5000	Standard		●					●		●	
Acti9 iEM3000	Standard										
Accusine PCS+	Standard										
Accusine PCSn	Standard										
Accusine PFV+	Standard										
Varplus Logic	Standard										
Galaxy VM	Standard	●						●		●	
Galaxy VX	Standard	●						●		●	
Connexium Managed Switches	Advanced Limited					●		●			
Harmony Sologate ZBRN32	Standard										

(1) Product can acquire new capabilities. Capabilities to be confirmed when ordering.
(2) These are typical accuracies. Refer to product technical documentation to get information regarding the maximum achievable accuracy.

Table 5: EcoStruxure™ Power product time-synchronization capabilities

Products With Highly Accurate Time-Synchronization Capability

In Section 3 (Solution 1, p. 25) we explain how to implement the time-synchronization protocols for advanced products with high time-synchronization capabilities.

Products With Limited or No Time-Synchronization Capability

As described in the above table:
- Some products have no time-synchronization capabilities
- Some products can be time synchronized (over Modbus, for example), but are not compliant with high-accuracy time protocols.

Later in Section 3, we explain how to deal with such products for data recording when the implemented application requires:
- low-accuracy timestamping (Solution 2, p. 36)
- high-accuracy timestamping (Solution 3, p. 37).

SECTION 3

Implementing the Technical Solutions Which Will Enable the Required Time Criticality

Introduction

Why Read this Section?

In **Section 1**, the notion of time criticality level was introduced and was used to classify EcoStruxure™ Power digital applications.

Section 2 presented the three possible timestamping and data recording solutions which can be deployed to achieve the criticality level required by the digital application, as well as the selection criteria.

The objective of **Section 3** is to provide information on how to implement the timestamping/time-synchronization solution presented in Section 2.

Contents of this Section

Each solution (sub-solution) is presented along with the necessary equipment, as well as examples of digital architectures for:

- **Solution 1:** timestamping using the time-synchronized connected product itself, with a presentation of the main time-synchronization protocols (IRIG B, DCF77, 1per10, NTP/SNTP, PTP, Modbus/ION).
- **Solution 2:** timestamping using the Edge Control Software (PC Logging).
- **Solution 3:** timestamping using an externally time-synchronized connected product (PowerLogic ION9000/PM8000 Power Meter, Modicon M580 PAC Timestamping Module, 3rd Party Sequence of Event Recorder).

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (1/11)

Non-Ethernet-Based Time Protocols (Serial)

PRESENTATION

Time-synchronization based on non-Ethernet protocols uses a time reference provided by a GPS antenna, relayed to the connected product clocks by a GPS Receiver.

As the name suggests, those time-synchronization protocols do not use the Ethernet network.

Therefore, in addition to the installation of the GPS antenna and receiver, they require the installation of specific coaxial cables.

Although effective, the use of such protocols is expensive.

The most common serial GPS-based time protocols include:

- IRIG-B,
- DCF77
- 1per10.

About IRIG-B [1]

IRIG (Inter Range Instrumentation Group) is a series of serial timecodes, commonly used by electric utilities and industries for time-synchronization purposes in power management systems.

IRIG timecodes use a continuous stream of binary data to transmit information on date and time, typically distributed at 5 VDC and wired point-to-point.

There are six different formats of IRIG timecodes depending on pulse rate attributes such as:

- Modulated or un-modulated
- Carrier frequency
- Type of coded expression.

The most commonly used format is modulated **IRIG-B** (1 kHz carrier).

About DCF77 [2]

DCF77 is a time-synchronization protocol with its origin in Germany.

When used as an electrical signal, the DCF77 timecode is transmitted as a 24 VDC pulse-width modulated signal that provides a complete date/time string once every minute.
The signal contains a one-pulse-per-second component that is accurate to 100 microseconds in reference to UTC (Coordinated Universal Time).

As DCF77 uses 24 Vdc nominal voltage, it can be distributed to multiple products over long distances, making it well suited to power and automation applications. Thanks to its relatively low bit rate of 1 pulse-per-second and time frame of 1 minute (compared to 100 pps and 1 second for IRIG-B), DCF77 requires less processor overhead, yet can achieve equivalent accuracies.

TYPICAL CHARACTERISTICS

Time-Synchronization Source

- GPS antenna + Time server

Accuracy

- +/-1 ms (IRIG-B)
- +/-100 ms (DCF77)
- +/-1 s (1per10)

Required Hardware

- GPS antenna
- Time server
- Dedicated cables and distribution modules

Device Compatibility

- Most MV protection relays, PLCs and high-end power meters support at least one of these protocols.

Limitations

- Requires dedicated cabling
- Can be expensive

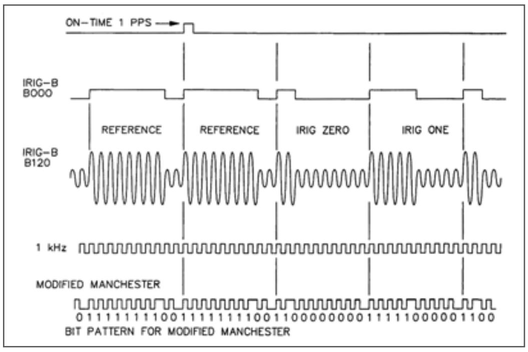

Figure 1: IRIG-B timecode signal

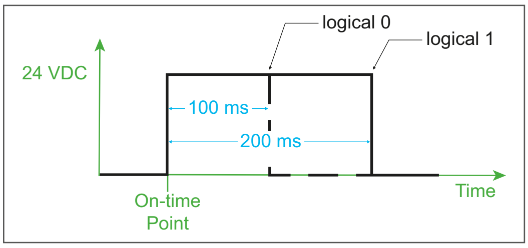

Figure 2: DCF77 timecode signal

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (2/11)

Non-Ethernet-Based Time Protocols (serial) (cont.)

PRESENTATION (cont.)

About 1per10 [3]

1per10 (one-pulse-per-ten-seconds) is a simple time protocol that uses one synchronizing pulse every 10 seconds to provide an accurate time reference for power system products.

The rising edge of the first 1per10 pulse occurs at the exact start of a minute, and subsequent pulses follow at 10 second intervals. Since only the rising edge is used for synchronization, the width (duration) of the pulse is not important. The diagram on the right shows a typical 1per10 signal.

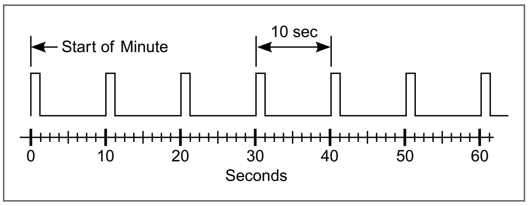

Figure 3: 1per10 timecode signal

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IMPLEMENTATION

Main Components Involved

① **GPS antenna**

- This component is mounted on the roof or other external location, allowing line-of-sight access to multiple satellites
- It retrieves absolute time over one or (ideally) various GNSS systems, such as GPS (US), Galileo (Europe), Beidou (China).
- The antenna generates a pulse-per-second (PPS) output synchronized to UTC with a precision of a few nanoseconds.

② **GPS receiver / Satellite time server**

- This device is in charge of sending the time reference to the power products over a dedicated serial line. Many time servers can distribute this time reference over one or more serial protocols (IRIG-B, DCF-77, 1per10).

③ **IRIG-B distribution module**

- When the time reference signal must be distributed over long distances, distribution modules operating at 24 VDC are required
- These modules then distribute the signal with the IRIG-B unmodulated 5 VDC protocol, as most of the power products only support this IRIG-B protocol.

④ **Communication cables**

- The type of cable will depend on the protocol used. Table 6, p. 27 details the specifications of serial cables for each time-synchronization protocol.

⑤ **Power products**

- These protocols require the use of products with provisions for synchronizing to a GPS time signal over a serial line. Power system products such as power meters and protective relays with onboard clocks are often equipped with such capabilities
- Devices may support one or more of the protocols (See Table 5, p. 21 for detailed product capabilities).

Typical Architecture

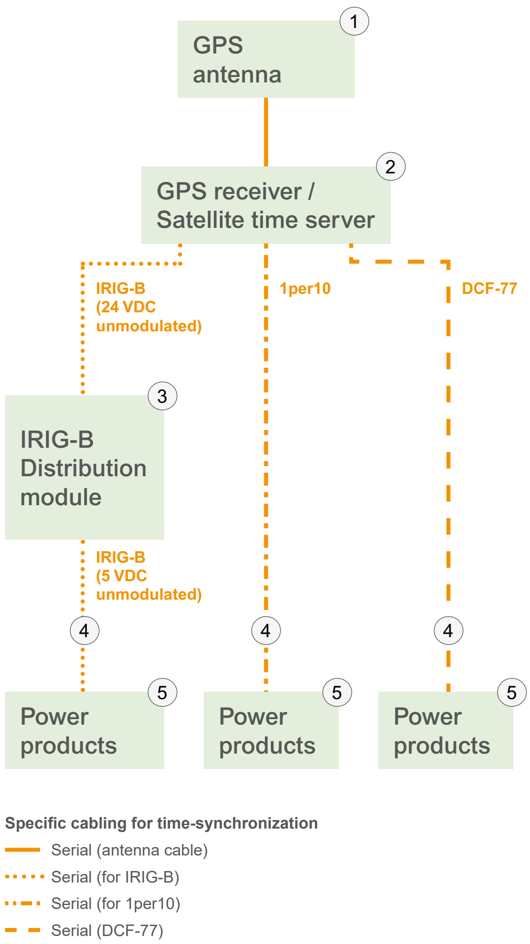

Figure 4: Typical architecture using non-Ethernet-based time protocols for product time-synchronization

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (3/11)

Non-Ethernet-Based Time Protocols (serial) (cont.)

IMPLEMENTATION (cont.)

Cabling Specifications Which Impact System Architecture

Depending on the non-Ethernet protocol used, the maximum permissible number of synchronized connected products, the maximum cabling distance and the type of cables used differ, as summarized in the table below.

Non-Ethernet-Based Time-Synchronization Protocol		Maximum Number of Devices	Maximum Distance	Recommended Cable	Cable Specifications
IRIG-B	Unmodulated (24 V DCLS)	8	600 m (2000 ft.)	Belden 8770 (or equiv.)	Shielded, 3-conductor cable, copper, #18AWG, 300 V rms
	Unmodulated (5 V DCLS)	4	300 m (1000 ft.)	Belden 8760 (or equiv.)	Shielded, twisted-pair cable, copper, #18AWG, 300 V rms
	Modulated	4	1200 m (4000 ft.)	Belden 8760 (or equiv.)	Shielded, twisted-pair cable, copper, #18AWG, 300 V rms
DCF77		16	1200 m (4000 ft.)	Belden 8760 (or equiv.)	Shielded, twisted-pair cable, copper, #18AWG, 300 V rms
1per10		16	600 m (2000 ft.)	Belden 8760 (or equiv.)	Shielded, twisted-pair cable, copper, #18AWG, 300 V rms

Table 6: Cabling recommendations for non-Ethernet-based time-synchronization protocols

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (4/11)

Non-Ethernet-Based Time Protocols (serial) (cont.)

EXAMPLE OF DIGITAL ARCHITECTURE

Below is an example of a digital architecture that implements time-synchronization using several non-Ethernet-based communication protocols:

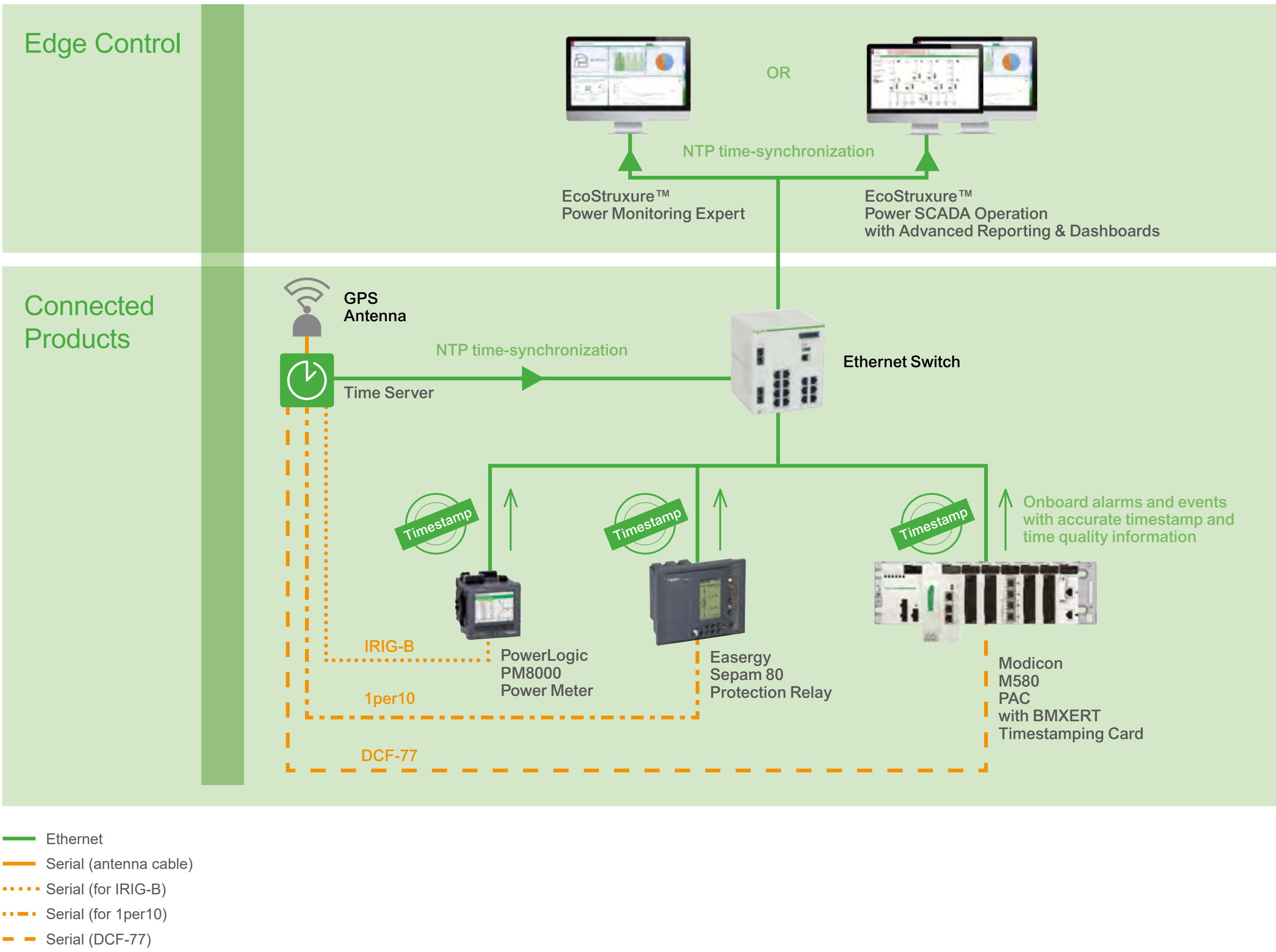

Figure 5: Example of an architecture that implements time-synchronization via IRIG-B, DCF77 and 1per10 time protocols, using a GPS antenna

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (5/11)

Network Time Protocol (NTP)
Simple Network Time Protocol (SNTP)

PRESENTATION

Network Time Protocol (NTP) is a highly robust protocol, widely deployed throughout the Internet. Well tested over the years, it is generally regarded as state-of-the-art in distributed time-synchronization protocols for unreliable networks.

A simplified version of the NTP protocol, SNTP, can also be used as a pure single-shot stateless master-slave synchronization protocol. Both full NTP and SNTP rely on the same architecture and use the same data packet from a time server message.

The only difference is that SNTP does not include all the sophisticated algorithms used by NTP to correct and adjust time accuracy.
As a result the accuracy will be limited to a 1 s range while full NTP implementation can lead to 10/100 ms accuracy.

IMPLEMENTATION

Main Components Involved

1 **GPS antenna (optional)**
- This component is mounted on the roof or other external location, allowing line-of-sight access to multiple satellites
- It retrieves absolute time over one or (ideally) various GNSS systems, such as GPS (US), Galileo (Europe), Beidou (China), etc.

2 **NTP server**
- Synchronizes all client clocks connected to its own clock.

3 **NTP client**
- Can be any connected product supporting time-synchronization through NTP. Specific algorithms (e.g. Clock filter, clock select.) are implemented in the product in order to match full NTP implementation requirements and achieve the highest level of accuracy.

TYPICAL CHARACTERISTICS

Time-Synchronization Source
- NTP Time server

Accuracy
- +/-10 ms to +/-100 ms depending on product level of support
- +/-1 s for SNTP

Required Hardware
- NTP time server

Device Compatibility
- NTP support or at minimum SNTP is widespread among power products

Limitations
- Not suitable for critical applications

Typical Architecture

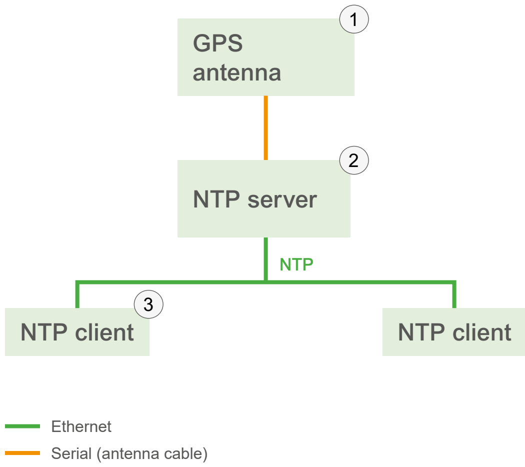

Figure 6: Typical architecture using NTP for product time-synchronization

Comment 1:
This architecture also applies to synchronization using the SNTP protocol.

Comment 2:
The architecture above is a simplified version of the NTP architecture. Complex systems may involve several layers of NTP servers (called stratum). In this case, several communication mechanisms are used to ensure proper time-synchronization between servers:
- Master / Client
- Peer-to-peer
- Broadcast.

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (6/11)

Network Time Protocol (NTP) Simple Network Time Protocol (SNTP) (cont.)

EXAMPLE OF DIGITAL ARCHITECTURE

Below is an example of a digital architecture that implements time-synchronization with NTP/SNTP communication protocols:

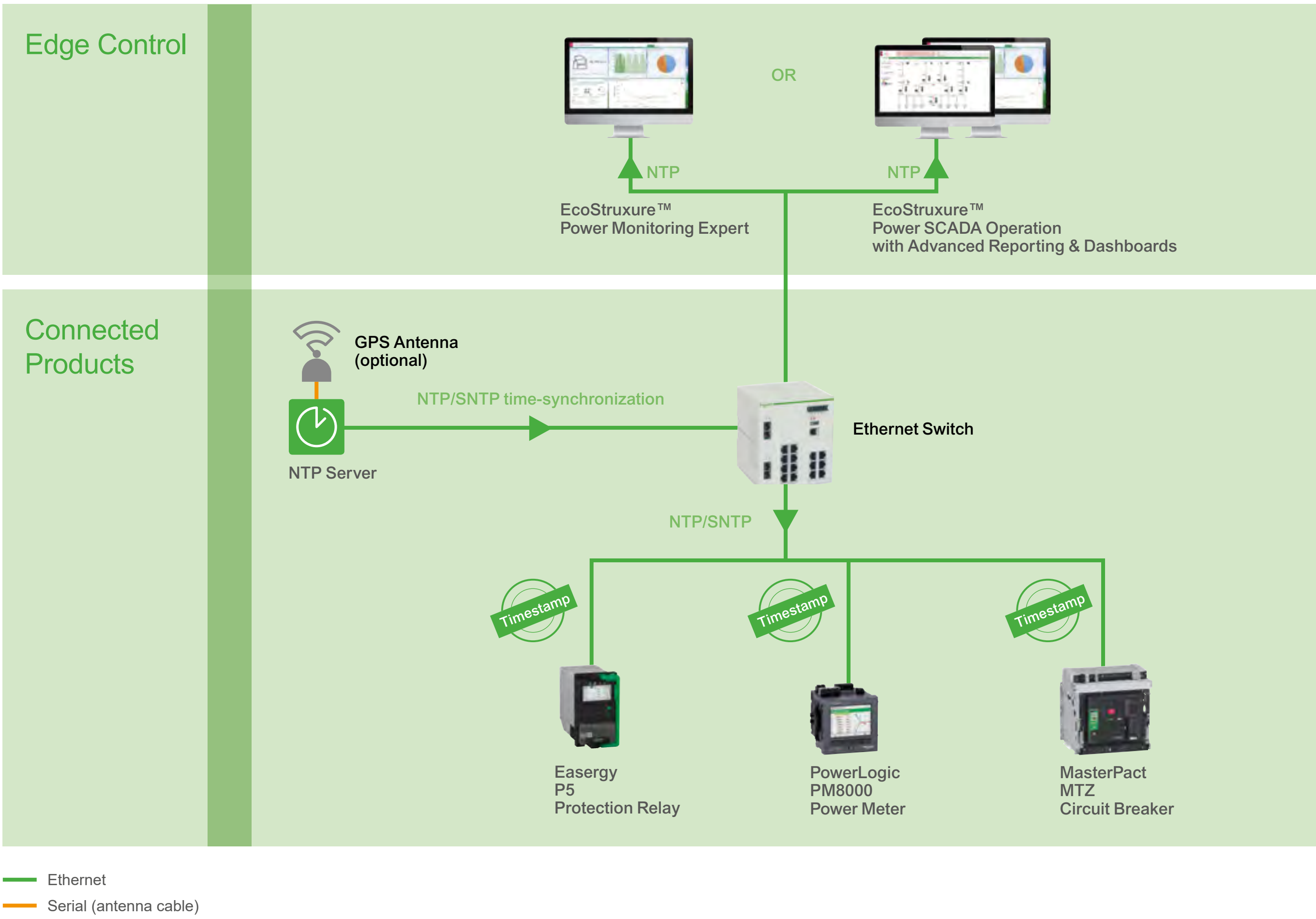

Figure 7: Example of an architecture that implements time-synchronization via Simple NTP/SNTP and optional GPS antenna

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (7/11)

Precision Time Protocol (PTP) / IEEE 1588

PRESENTATION

PTP was designed to respond to the weaknesses of NTP and to give better accuracies than those attainable with NTP. It has also been designed for applications that cannot support the cost of a GPS receiver on each connected product, or for which GPS signals are inaccessible, and in particular for measurement and control systems.

Refer to the "Time-synchronization and Protection and Control" white paper by Henri Grasset

In addition to PTP system-related settings, the accuracy of your product's clock also depends on the physical network configuration. A star network topology is highly recommended in order to achieve the level of clock precision specified.

IMPLEMENTATION

Main Components Involved

① GPS antenna (optional)

- This component is mounted on the roof or other external location, allowing line-of-sight access to multiple satellites
- It retrieves absolute time over one or (ideally) various GNSS systems, such as GPS (US), Galileo (Europe), Beidou (China).

② IEEE 1588 grandmaster clock

- The Grandmaster clock can provide precise nanosecond timestamp resolution and accuracy better than 30 nanoseconds referenced to GPS.

③ IEEE 1588 transparent clock

- A transparent clock is an Ethernet switch that handles IEEE-1588 packets differently compared to a standard switch. The transparent clock measures the time that the packet is stored in the switch. It then adds the measured time into the correction field of the follow-up message. To account for the packet delay, the slave clock uses the origin timestamp and the correction field.

④ IEEE 1588 boundary clock

- A boundary clock is an Ethernet switch that handles IEEE-1588 packets differently compared to a standard switch or transparent switch. The subnets to a network must isolate PTP packets when installing a boundary clock. The boundary clock acts much like an ordinary clock on the network and becomes the master clock on the isolated subnets.

⑤ IEEE 1588 slave clocks (connected products)

- Any product supporting time-synchronization through PTP protocol.

TYPICAL CHARACTERISTICS

Time-Synchronization Source
- PTP Master Clock

Accuracy
- +/-1 ms for "Simple" PTP
- Better than +/-1 ms for standard PTP profiles

Required Hardware
- IEEE 1588 compliant Master clocks
- IEEE 1588 compliant Ethernet switches (boundary and/or transparent clocks)

Device Compatibility
- Easergy T300
- High-end power meters (PowerLogic ION9000, PM8000)

Limitations
- Few connected products currently support PTP / IEEE1588

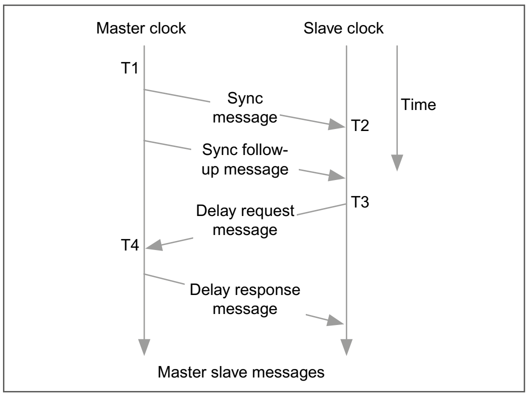

Figure 8: PTP timestamps

Typical Architecture

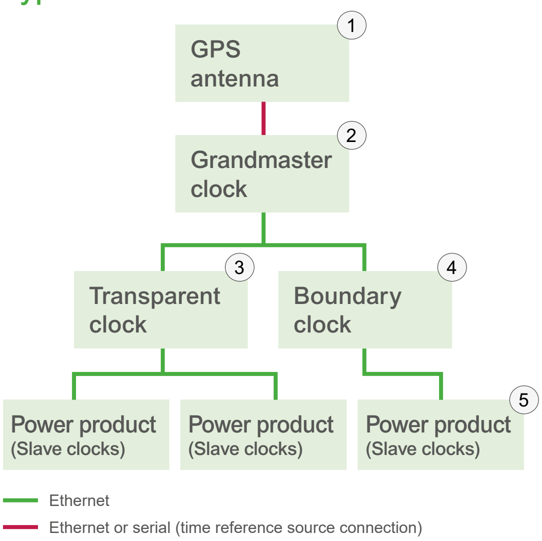

Figure 9: Typical architecture using PTP for product time-synchronization

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (8/11)

1 2 3 4 5 6

Precision Time Protocol (PTP) / IEEE 1588 (cont.)

IMPLEMENTATION (cont.)

The PTP Grandmaster Clock may use any convenient time source: GPS, IRIG-B, DCF77, NTP or Modbus TCP. If the requirement is simply to ensure that all products are synchronized with respect to one another (and not necessarily to GPS time), the PTP Master Clock may even accept periodic updates from EcoStruxure™ Power Monitoring Expert or Power SCADA Operation using Modbus TCP. A GPS antenna or receiver is optional. However, most systems benefit from having all clocks synchronized with high-accuracy to a reference time source traceable to a known standard, such as GPS.

PTP Profiles

The IEEE 1588 standard defines several implementation options for PTP as shown in table below.

Specific profiles have been defined, for example the "power profile" as per IEEE C37.238-2011. This profile allows time accuracy up to 1 µs and is especially best suited for electric utility substation automation.

PTP Options	Possible Values	Power Profile (IEEE C37.238-2011)	Simple PTP Profile
Target accuracy	<1µs	1µs	0,1 ms
Required clock types	Master Transparent Boundary Slave	Master Transparent Slave	Master Slave (no PTP compliant switch required)
Communications Model	Multicast Unicast	Multicast	Multicast
Network Transport Protocol	802.3 UDP/IPv4 UDP/IPv6	802.3	UDP/IPv4
Path Delay Mechanism	Peer-to-Peer (P2P) End-to-End (E2E)	Peer-to-Peer (P2P) only	E2E only
Operating Mode	1-step 2-step	1-step or 2-step	2-step
Delay requests frequency	Variable delay requests	Variable delay requests (typically 1 s)	32 seconds
Network tags	None Optional Required	TLV, MIB, VLAN tags required	None

Table 7: PTP options / Simple PTP definition

Selecting a PTP Profile for EcoStruxure™ Applications

For the purpose of this paper and considering EcoStruxure™ Power system constraints, we recommend considering a "**Simple PTP Profile**" as defined in the table above which is typically "just right" for commercial/industrial power system applications (including data centers, hospitals and microgrids).

Starting with an accuracy goal of 1 ms, many simplifications are possible. The most significant of which is to take advantage of the same Ethernet network infrastructure used for power monitoring, without requiring special IEEE1588 / PTP compliant Ethernet switches (transparent or boundary clocks).

Eliminating this requirement greatly reduces cost and simplifies the system hierarchy to a single grandmaster and slave-only clocks.

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (9/11)

Precision Time Protocol (PTP) / IEEE 1588 (cont.)

EXAMPLE OF DIGITAL ARCHITECTURE

Below is an example of a digital architecture that implements time-synchronization with the simple PTP communication protocol:

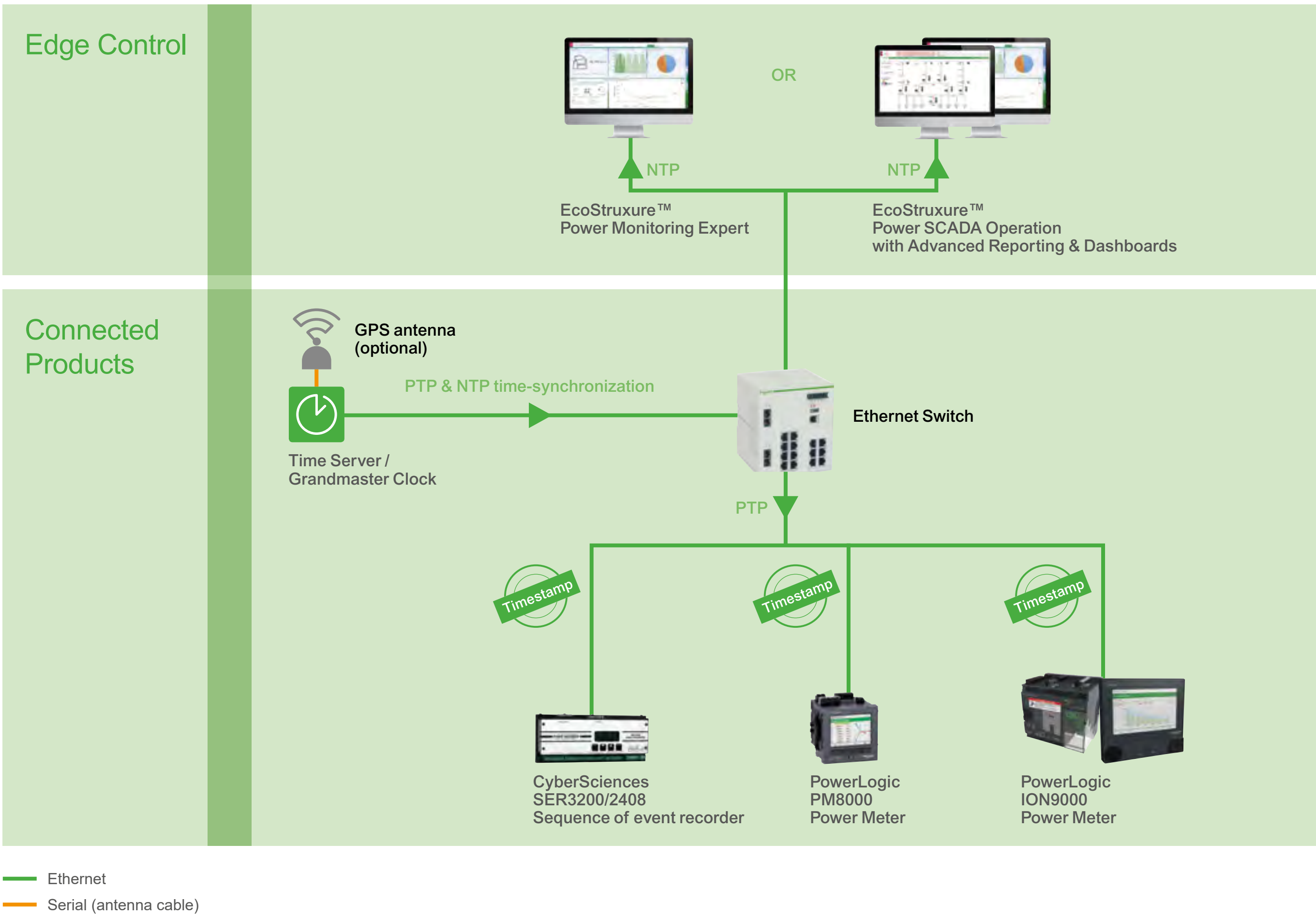

Figure 10: Example of an architecture that implements time-synchronization via Simple PTP

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (10/11)

Modbus or ION Communication Protocols

PRESENTATION

This is the most common method of time-synchronization in use today. It is the easiest and least expensive to deploy. However, the limitation of this method is the achievable time accuracy of +/-1 s. Often, the resulting accuracy is better than this, but realistically, +/-1 s is the commonly accepted limit.

Synchronization through Modbus protocol leverages the existing network architecture used for communication over Modbus. The Modbus Master, typically the Edge Control software, will periodically send a command to update the date and time registers of all Modbus slaves that it is connected to. These products may have such registers available for Read and Write through communication to enable this time-synchronization method.

This principle and the architecture defined below may also apply when the ION protocol is used for communication (for example between EcoStruxure™ Power Monitoring Expert and Powerlogic ION9000 or PM8000 high-end meters).

TYPICAL CHARACTERISTICS

Time-Synchronization Source
- Edge Control software

Accuracy
- +/-1 s

Required Hardware
- No specific additional hardware required

Device Compatibility
- Any Modbus communicating connected product

Limitations
- Achievable time criticality is low, not suitable for high and medium needs

IMPLEMENTATION

Main Components Involved

(1) Modbus master
- Typically, the Edge Control software / SCADA will take this role. The Modbus Master will send a time set command periodically to synchronize the downstream slave products.

(2) Modbus TCP to RTU gateway
- As communication over Ethernet (through Modbus TCP) is required by Edge Control software, such products are needed to aggregate Modbus slaves that only support communication over RS485 serial line (Modbus RTU).

(3) Modbus TCP slave
- Any product that communicates with the Modbus Master and whose clock will be set by the master through Modbus TCP protocol.

(4) Modbus serial slave
- Any product that communicates with the Modbus Master and whose clock will be set by the master through Modbus RTU protocol, via a gateway.

Typical Architecture

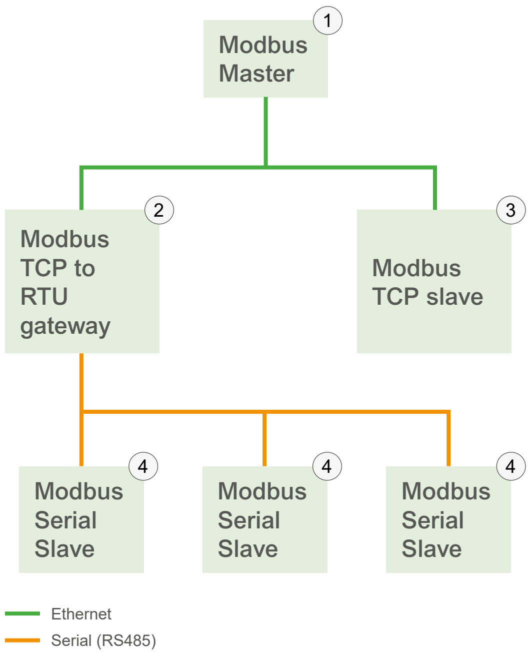

Figure 11: Typical architecture using Modbus communication protocol for product time-synchronization

1 2 3 4 5 6

Solution 1: Timestamping and Data Recording Using Time-Synchronized Connected Products (11/11)

Modbus or ION Communication Protocols (cont.)

EXAMPLE OF DIGITAL ARCHITECTURE

Below is an example of a digital architecture that implements time-synchronization with Modbus/ION communication protocols:

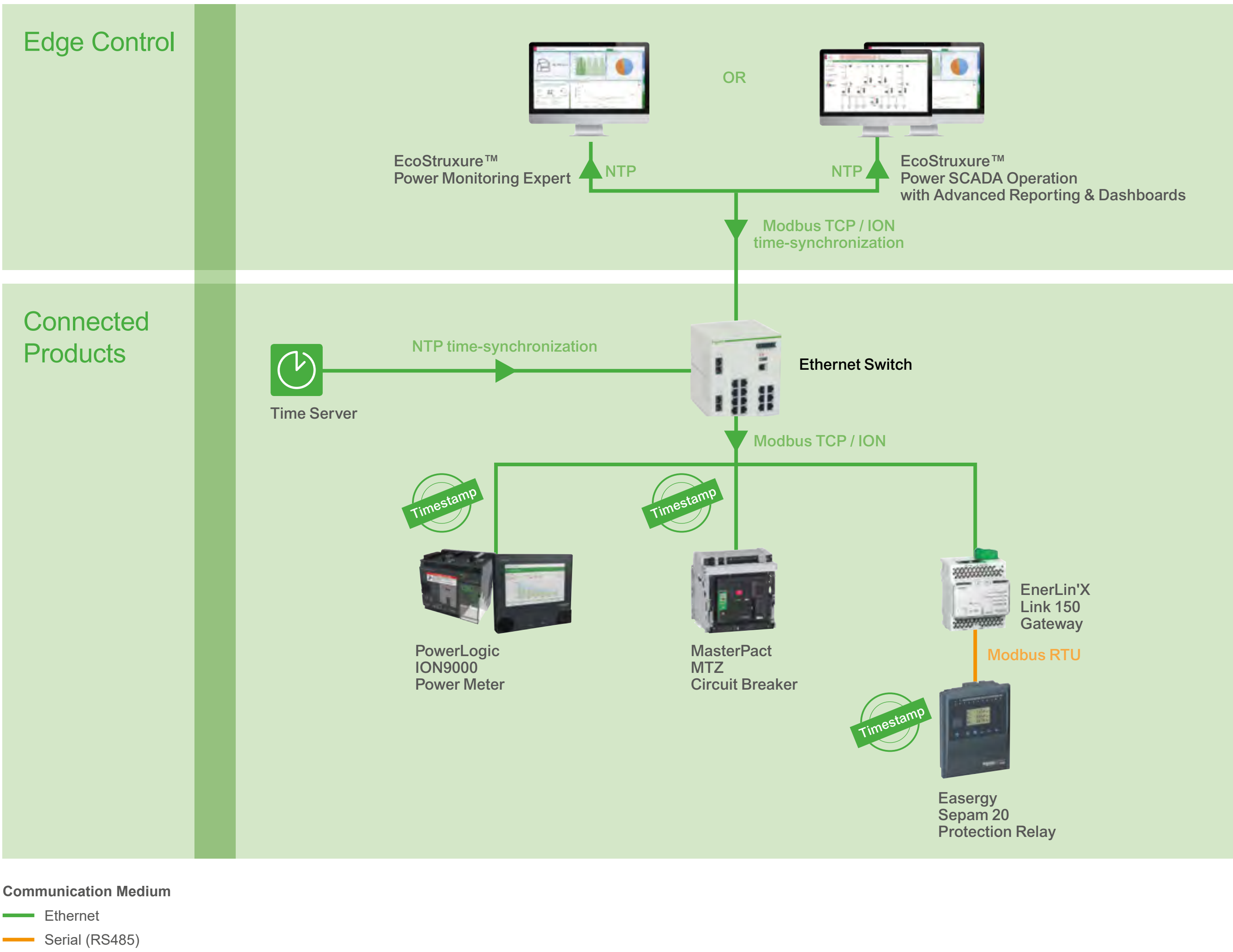

Figure 12: Example of an architecture that implements time-synchronization via Modbus / ION

Solution 2: Timestamping and Data Recording Using the Edge Control

PC Logging from Edge Control

PRESENTATION

When field devices do not support onboard event or data logging, an option to consider is to have the Edge Control software log and timestamp the data. This methodology is often referred to as PC logging. It is less accurate than field device onboard data logging (accuracy can be >10 s) but can provide sufficient performance for less demanding applications.

EXAMPLE OF DIGITAL ARCHITECTURE

Below is an example of a digital architecture implementing timestamping by Edge Control:

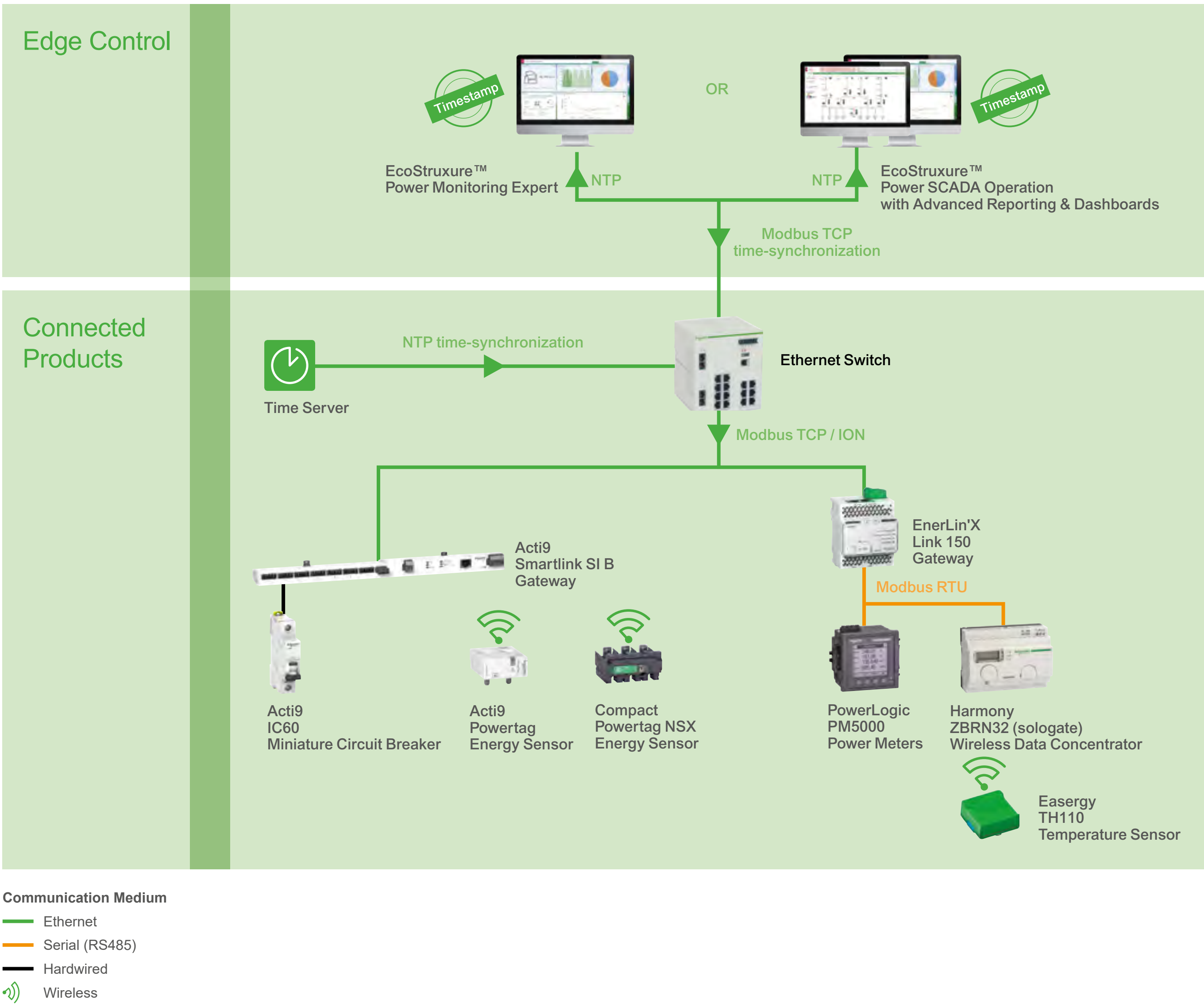

Figure 13: Example of an architecture that implements PC logging

Solution 3: Timestamping and Data Recording Using an External Time-Synchronized Product (1/5)

Presentation of the Problem

For critical applications, a high time accuracy (down to 1 ms) is required.

However, as shown in Table 5, p. 21, some products do not support accurate enough time-synchronization (not better than 1 second accuracy) for critical applications.

Typical examples are:
- LV and MV circuit breaker status changes
- Automatic Transfer Switch (ATS) status changes
- Control scheme status changes
- UPS status changes
- Generator status changes.

In the above examples, highly accurate data recording and timestamping is required for Power Event Analysis applications.

How can we sufficiently improve the timestamp accuracy of these status changes?

Technical Options

In order to log such status changes with high time accuracy, these statuses must be hardwired to products having the capabilities to:
- Log status changes / events
- Be synchronized through a highly accurate protocol (ideally Ethernet-based such as PTP).

On the following pages, we will detail three technical options which meet these requirements:
- Using PowerLogic ION9000/PM8000 Powermeter's digital Input Channels
- Using Modicon M580 PAC*'s digital Input Channels
- Using a 3rd party sequence of event recorder (SER-3200 or SER-2408).

This will improve the time accuracy of the recorded data to that of the advanced data recording product.

Device Type	Statuses to Be Monitored with Accurate Timestamp	Number of Digital Inputs per Product
MV circuit breaker (withdrawable)	OPEN CLOSED TRIPPED CONNECTED (CE) DISCONNECTED (CD) TEST BREAKER CONTROL	7
MV circuit breaker (non withdrawable)	OPEN CLOSED TRIPPED TEST BREAKER CONTROL	5
LV circuit breaker (withdrawable)	OPEN CLOSED TRIPPED CONNECTED (CE) DISCONNECTED (CD) TEST	6
LV circuit breaker (non withdrawable)	OPEN CLOSED TRIPPED	3
Automatic Transfer Switch (ATS)	NORMAL EMERGENCY TEST	3
Control scheme	AUTO MANUAL TEST	3
UPS	NORMAL BYPASS	2
Generator	STARTING RUNNING STOPPED	3

Table 8: Product statuses to be monitored with accurate timestamp

* PAC stands for Programmable Automation Controller

Solution 3: Timestamping and Data Recording Using an External Time-Synchronized Product (2/5)

Using PowerLogic ION9000/PM8000 Powermeter's Digital Input Channels

PRESENTATION

PowerLogic ION9000 and PM8000 are accurately synchronized with IRIG-B, NTP, or PTP. They both have integrated and optional I/O capabilities to retrieve other product statuses:

- PowerLogic ION9000:
  - 8 digital inputs (embedded)
  - + 6 digital inputs per optional module (max. 4 modules).
- PowerLogic PM8000:
  - 3 digital inputs (embedded)
  - + 6 digital inputs per optional module (max. 4 modules).

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EXAMPLE OF DIGITAL ARCHITECTURE

The diagram below displays the setup needed to retrieve Masterpact NT/NW withdrawable circuit breaker statuses using a PowerLogic advanced power meter, time synchronized with IRIG-B protocol. Events and alarms from the circuit breaker will be identified as onboard alarms generated by the advanced meter.

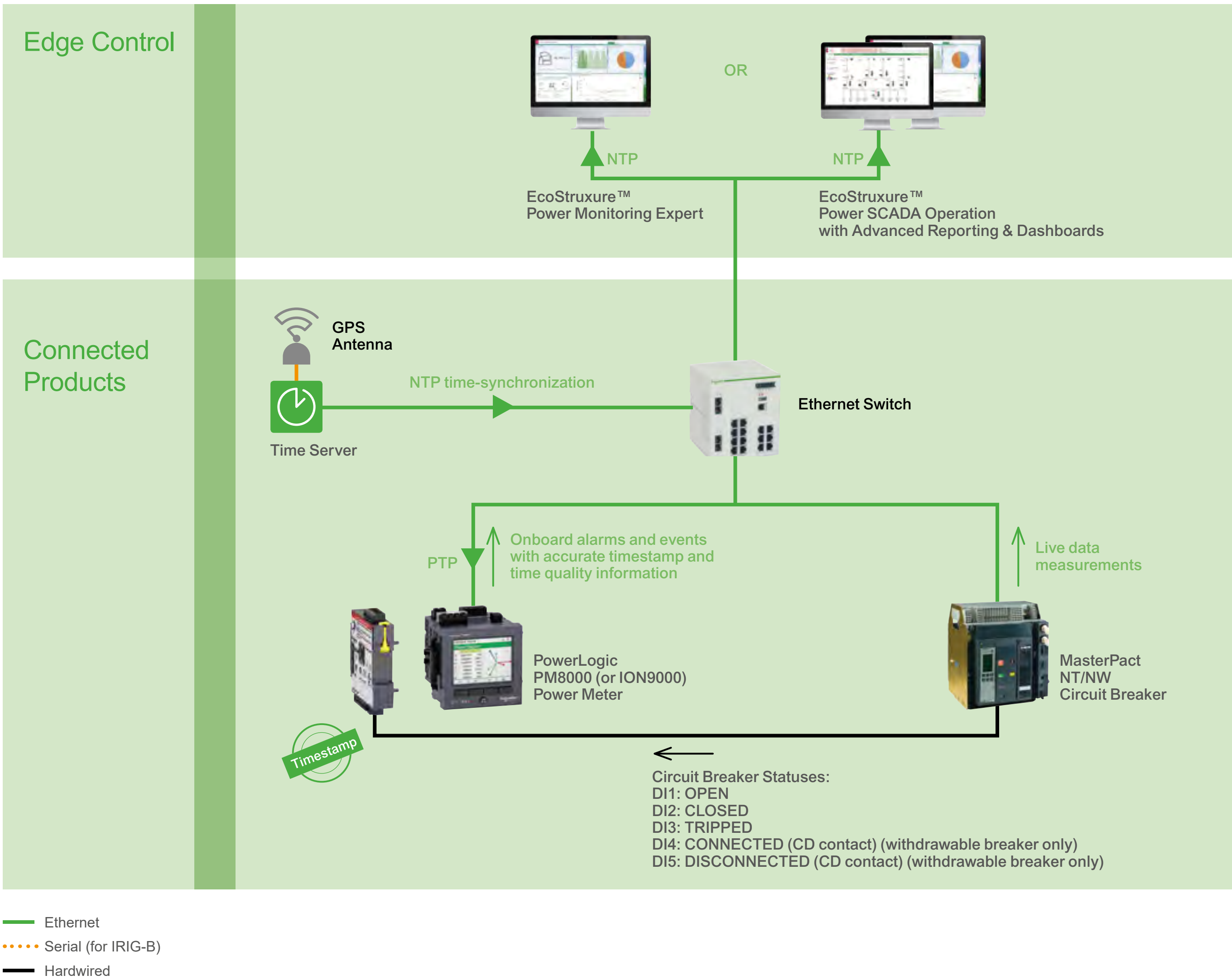

Figure 14: Example of an architecture that implements timestamping and data recording using PowerLogic PM8000 (ION9000) powermeter's digital input channels

Solution 3: Timestamping and Data Recording Using an External Time-Synchronized Product (3/5)

Using Modicon M580 PAC's* Timestamping Module

PRESENTATION

Timestamping and Synchronization

In the power system, protection products may not communicate directly with the supervision system; instead they may communicate through a PLC* or PAC*.

This architecture can be used to improve the response time to get data displayed in the supervision system. Indeed, instead of sending queries to multiple products, the supervision system sends one query to the PLC* to retrieve data from all the products connected to it.

Standalone PLCs* or Hot-Standby PAC* (Modicon M580 or legacy Quantum) can be used to log events. A time resolution of 1 ms can be reached using a Modicon BMXERT digital input module supporting highly accurate timestamping. The IRIG-B 004/5/6/7 or DCF77 signals generated by a GPS receiver are used to synchronize the BMXERT module's time clock.

In addition, an external NTP server may be used to provide the time clock for the PLC / PAC* CPUs. In a Modicon M580 distributed architecture, the M580 CPU can act as an NTP server to synchronize its I/O drops module's time clock.

Edge Control Connectivity

Edge Control software will retrieve timestamped events and alarms through OPC (Open Platform Communications). One advantage of this methodology is that it does not require any specific programming on the PAC*, just configuration (using OPC Factory Server OFS). This implementation also enables direct communication between the timestamping modules (BMXERT) and the Edge Control software; as a result, the available communication bandwidth in the PAC* is preserved.

For more information about how to retrieve timestamped data from EcoStruxure™ Power SCADA Operation using OFS, please consult the Power SCADA Operation system guide:

EcoStruxure™ Power SCADA Operation 9.0
with Advanced Reporting & Dashboards

System Guide
Ref: PowerSCADAOperationSystemGuide
7EN02-0413-00
09/2018

https://www.se.com/en/download/document/PowerSCADAOperationSystemGuide/

* PLC stands for Programmable Logic Controller
PAC stands for Programmable Automation Controller

Solution 3: Timestamping and Data Recording Using an External Time-Synchronized Product (4/5)

Using Modicon M580 PAC's* Timestamping Module (cont.)

EXAMPLE OF DIGITAL ARCHITECTURE

The diagram below displays the setup needed to retrieve MasterPact NT/NW withdrawable circuit breaker statuses using a Modicon M580 PAC timestamping module, time synchronized with IRIG-B protocol. Events and alarms from the circuit breaker will be identified as onboard alarms.

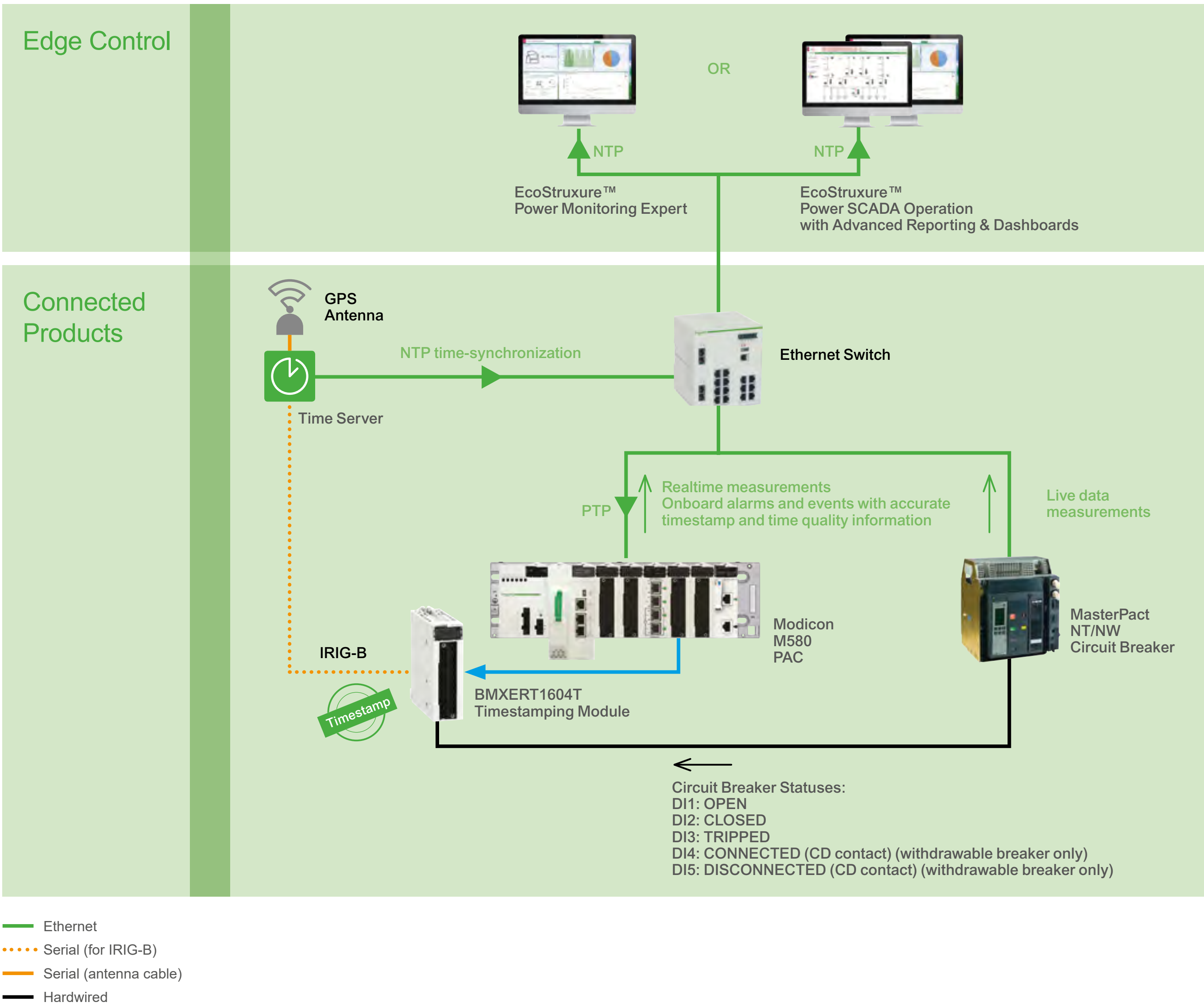

Figure 15: Example of an architecture that implements timestamping and data recording using Modicon M580 PAC's timestamping module

* Programmable Automation Controller

Solution 3: Timestamping and Data Recording Using an External Time-Synchronized Product (5/5)

Using a 3rd Party Sequence of Event Recorder (Cyber Sciences™ SER-3200 or SER-2408)

PRESENTATION

The Cyber Sciences™ company manufactures Sequence of Events Recorders. They provide precise timestamped event reporting for up to 32 channels to enable root-cause analysis and advanced system diagnostics.

The Sequence of Events Recorders themselves are accurately synchronized with IRIG-B, DCF77, or PTP.

The I/O configuration for the 32 channels varies by model:

- SER-3200—32 high-speed digital inputs
- SER-2408—24 high-speed digital inputs and 8 control relay outputs.

These products are natively supported in EcoStruxure™ Power Monitoring Expert (PME 8.2 and onwards) and Power SCADA Operation (PSE 7.40 and onwards).

EXAMPLE OF DIGITAL ARCHITECTURE

The diagram below displays the setup to retrieve Masterpact NT/NW circuit breaker statuses using a Cyber Sciences™ sequence of event recorder, time synchronized with IRIG-B protocol. Events and alarms from the circuit breaker will be identified as onboard alarms in the sequence of events recorder:

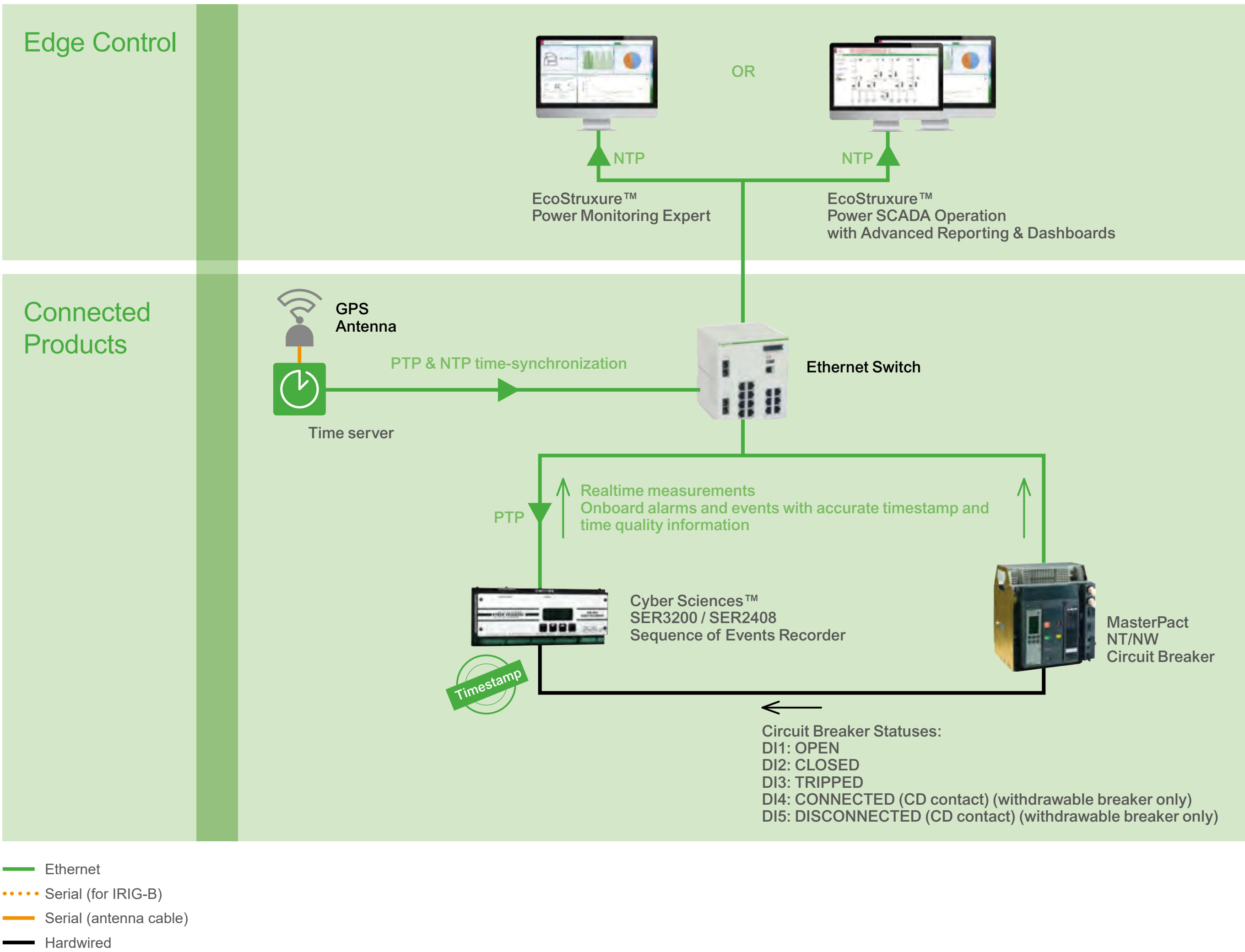

Figure 16: Example of an architecture that implements timestamping and data recording using Cyber Sciences™ SER-3200 or SER-2408 sequence of event module

SECTION 4

Application Examples

Introduction

Why Read this Section?

The general principles and main technologies for timestamping and time-synchronization have been presented in previous sections.

The aim of **Section 4** is to provide concrete examples of how to implement an adapted timestamping solution, depending on the application's time criticality level.

Contents of this Section

This section will follow the methodology presented in this document's introduction (p. 6).

We:

- Define a generic electrical installation for our study,
- Select three case study applications from amongst the applicable EcoStruxure™ Power Applications.

For each case study application, we:

- Define the data to be retrieved and associated connected products specific for the application;
- Deduce the appropriate timestamping and time-synchronization solution(s), depending on the time criticality of each application;
- suggest associated timestamping and time-synchronization architecture(s).

Defining the Electrical Installation and Selecting the Digital Applications (1/8)

Definition of the Electrical Distribution Architecture

The first step of the methodology is to define the electrical installation of the building.

For the purpose of this section, below is a diagram which defines a generic electrical installation on which we will illustrate the various implementation scenarios of data timestamping and time-synchronization:

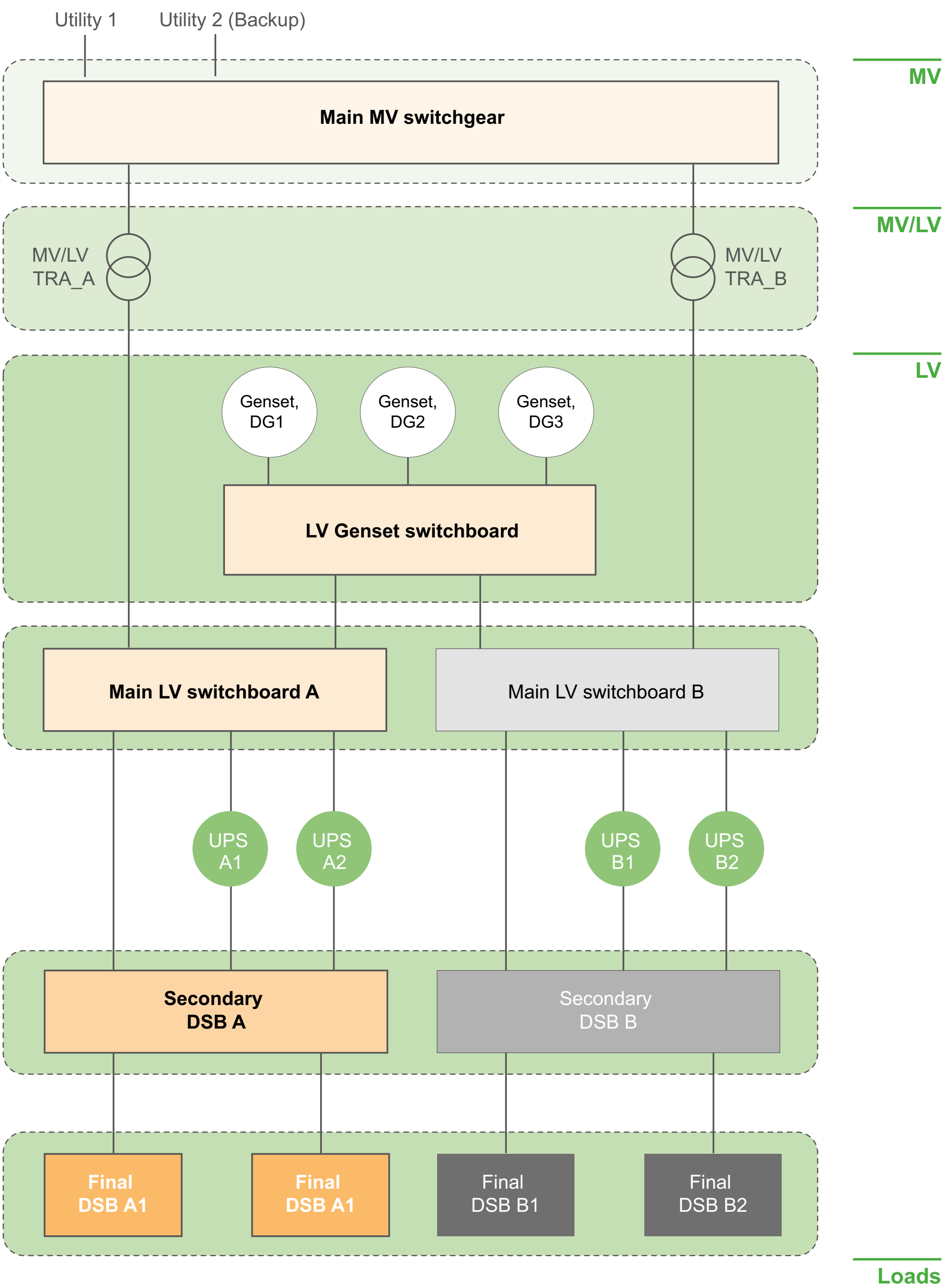

Figure 17: Generic electrical architecture

Each orange box will be further detailed in the following pages, both in terms of single line diagram and digital architecture.

Defining the Electrical Installation and Selecting the Digital Applications (2/8)

Selecting the Applications

APPLICABLE ECOSTRUXURE™ POWER APPLICATIONS

Once the electrical architecture has been defined, we must select the EcoStruxure™ Power digital applications to embed, in order to meet the requirements of the building/facility.

The list of applications can be found in Table 2 p.13 in Section 1. Further information about the applications' purpose is available in Section 1 of EcoStruxure™ Power Digital Application Design Guide.

SELECTED APPLICATIONS FOR OUR STUDY

To illustrate the various needs for time accuracy and their implementation in the electrical distribution system, let's select some applications, representative for various time criticality levels:

- **High Time Criticality:** Power Event Analysis
- **Medium Time Criticality**: Electrical Distribution Monitoring & Alarming
- **Low Time Criticality:** Cost Allocation.

Digital Applications for Large Buildings and Critical Facilities
IEC EcoStruxure™ Power Design Guide
Ref: ESXP2G001EN
12/2019

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Defining the Electrical Installation and Selecting the Digital Applications (3/8)

Selecting the Connected Products

DISTRIBUTION BY APPLICATION

After the EcoStruxure™ Power digital applications have been selected, the next step is to select the products to connect (either already embedded or to be added) to implement each application.

With the help of the implementation section (Section 3) of the EcoStruxure™ Power Digital Application Design Guide, we can define the key switchboards which will be part of the implementation of the above-listed applications:

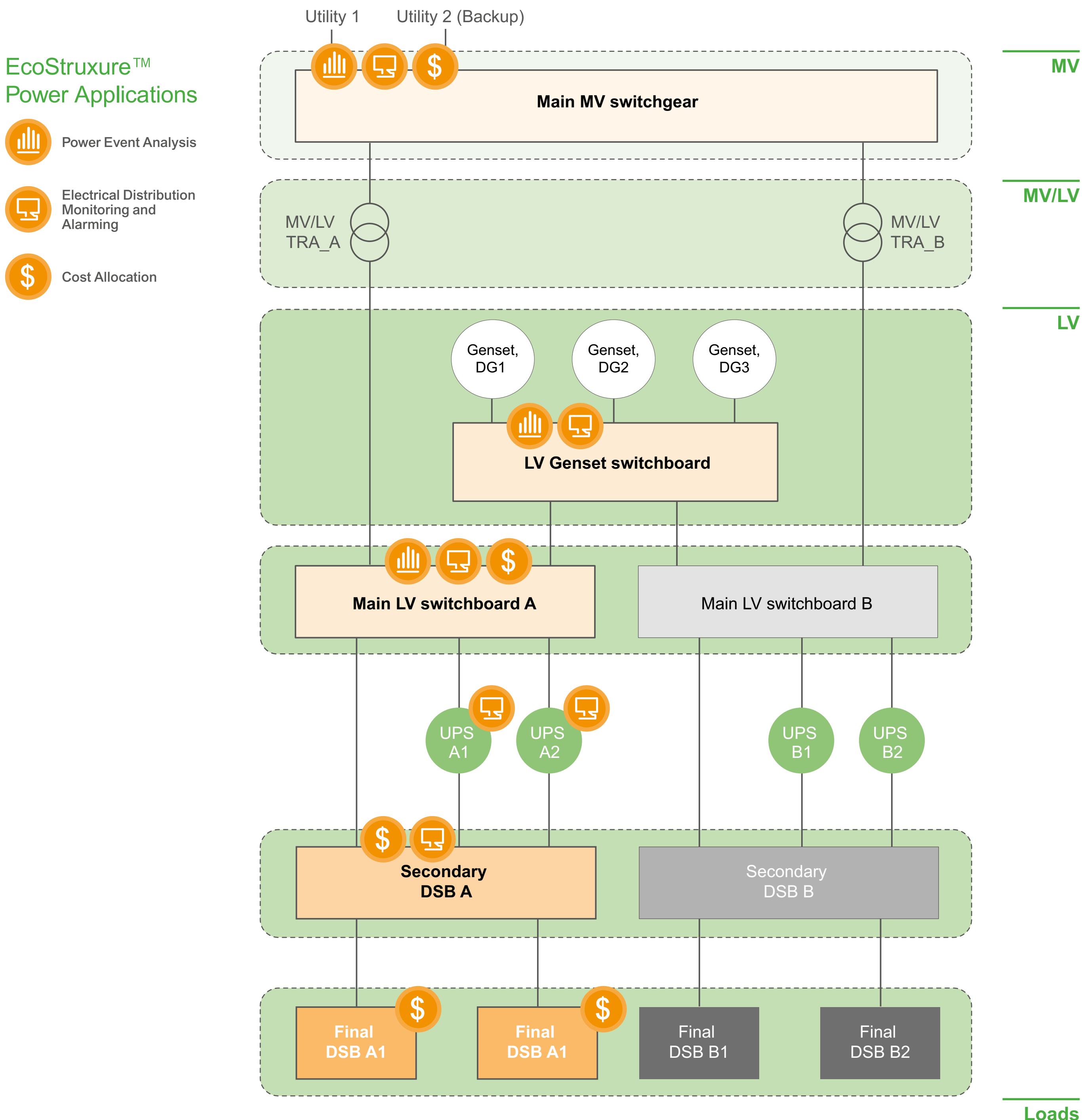


Figure 18: Equipment implementation for the three digital applications selected

In the following pages, we will detail the switchboards (orange boxes) of the electrical installation, in terms of electrical and digital architectures. For simplicity's sake, the diagrams will integrate the connected products used for the three selected applications.

Defining the Electrical Installation and Selecting the Digital Applications (4/8)

Selecting the Connected Products (cont.)

DETAILED VIEW OF MAIN MV SWITCHGEAR

We focus here on the MV switchgear of our predefined generic electrical distribution architecture.

Electrical Architecture

The diagram below details the MV distribution switchboard's single line diagrams.
This MV switchgear includes the following equipment:

- Two utility incomers with one automatic transfer system (managed with Easergy T300)
- One main MV incomer circuit breaker (with Easergy P3 protection relay) equipped with one incoming advanced power quality meter (ION9000)
- Two feeder circuit breakers (with Easergy P3 protection relays).

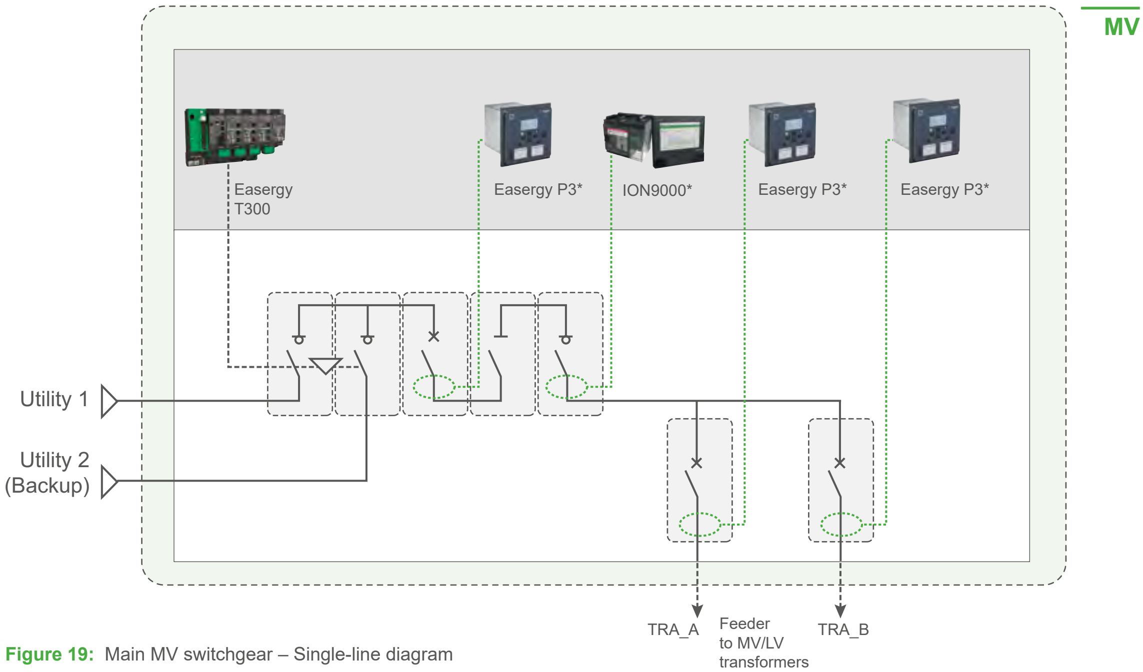


Figure 19: Main MV switchgear – Single-line diagram

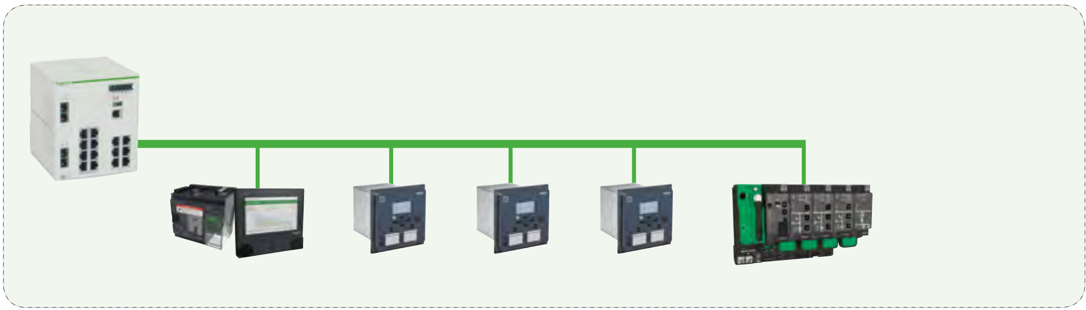
Defining the Electrical Installation and Selecting the Digital Applications (5/8)

Selecting the Connected Products (cont.)

DETAILED VIEW OF MAIN MV SWITCHGEAR (cont.)

Digital Architecture

The diagram below details the digital architecture of the main MV switchgear:



Ethernet – Technical LAN
Serial - RS485
Hardwired

Figure 20: Main MV switchgear – Digital architecture

Easergy
T300

Easergy
P3

Harmony
Sologate ZBRN32

PowerLogic
ION9000

Defining the Electrical Installation and Selecting the Digital Applications (6/8)

Selecting the Connected Products (cont.)

DETAILED VIEW OF MAIN, GENSET AND SECONDARY LV SWITCHBOARD

Electrical Architecture

The diagram below details the key LV distribution switchboard's single line diagrams:
- Main LV Switchboard
- LV Genset Switchboard
- LV Secondary Distribution Switchboard

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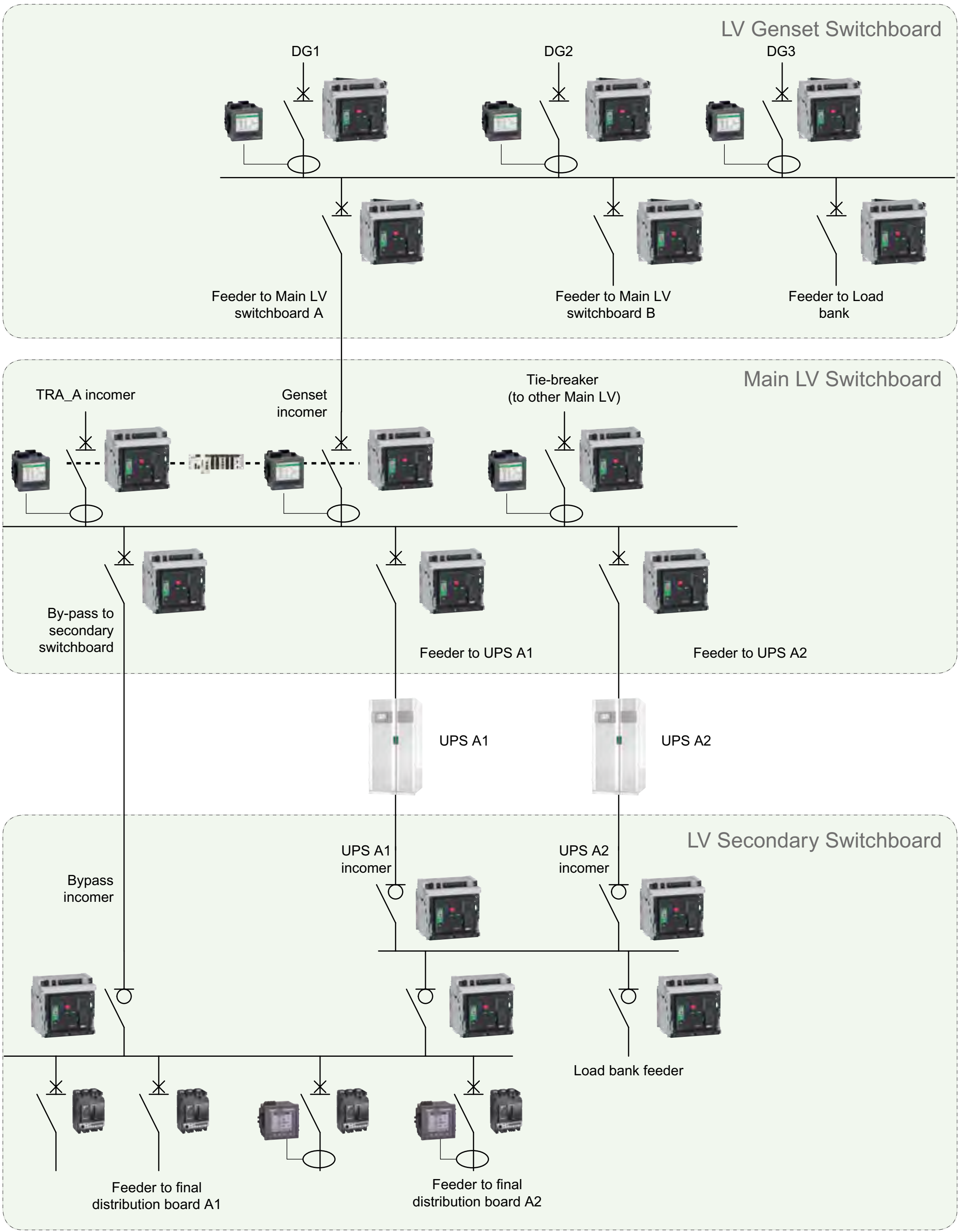


Figure 21: Main, genset and secondary switchboard – Single-line diagram

Defining the Electrical Installation and Selecting the Digital Applications (7/8)

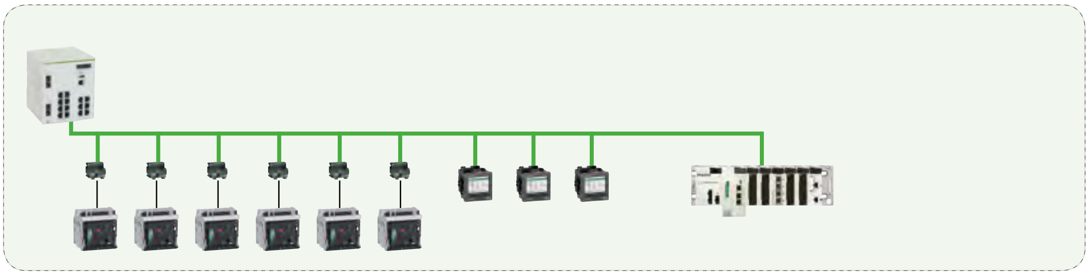
Selecting the Connected Products (cont.)

DETAILED VIEW OF MAIN, GENSET AND SECONDARY LV SWITCHBOARD (cont.)

Main LV Switchboard Digital Architecture

Typical functions of the main LV switchboard include:

- Large incomer circuit breakers and bus-tie (MasterPact MTZ) equipped with power quality meter (PowerLogic PM8000)
- Large feeder circuit breakers (MasterPact MTZ)
- Automatic Transfer System (based on PLC M340 / M580).



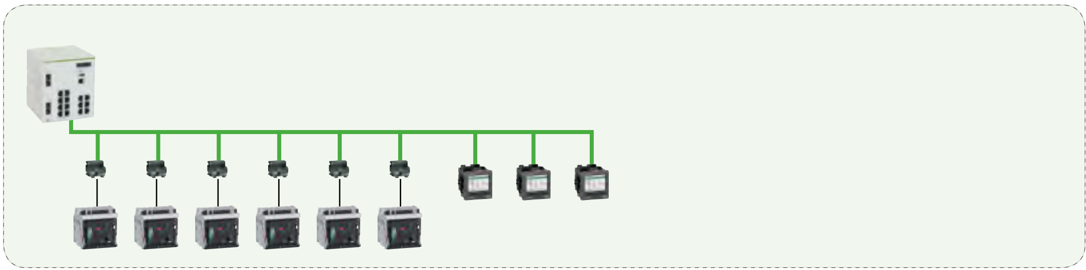
Ethernet – Technical LAN

Figure 22: Main LV switchboard – Digital architecture

LV Genset Switchboard Digital Architecture

Typical functions of the LV Genset switchboard include:

- Large Diesel Generator incomer circuit breakers (MasterPact MTZ) equipped with power quality meter (PowerLogic PM8000)
- Large feeder circuit breakers (MasterPact MTZ)



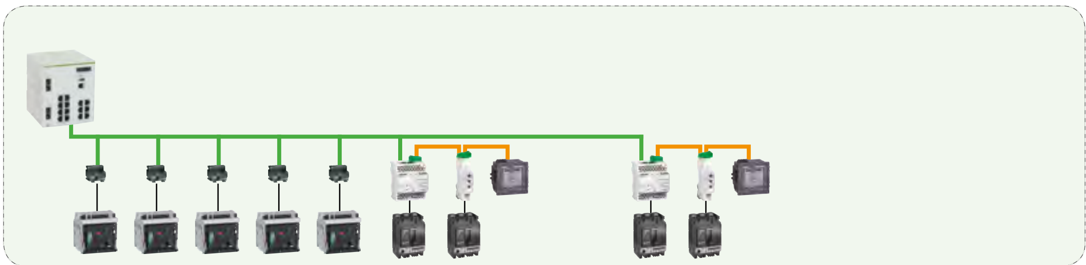
Ethernet – Technical LAN

Figure 23: LV Genset switchboard – Digital architecture

LV Secondary Switchboard Digital Architecture

Typical functions of the LV Genset switchboard include:

- Large incomer circuit breakers and switch disconnectors (MasterPact MTZ)
- Small feeder circuit breakers (ComPact NSX), equipped with basic power meters when critical load energy monitoring is required (PowerLogic PM5000).



Ethernet – Technical LAN

Serial - RS485

Figure 24: LV Secondary switchboard – Digital architecture

Masterpact MTZ with Micrologic X

ComPact NSX

PowerLogic PM8000

PowerLogic PM5000

Modicon M580

Connexium

Enerlin'X EIFE

Enerlin'X IFE gateway

Enerlin'X IFM

1 2 3 4 5 6

Defining the Electrical Installation and Selecting the Digital Applications (8/8)

Selecting the Connected Products (cont.)

DETAILED VIEW OF LV FINAL DISTRIBUTION PANELBOARD

Electrical Architecture

Typical functions of an LV final distribution panel board include:
- One incomer circuit breaker (ComPact NSX) with or without embedded metering capacity
- Feeders protected by miniature circuit breakers (Acti9)
- Basic energy metering per feeder (Acti9 iEM3000).

Other specific functions, such as insulation monitoring devices may be installed at this level of the architecture.

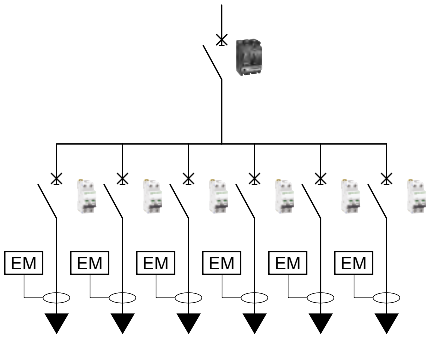


Figure 25: LV final distribution panelboard – Single-line diagram

ComPact NSX

Acti9 iC60 with zigBee I/O module

Acti9 IEM3000

Acti9 Powertag Link

PowerLogic PowerTag

PowerLogic PowerTag NSX

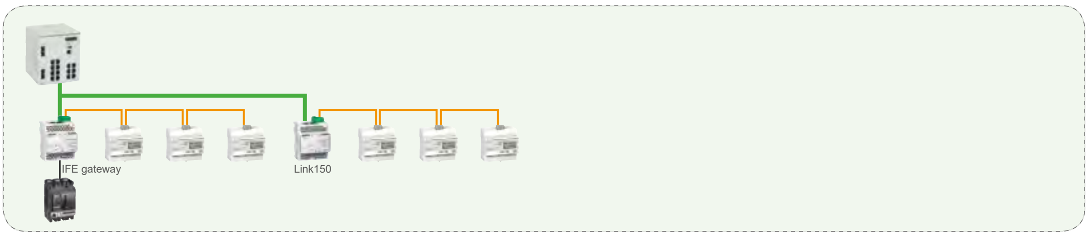
Enerlin'X IFE gateway

Enerlin'X Link150

Connexium

Digital Architecture

Energy data for the Cost Allocation application can be obtained either through wired or wireless devices; the respective digital architectures for these two categories are shown hereafter.



Ethernet – Technical LAN
Serial - RS485

Figure 26: LV final distribution panelboard with wired energy metering – Digital architecture

Ethernet – Technical LAN
Wireless

Figure 27: LV final distribution panelboard with wireless energy metering - Digital architecture

Defining the Time Criticality of the Electrical Distribution System

Time Criticality of the Selected Applications

The choice of solution for timestamping the data depends on the recommended time accuracy illustrated by the time criticality of each application.

The table below, which defines the time criticality of our selected applications, is an extract of Table 2, p. 13:

Applications	Time Criticality	Recommended Time Accuracy [+/-]	Minimum Required Time Accuracy [+/-]
Power Events Analysis	High	1 ms	100 ms
Electrical Distribution Monitoring & Alarming	Medium	10 ms	1 s
Cost Allocation	Low	1 s	10 s

Table 9: Recommended time accuracy for the selected applications (extract of Table 2)

Time Criticality of the Digital Installation

When a system uses several applications, the most stringent time accuracy requirements must be considered when defining the solution for timestamping the data. Time accuracy requirements shall also be considered according to the criticality of the load supplied, i.e. per switchboard or panelboard.

In the following pages, for simplicity's sake, we will consider the three applications separately.

Implementing the Power Event Analysis Application (1/5)

Data to Be Retrieved

With the help of the implementation section (Section 3) of the [EcoStruxure™ Power Digital Application Design Guide](), we can define what data needs to be retrieved in the different parts of the installation and which key equipment is able to provide it.

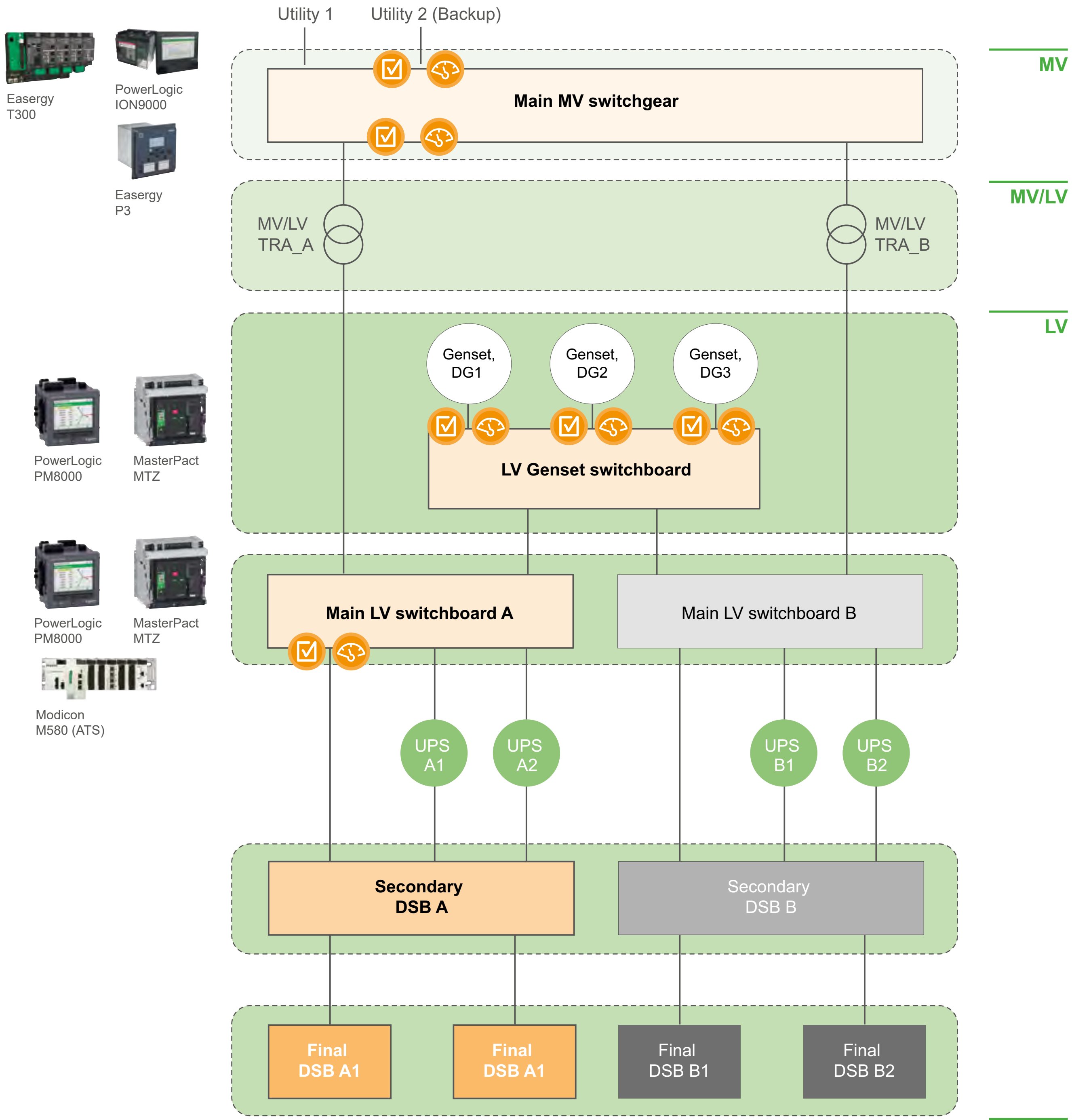


Figure 28: Data to be retrieved for the Power Event Analysis application and associated devices

Electrical Measurements From Utilities and the ED Network
- Current, voltage, energy
- Power (Active, Reactive, Apparent)
- Frequency
- Power factor
- Harmonic distortion
- Voltage and current unbalance
- Sags, swells

Status from Equipment

Circuit Breaker
- Position (open, closed, racked-in, racked-out, etc)
- Trip status, protection status

Genset
- Statuses
- Operating modes or conditions
- (RUN, STOP, STARTING)

ATS
- Status, events and diagnostic information
- Normal, test, emergency

Implementing the Power Event Analysis Application (2/5)

Selecting the Timestamping Solution

TIMESTAMPING OPTIONS FOR HIGHLY TIME CRITICAL APPLICATIONS

As explained in Section 2, the Power Event Analysis application's time criticality is high, with a recommended time accuracy of 1 ms. According to the extract of Table 4 p. 20 in Section 2 below, this can be achieved by time synchronizing devices with IRIG-B or PTP protocols.

Application Time Criticality	Typical Accuracy	Protocol Media	Protocol	Typical Cost
High	+/-1 ms	Ethernet	PTP (IEEE1588)	$$
High	+/-1 ms	Serial	IRIG-B	$$$

Table 10: Recommended time accuracy for the selected applications (Extract from Table 2)

Using Table 2, p. 13 in Section 1, we can check the capabilities of the devices at stake to implement the Power Event Analysis application, for IRIG-B or PTP protocols and deduce the most suitable solution.

OPTION A: FULL IRIG-B BASED ARCHITECTURE

Synchronization with IRIG-B protocol enables the most complete timestamped data collection: many embedded field devices support this protocol such as the Easergy P3 and T300, PowerLogic PM8000, and Modicon M580 with ERT timestamping module.

Devices with no IRIG-B capabilities (e.g.: MasterPact MTZ), can be hardwired to products which support IRIG-B and will timestamp the data for them. It can be:

- a high-end meter (such as Powerlogic PM8000) already installed for Power Quality monitoring
- a specifically added time-synchronized device, such as a PAC (Modicon M580) or Sequence of Event Recorder.

OPTION B: PTP-BASED ARCHITECTURE

Synchronization with PTP is easier and less expensive, but is compatible with fewer field devices.

Some products, like Easergy T300, PowerLogic ION9000 and PM8000 intrinsically support the PTP protocol.

As Easergy P3 is not PTP compatible, we suggest collecting and timestamping information from MV circuit breaker statuses using digital inputs of Easergy T300. Without an Easergy T300 present, ION 9000 digital inputs can be used.

MasterPact, which also does not support PTP, should be hardwired to another device which supports PTP and will timestamp the data. Here, we suggest connecting MasterPact statuses to an embedded PowerLogic PM8000 when available and to add sequence of event recorders if PM8000 digital inputs cannot be used to relay the statuses.

OPTION C: HYBRID ARCHITECTURE (PTP / IRIG-B)

Due to limitations on product capabilities regarding supported time-synchronization, pure PTP time-synchronization implementation is not yet achievable with systems such as the one given in this example. On the other hand, pure IRIG-B / serial line based protocols can lead to significant extra cost.

A good compromise for data collection with high time accuracy can be achieved by combining the benefits of both protocols (PTP and IRIG-B), to make the most of each device's capability. This is also facilitated by the fact that many master clocks can act as master for both types of protocols (PTP, IRIG-B, but also DCF77 or NTP if needed).

Implementing the Power Event Analysis Application (3/5)

Digital Architecture

OPTION A: FULL IRIG-B BASED ARCHITECTURE

Additional hardware required for this architecture would include:

- GPS Antenna (x1)
- Time Server (x1)
- IRIG-B interface modules (x3)
- Serial line cables
- Additional sequence of event recorder (x2)
- Additional wires for circuit breaker statuses (x5 to x7 per breaker)

1 2 3 4 5 6

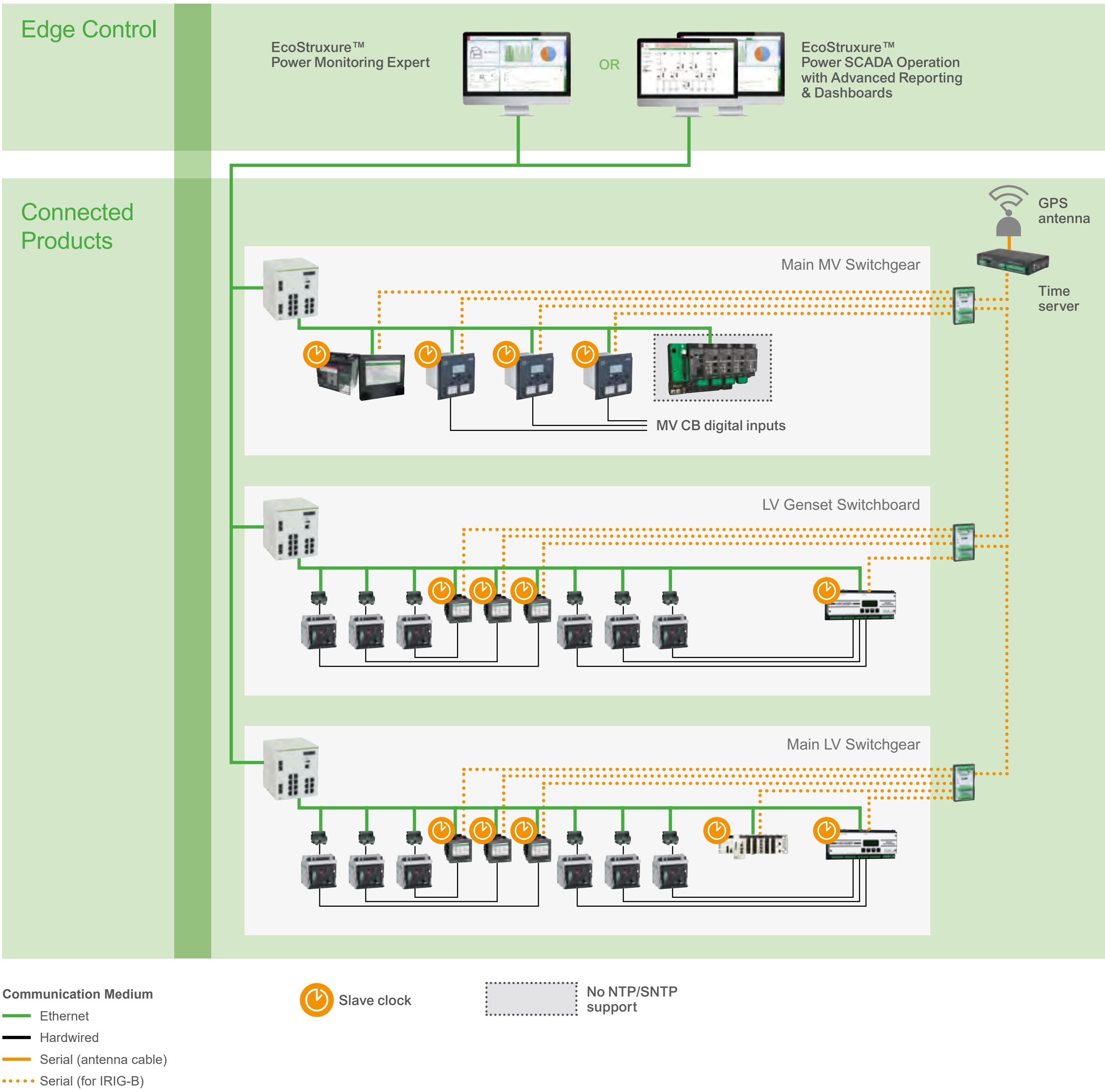


Figure 29: Digital architecture for a Power Event Analysis application, based on IRIG-B time-synchronization protocol

Implementing the Power Event Analysis Application (4/5)

Digital Architecture (cont.)

OPTION B: PTP-BASED ARCHITECTURE

Additional hardware required for this architecture would include:

- PTP Grandmaster Clock
- Additional sequence of event recorder (x3)
- Additional wires for circuit breaker statuses (x5 to x7 per breaker)

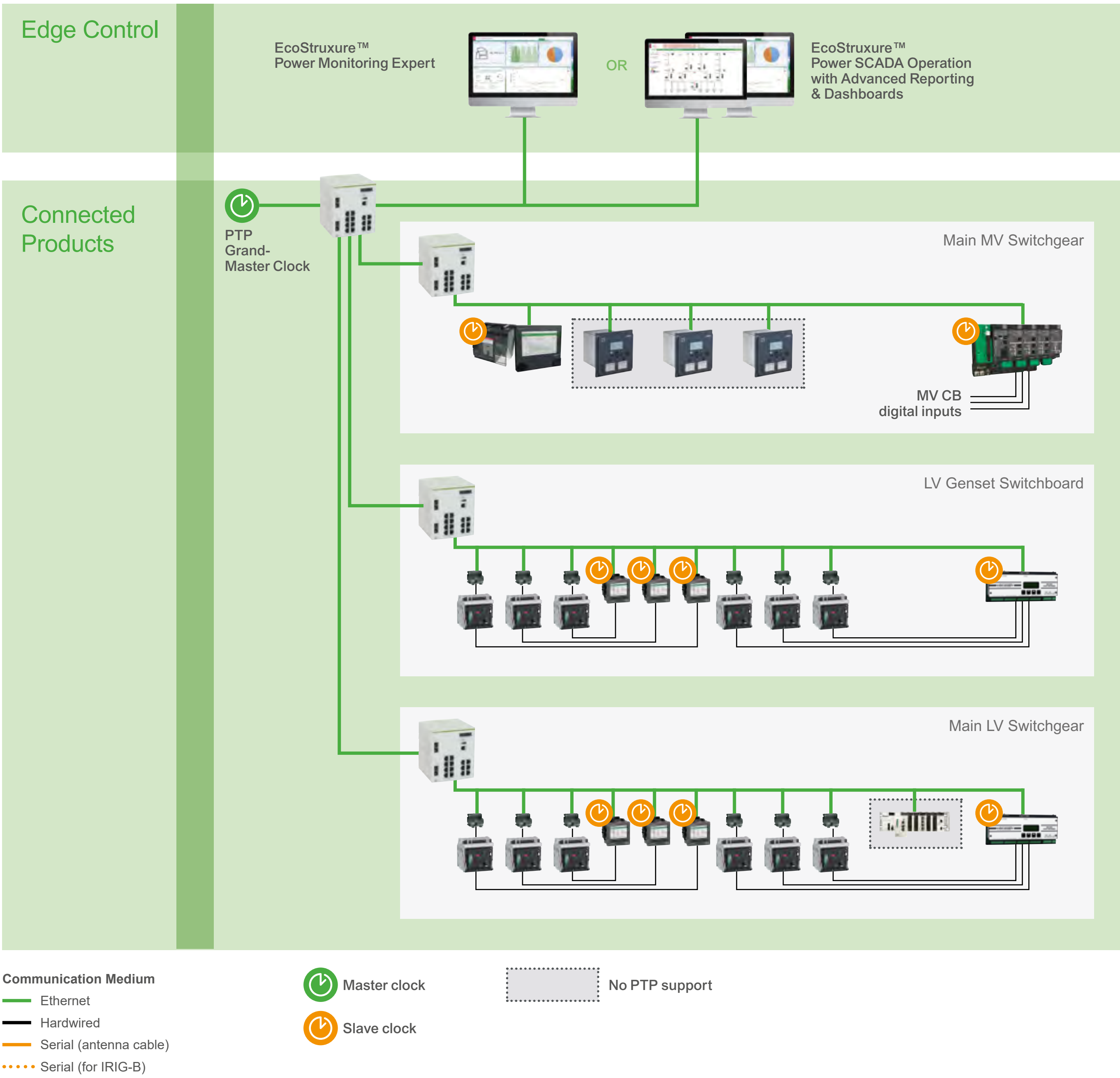


Figure 30: Digital architecture for a Power Event Analysis application, based on PTP time-synchronization protocol

Implementing the Power Event Analysis Application (5/5)

Digital Architecture (cont.)

OPTION C: HYBRID ARCHITECTURE (PTP / IRIG-B)

Additional hardware required for this architecture would include:

- GPS Antenna (x1)
- Time Server (x1)
- IRIG-B interface modules (x3)
- Serial line cables
- Additional sequence of event recorder (x1)
- Additional wires for circuit breaker statuses (x5 to x7 per breaker)

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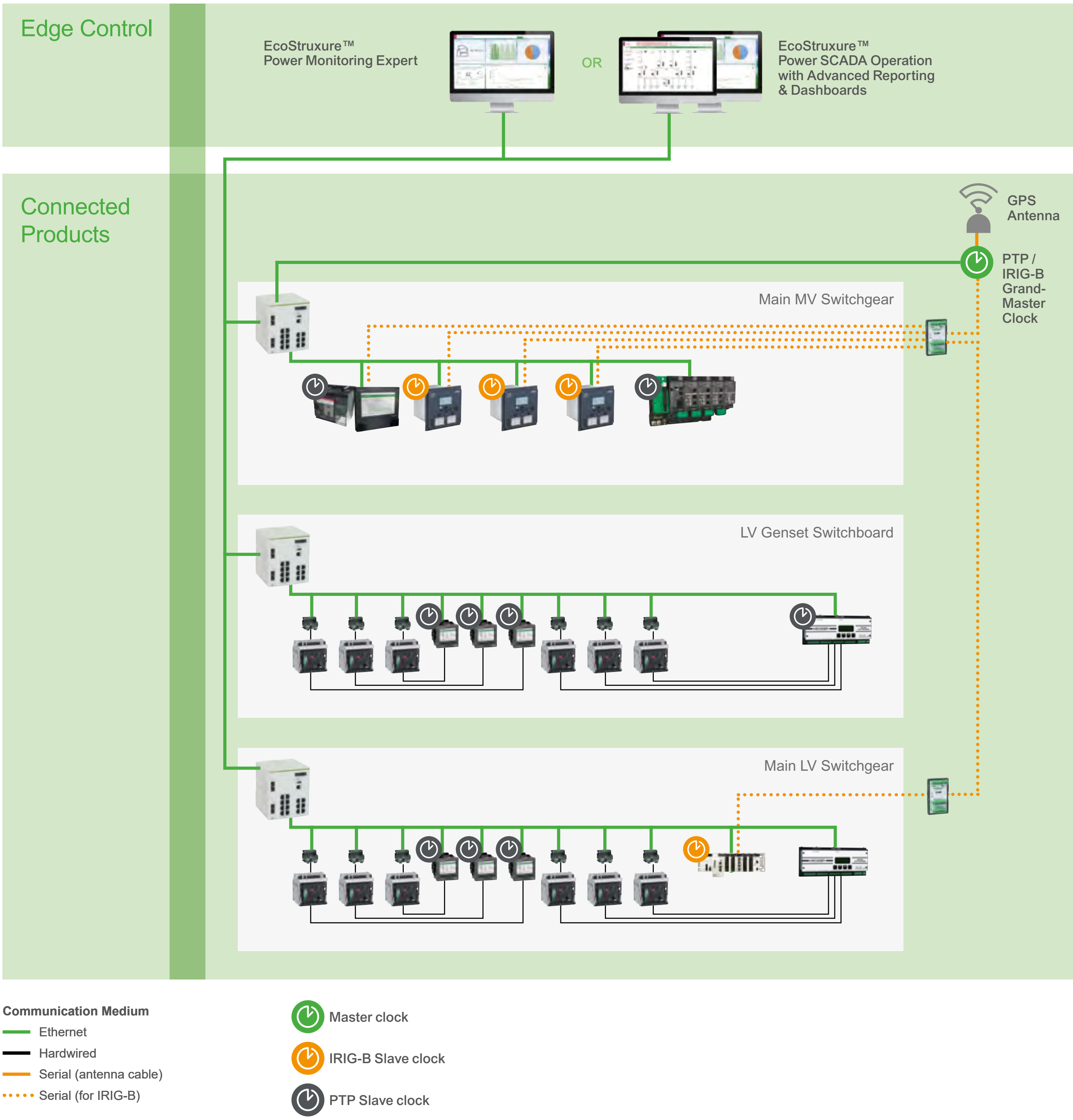

Figure 31: Hybrid digital architecture for a Power Event Analysis application, based on PTP and IRIG-B time-synchronization protocols

Note: similar alternatives may be acceptable

Implementing the Electrical Distribution Monitoring & Alarming Application (1/4)

Data to Be Retrieved

With the help of the implementation section (Section 3) of the EcoStruxure™ Power Digital Application Design Guide, we can define what data needs to be retrieved in the different parts of the installation and which key equipment is able to provide it.

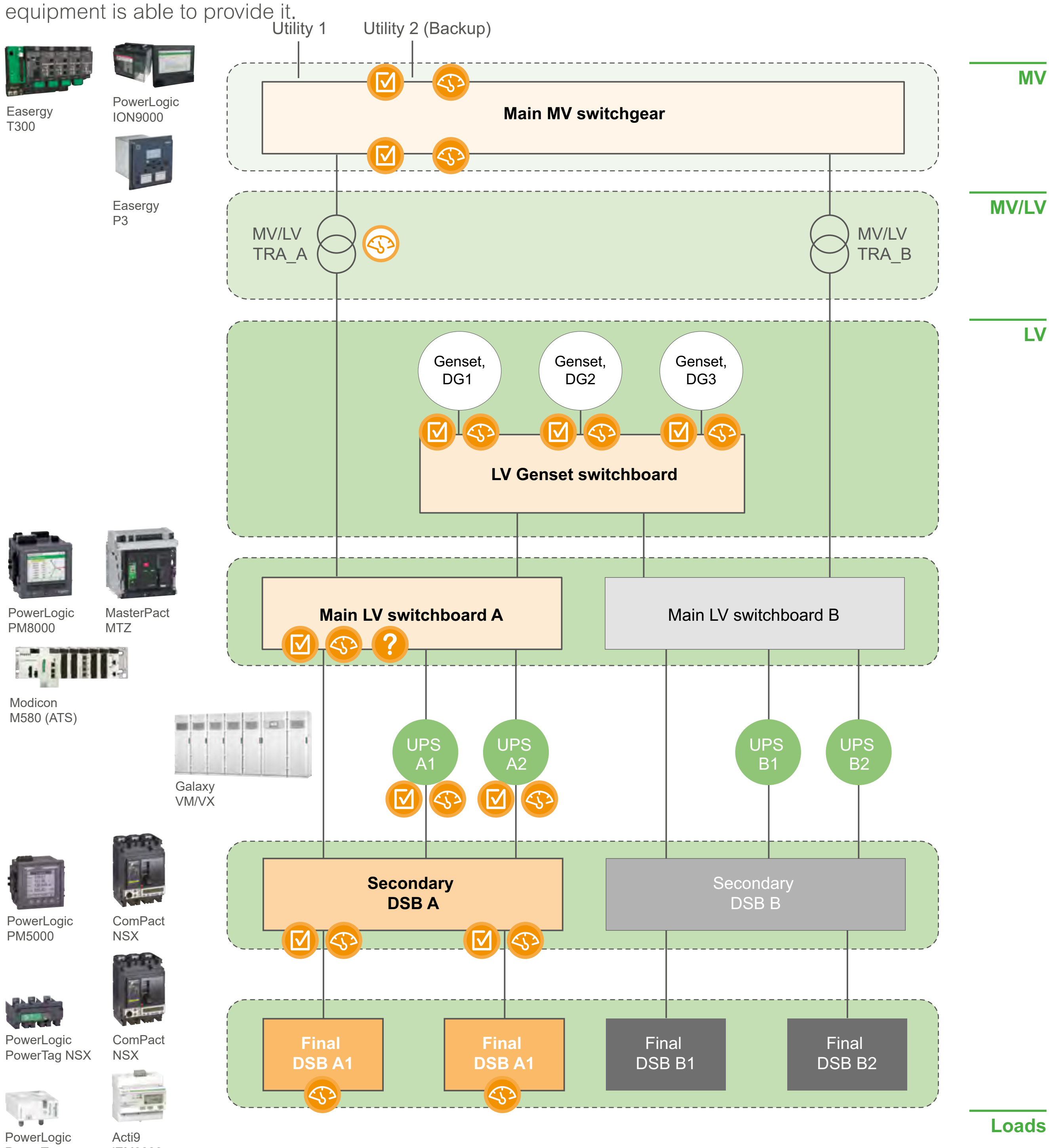

Figure 32: Data to be retrieved for the Electrical Distribution Monitoring & Alarming application and associated devices

Electrical Measurements From Utilities and the ED Network
- Current, voltage, energy
- Power (Active, Reactive, Apparent)
- Frequency
- Power factor
- Harmonic distortion
- Voltage and current unbalance

Status from Equipment

Circuit Breaker
- Position (open, closed, racked-in, racked-out, etc.)
- Trip status, protection status

- Genset
- Statuses
- Operating modes or conditions
- (RUN, STOP, STARTING)

UPS
- Statuses

ATS
- Status, events and diagnostic information
- Normal, test, emergency

Other Physical Measurements
- Temperature
- Humidity

Other Information
- Other statuses, operating modes or conditions
- Control actions (operator or automatic)

Implementing the Electrical Distribution Monitoring & Alarming Application (2/4)

Selecting the Timestamping Solution

TIMESTAMPING OPTIONS FOR MEDIUM TIME CRITICAL APPLICATIONS

As explained in Section 2, the Electrical Distribution Monitoring & Alarming Application's time criticality is medium, with a recommended time accuracy of 10 ms (maximum 1 s).

According to the extract of Table 4 p. 20 in Section 2 below, this can be achieved by time synchronizing devices with NTP/SNTP or DCF77 protocols, or over Modbus/ION.

Application Time Criticality	Typical Accuracy	Protocol Media	Protocol	Typical Cost
Medium	+/-10 ms to 100 ms	Ethernet	NTP	$
Medium	+/-100 ms	Serial	DCF77	$$
Medium	+/-1 s	Ethernet	SNTP	$
Medium	+/-1 s	Ethernet	Over Modbus / ION	-

Table 11: Characteristics of time-synchronization for medium time criticality applications

Using Table 2, p. 13 in Section 1, we can check, for the above protocols, the capabilities of the devices at stake to implement the Electrical Distribution Monitoring & Alarming application.

As very few field devices can support the DCF77, we suggest implementing time-synchronization with SNTP-NTP or Modbus/ION, with the advantage of being less expensive for the former and without cost for the latter.

SOLUTION A: SNTP-NTP PROTOCOL

A few high-end devices (such as PowerLogic ION9000 and PM8000, MasterPact MTZ with IFE) support true NTP which allows time accuracy in the range of +/-10 to +/-100 ms.

For many EcoStruxure™ Power field devices, the simplified version of NTP (called SNTP) has been implemented; SNTP relies on the same network architecture but achievable accuracy performances are typically lower, in the range of +/-1 s.

SOLUTION B: SYNCHRONIZATION OVER MODBUS / ION

Synchronization over Modbus or ION communication protocol can provide sufficient accuracy when Electrical Distribution Monitoring and Alarming is deployed for less critical applications. In this case, a +/-1 s accuracy is commonly achievable, and the advantage is that it comes without any additional cost with device integration in Edge Control software for most cases.

Implementing the Electrical Distribution Monitoring & Alarming Application (3/4)

Digital Architecture

SOLUTION A: SNTP-NTP PROTOCOL

Additional hardware required for this architecture would include:

- NTP time server.

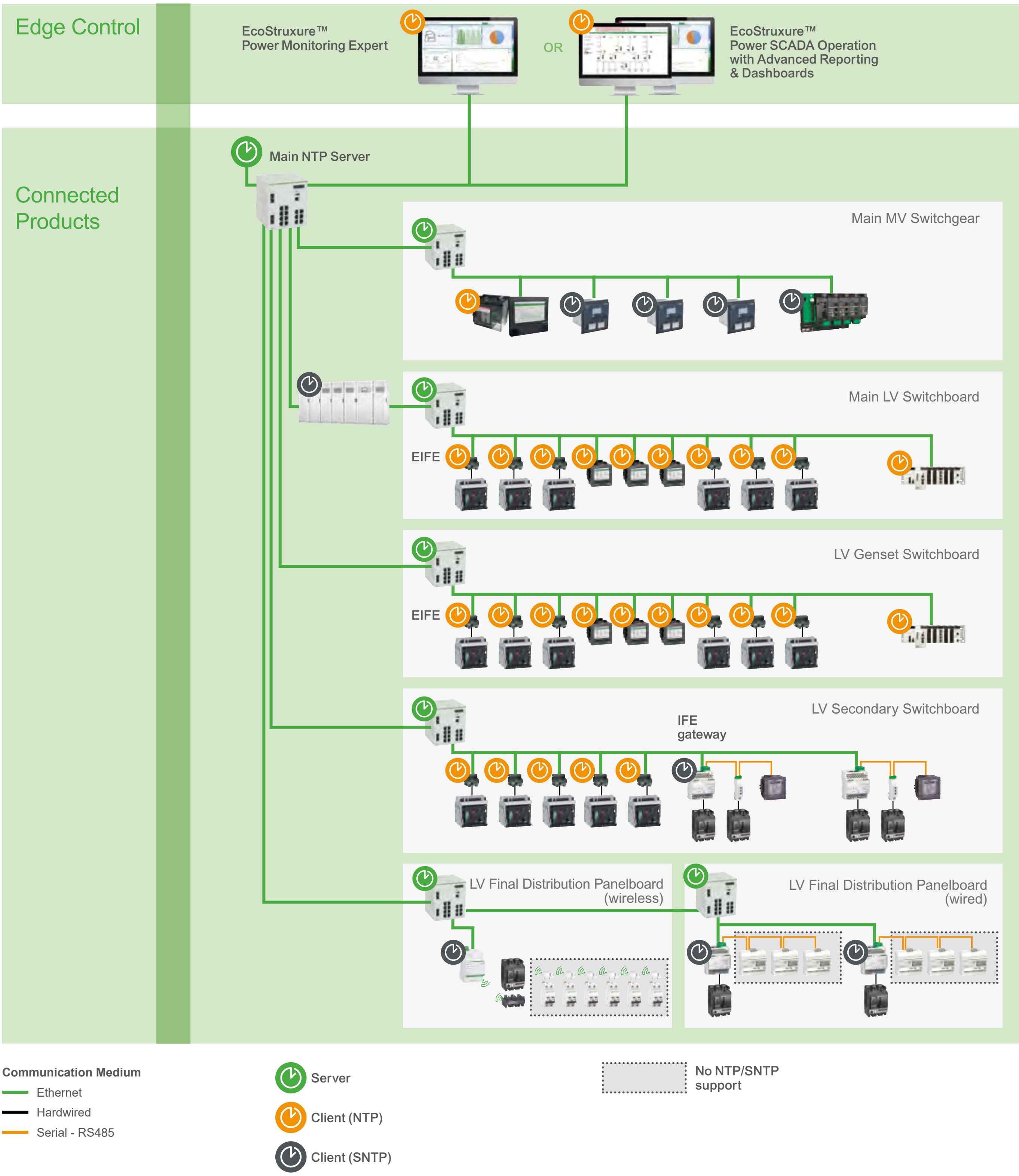

Figure 33: Digital architecture for the Electrical Distribution Monitoring & Alarming application, based on SNTP-NTP time-synchronization protocol

Implementing the Electrical Distribution Monitoring & Alarming Application (4/4)

Digital Architecture (cont.)

SOLUTION B: SYNCHRONIZATION OVER MODBUS / ION

No additional hardware required for this architecture.

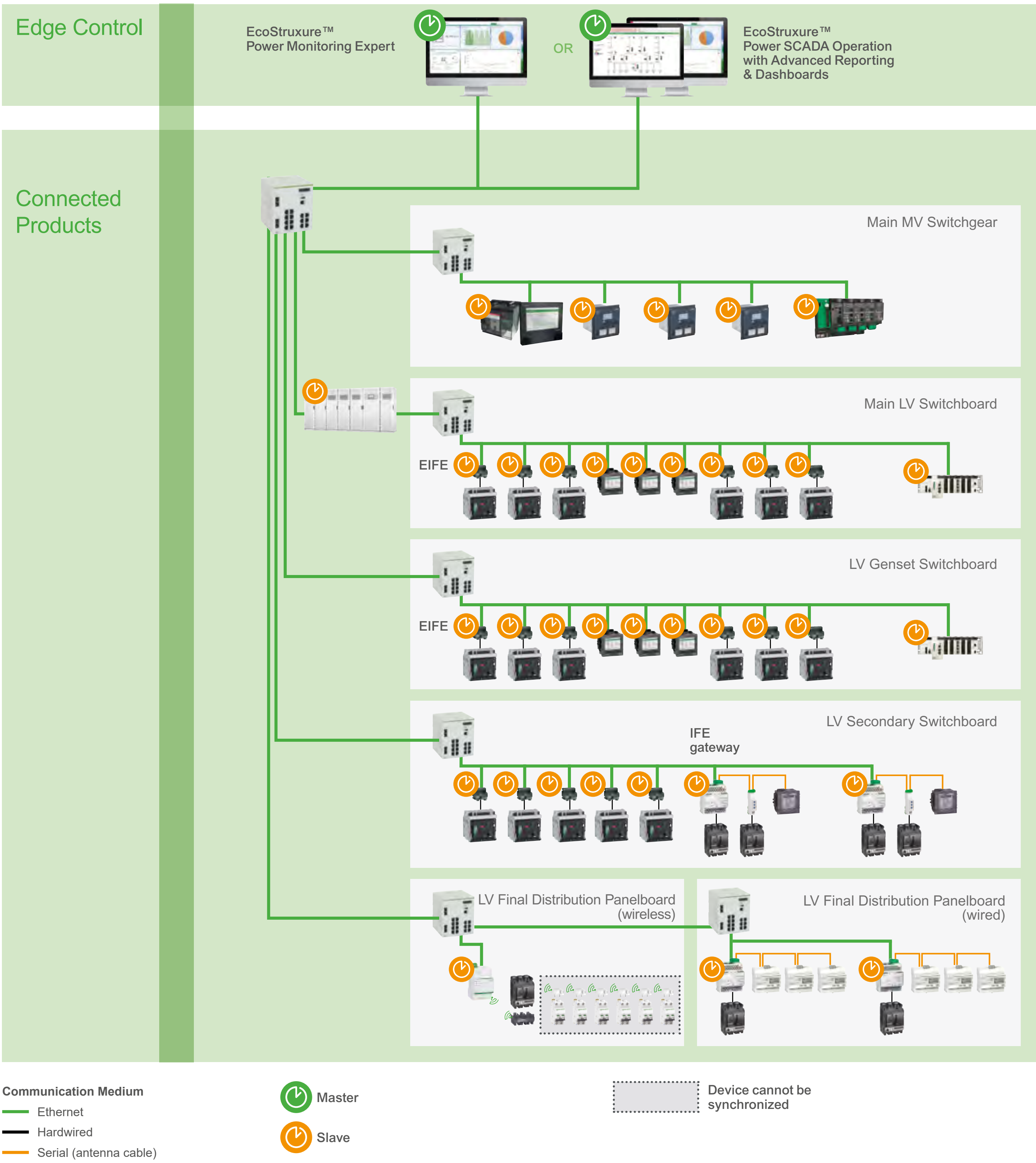

Figure 34: Digital architecture for the Electrical Distribution Monitoring & Alarming application, based on time-synchronization over Modbus / ION

Implementing the Cost Allocation Application (1/3)

Data to Be Retrieved

With the help of the implementation section (Section 3) of the EcoStruxure™ Power Digital Application Design Guide, we can define what data needs to be retrieved in the different parts of the installation and which key equipment will provide it.

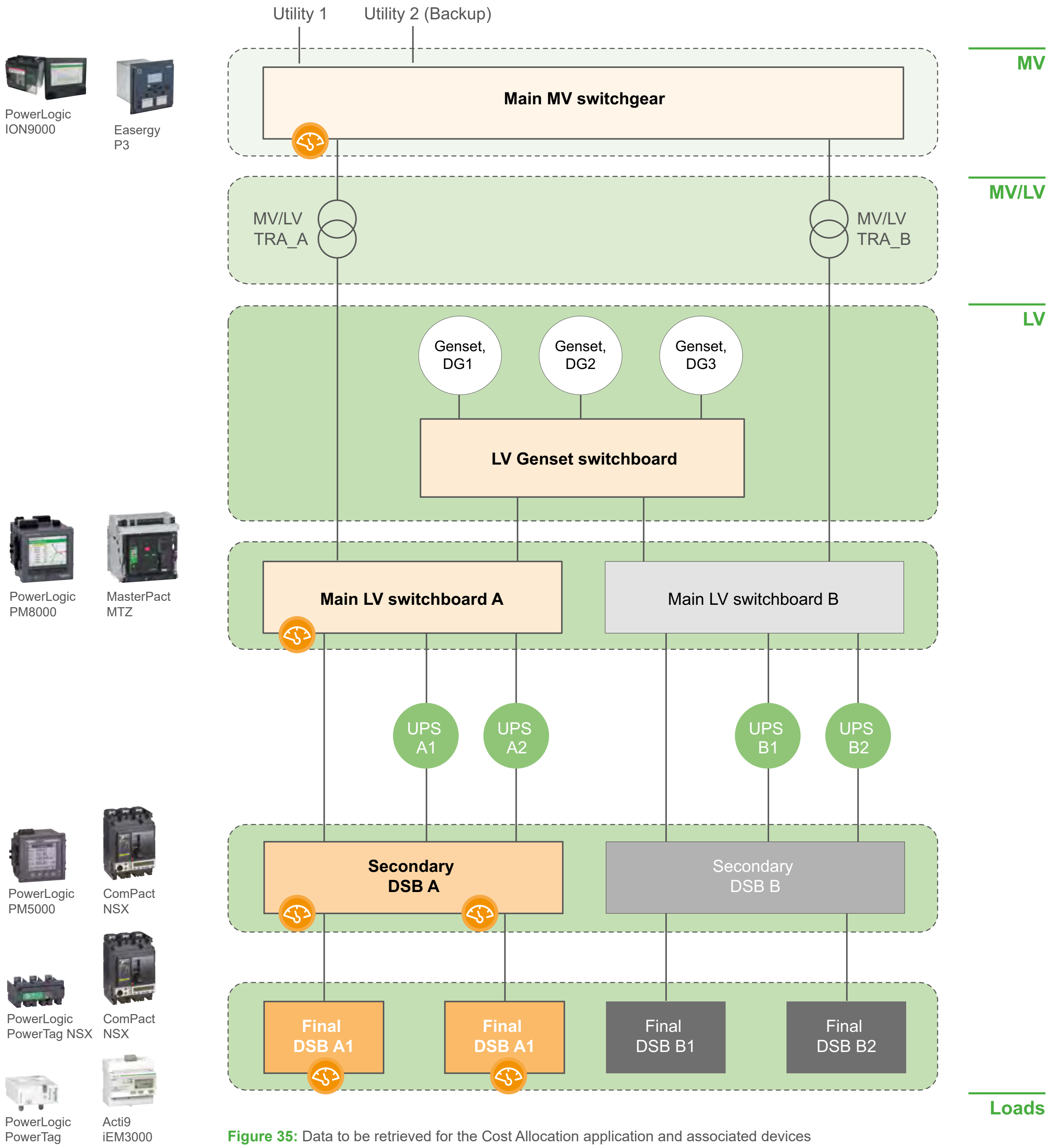

Figure 35: Data to be retrieved for the Cost Allocation application and associated devices

Electrical Measurements From Utilities and the ED Network
- Current, voltage, energy
- Power (Active, Reactive, Apparent)
- Frequency
- Power factor
- Harmonic distortion
- Voltage and current unbalance

Implementing the Cost Allocation Application (2/3)

Selecting the Timestamping Solution

TIMESTAMPING OPTIONS FOR MEDIUM TIME CRITICAL APPLICATIONS

As explained in Section 2, the Cost Allocation application's time criticality is low, with a recommended time accuracy of 1 s.
According to the extract of Table 4 p. 20 in Section 2 below, this can be achieved by time synchronizing devices with SNTP, Modbus or 1per10 protocols:

Application Time Criticality	Typical Accuracy	Protocol Media	Protocol	Typical Cost
Low	+/-1 s	Ethernet	SNTP	$
Low	+/-1 s	Ethernet	Over Modbus / ION from Edge Control	$
Low	+/-1 s	Serial	1per10	$$

Table 12: Characteristics of time-synchronization for low time criticality applications

However, none of these time-synchronization protocols is compatible with all the products from which we would like to collect data. Therefore, we suggest implementing timestamping using the Edge Control (Solution 2 p. 36 in Section 3).

SOLUTION: TIMESTAMPING USING THE EDGE CONTROL SOFTWARE (PC LOGGING)

Timestamping using the Edge Control software enables data collection from all the products connected to the communication network (even basic energy meters which do not have onboard timestamping). It also has the advantage of being a cost-effective solution as it does not require any additional hardware.

The main drawback of this solution is that the overall time accuracy is typically in the range of 1 to 10 s. This can be considered an applicable solution for low time critical applications.

Implementing the Cost Allocation Application (3/3)

Digital Architecture

Solution: Timestamping using the Edge Control Software (PC Logging)

Timestamping using the Edge Control software requires no specific additional hardware apart from the classical communication network:

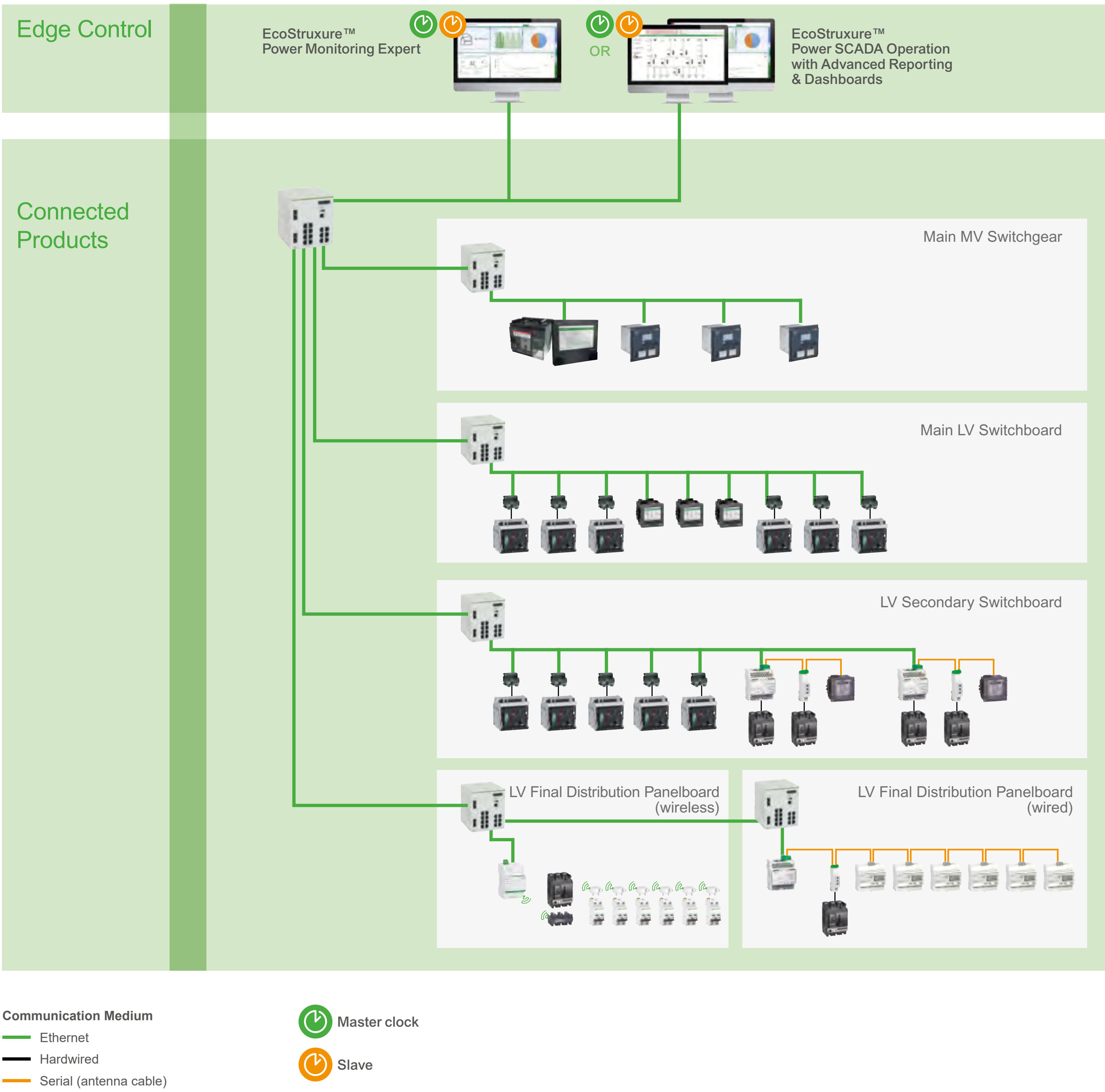

Figure 36: Digital architecture for Cost Allocation application implementation, implementing timestamping using the Edge Control

APPENDIX

Product Information

Connected Products (1/8)

PROTECTION, MONITORING & CONTROL DEVICES

Easergy P5

Medium voltage network protection relay

Easergy P5 is a range of protection relays for demanding medium voltage applications. It offers users dedicated features for industry-leading protection relay functionality to reduce risks and improve reliability, all with advanced connectivity.

Easergy P3

Medium voltage network protection relay

Easergy P3 is a range of easy-to-use protection relays for medium voltage applications. With fast delivery, it is ideal for saving panel builders, contractors and partners time. Easergy P3 has been designed to meet customer's needs including overcurrent and arc flash protection and latest connectivity.

Easergy Sepam Series

Medium voltage network protection relay

Sepam series has all the functionalities required for protecting MV substations, transformers, busways as well as LV distribution, capacitor banks and motors, and for managing gensets. If a problem occurs, clear and complete information is provided to make the right decision immediately. Sepam can be used in the harshest environments, including off-shore oil rigs and chemical factories.

Easergy T300

Distribution network management for MV and LV applications

Easergy T300 is a modular platform for hardware and firmware, and an application building block for medium voltage and low voltage distribution network management. It offers a single solution for control and monitoring, from a simple pole-top device to a large MV/LV substation. It is a powerful Remote Terminal Unit for feeder automation.

MasterPact MTZ

High current air circuit breakers up to 6300 A embedding advanced digital technologies for LV applications

Future Ready Masterpact MTZ is a comprehensive range of air circuit breakers designed to protect electrical systems from damage caused by overloads, short circuits and equipment ground faults. Masterpact MTZ embeds advanced digital technologies and Micrologic X control units help contribute to safety and energy efficiency.

MasterPact NW

High current air circuit breakers up to 6300 A for LV applications

Masterpact NW is a comprehensive range of air circuit breakers designed to protect electrical systems from damage caused by overloads, short circuits and equipment ground faults. The embedded Micrologic control unit contributes to safety and energy efficiency. The range covers ratings from 800 to 6300 A in two different sizes.

MasterPact NT

High current air circuit breakers from 800 to 1200A for LV applications

MasterPact NT is a range of air circuit breakers designed to protect electrical systems from damage caused by overloads, short circuits and equipment ground faults

1 2 3 4 5 6

Connected Products (2/8)

PROTECTION, MONITORING & CONTROL DEVICES (cont.)

ComPact NS

Molded case circuit breakers from 630 to 3200 A for LV applications

ComPact NS is a range of molded case circuit breakers (MCCB) with embedded MicroLogic control units for built-in power & energy metering. The solution covers ratings from 630 to 3200 A.
It offers built-in power and energy metering in addition to electrical measurement and analysis functions. The solution can be used to deliver a source changeover switch function (TransferPact). It can also evolve with the installation, with interchangeable trip units that combine protection and measurement, as well as standardised accessories.

ComPact NSX

Molded case circuit breakers up to 630 A for LV applications

Compact NSX is a full range of high performance molded case circuit breakers in 2 frame sizes designed to meet your needs from thermal-magnetic to advanced Micrologic trip units. Micrologic allows for wired communication, or Powertag NSX is designed for wireless communication.

PowerLogic Vamp

Arc flash protection system

PowerLogic Vamp is a range of ultra-fast and flexible arc flash protection products which help eliminate or minimize the costs resulting from arc flash damages -- downtime, repair time, interruption of processes and equipment. PowerLogic Vamp helps avoid personal injury due to arc flash events.

INSULATION MONITORING & FAULT LOCATION DEVICES

Vigilohm IM20-H

Insulation monitoring device (IMD) for hospital applications

Vigilohm IM20-H is a specific Insulation Monitoring Device (IMD) that complies with IEC 61557-8 and provides insulation integrity alarming, isolation transformer overload and temperature monitoring.
The communication protocol is Modbus RTU.

Vigilohm IMD IFL12H

Insulation fault locator (IFL) for Hospital application

Vigilohm IMD IFL12H is a digital Insulation Fault Locator (IFL) for low-voltage ungrounded power systems. When installed in conjunction with an IM20-H, this insulation fault locator individually monitors each of the feeders. It reports fault locations, either locally, through a light and a contact, or remotely, through the Modbus communication port.

Connected Products (3/8)

POWER METERS

PowerLogic ION9000 series

Power quality meters for utility incomers or highly critical applications

PowerLogic ION9000 series is a range of advanced power quality meters, designed for high-accuracy, energy cost, network management and power quality requirements.

PowerLogic PM8000 series

Power quality meters for critical applications

PowerLogic PM8000 series is a range of high-performance power meters for cost and network management applications on feeders and critical loads. It simplifies power quality, and maximizes versatility.

PowerLogic PM5000 series

Power meters with basic power quality functionality

PowerLogic PM5000 series is a range of high-end, cost effective and compact power meters which enable energy cost and basic network management applications.

Acti9 iEM3000 series

Energy meters (DIN rail-mounting)

Acti9 IEM3000 series is a range of cost effective energy meters which can easily be integrated into an Energy Management System or a Building Management System thanks to native Modbus, BACnet, M-bus and LON protocols. It provides a full view of energy consumption and multiple tariffs give customers the flexibility to match the billing structure of their utility.

PowerTag Energy by PowerLogic

Energy sensors

PowerTag Energy is a range of wireless energy sensors that provide precise, real-time data on energy, currents,
power, voltage, and power factor. These sensors accurately monitor energy consumption and wirelessly communicate this data in real-time via a gateway.

1 2 3 4 5 6

Connected Products (4/8)

PLC & PAC

Modicon M580

Ethernet Programmable Automation Controller (ePAC) & safety PLC for process, availability & safety solutions

Modicon M580 high-end ePAC features redundant controllers, new stand-alone safety controllers (safety PLC) with native Ethernet, and cybersecurity embedded in its core.

ERT Module for Modicon M580 ePAC

Time stamp module for Ethernet Programmable Automation Controller (ePAC)

The ERT (BMXERT1604) module for the Modicon M580 ePAC features all the characteristics of a regular 16-channel discrete input module. In addition, the ERT module has a time stamping function which records the change (rising or falling edge) of each input channel. To optimize the precision of time stamps, the module is able to receive timecodes from a GPS or DCF77 receiver.

Modicon M340

Mid range PLC for industrial process and infrastructure

Modicon M340 Programmable Automation Controller (PAC) is built to suit the needs of the process industry and a wide range of demanding automation applications such as a multitasking system for optimal reflex time.

Substation Monitoring Device (SMD)

Local and/or remote monitoring for MV applications

The Substation Monitoring Device performs analytics on temperature and environmental data for monitoring and alarming via a local HMI or SCADA system. The Condition Monitoring Device consists of an M251 PLC and optional Magelis HMI. It is configured in the factory and automatically integrates with Edge Control Software. The SMD can also send SMS messages in case of alarms. The optional colour display provides SLD representation with overlaid temperature values.

Connected Products (5/8)

COMMUNICATION DEVICES & GATEWAYS

Smartlink SI B and Smartlink Modbus

Communication system

Smartlink is an open system that remotely measures, balances, monitors and controls final distribution. It is designed to fit into tertiary building projects and integrates seamlessly in a Building Management System or an Energy Management System.
It consists of:
• Modbus Slave version (Acti9 Smartlink Modbus)
• Modbus Master version (Acti9 Smartlink SI B) with the following functions: radio hub, Modbus gateway and embedded web server: this provides web pages for configuring the system, and real-time monitoring of values (status of circuit breakers, energy meters, alarms and monitoring and control).
These modules transmit data to a PLC or monitoring system.

PowerTag Link and PowerTag Link HD

Communication system

PowerTag Link is an Ethernet connection concentrator (Modbus TCP/IP) for wireless devices with data display web pages.
The associated PowerTag energy sensors allow alarms to be managed via email for terminal loads, and energy, power, current and voltage to be measured accurately in real-time.
The associated PowerTag Control modules are designed to monitor a circuit and wirelessly notify the concentrator of the information status of a contact (OF, SD, CT or TL position indication...).
The entire system can easily be installed in existing LV equipment using Multi9/Acti9/Compact NSX type circuit breakers.

Harmony Sologate ZBRN32

Data concentrator for wireless sensors & serial Modbus gateway

Each Zigbee concentrator has 60 inputs, numbered from I0 to I59. A sensor is paired with one of the Zigbee concentrator inputs, meaning the sensor's ID is associated with the concentrator input and all information concerning the sensor can be read in a Modbus table using the input index.

Enerlin'X IFE, IFE gateway, EIFE and IFM

Communications interfaces for Masterpact, PowerPact, and Compact circuit breakers

IFE: Ethernet interface for Masterpact, Compact and PowerPact circuit breakers.
IFE gateway: Ethernet interface for Masterpact, Compact and PowerPact circuit breakers. Also includes Modbus serial to TCP functionality.
EIFE: Ethernet interface for drawout Masterpact MTZ air circuit breakers.
IFM: Modbus Serial interface for Masterpact, Compact and PowerPact circuit breakers.

Connected Products (6/8)

COMMUNICATION DEVICES & GATEWAYS (cont.)

Enerlin'X Link150

Ethernet gateway

Link150 is a gateway for simple, cost-effective serial-to-Ethernet connectivity. It provides fast, reliable Ethernet connectivity in the most demanding applications, from single building to multi-site enterprises. It supports power and energy meters, circuit monitors, protective relays, trip units, motor controls and other devices that need to communicate data quickly and efficiently. It provides simple, cost-effective serial line to full Ethernet connectivity.

ConneXium

Ethernet TCP/IP managed Switch

The ConneXium range offers a smart and flexible way to integrate Ethernet solutions, from the device level to the control network and to the corporate network.

Connected Products (7/8)

POWER QUALITY MITIGATION, POWER FACTOR CORRECTION & UPS DEVICES

1 2 3 4 5 6

AccuSine PCS+

Active harmonic filter for industrial applications

AccuSine PCS+ is a high performance, scalable active power correction solution for stabilizing electrical networks by providing harmonic mitigation, power factor correction and load balancing.

AccuSine PCSn

Active harmonic filter for commercial buildings, the lighting industry and other less harsh environments

AccuSine PCSn series is built on the AccuSine+ platform, providing a scalable and flexible, high performance active harmonic filtering solution capable of mitigating neutral harmonic currents to bring reliability and efficiency to your electrical system, resulting in increased uptime, greater operational efficiency, prolonged equipment life, and improved energy efficiency.

AccuSine PFV+

Electronic reactive current compensation for specific and high performance applications

AccuSine PFV+ addresses power quality issues by simple, effective elimination of leading or lagging power factor and reduction of voltage fluctuations. Its unique design helps enhance equipment operating life and improves system power performance, and offers multiple features in one complete package. Power Factor correction with AccuSine PFV+ is worry-free and there is no risk of resonance.

VarSet LV with PowerLogic VarPlus Logic

LV capacitor bank

Varset LV is complete range of high quality power factor correction solutions is engineered to compensate reactive power and harmonic distortion. These are easy and flexible solutions that can immediately boost a facility's energy efficiency and productivity. Thanks to VarSet, your power factor is maintained at an ideal level for optimal power system efficiency and cost reduction.

Galaxy VS

3-phase uninterruptible power supply (UPS)

Galaxy VS is a highly efficient 3-phase UPS from 20 to 100kVA (400V/480V) and 10 to 50kVA (208V) for edge, small, and medium data centres and other business-critical applications.

Galaxy VM

3 phase uninterruptible power supply (UPS)

Galaxy VM is a 3 phase UPS power protection that seamlessly integrates into medium data centers, industrial or facilities applications.

Galaxy VX

3 phase uninterruptible power supply (UPS)

Galaxy VX is a scalable, high-performance extension of the Galaxy V-Series solutions. It is designed for large data centers and industrial applications.

Connected Products (8/8)

DATA LOGGERS

Cyber Sciences CyTime SER 2408 / 3200

Sequence of events recorder for high time accuracy applications

CyTimeTM SER2409/3200 record status changes of 32 channels, timestamped to 1 ms. Time-synchronization is achieved via PTP (IEEE 1588), IRIG-B, DCF77, NTP, Modbus TCP or an RS-485 signal from another SER.
One CyTime SER serves as PTP master and all other CyTime SER devices sync automatically within 100 microseconds—without special Ethernet switches.
https://www.cyber-sciences.com/product/sequence-of-events-recorder-ser/

SENSORS

Easergy TH110

Wireless thermal sensor for critical connections

The Easergy TH110 is a battery-free wireless temperature sensor used to perform the continuous thermal monitoring of critical connections made in the field, such as:

- MV Cable connections
- MV Busbar connections
- Withdrawable CB connections
- MV transformer input, windings, taps, LV output

Easergy CL110

Wireless thermal sensor for ambient temperature

The Easergy CL110 is a wireless temperature and humidity sensor with a battery for continuous ambient temperature monitoring:

- LV Busway junctions and tap-offs
- Internal to electrical switchgear

Edge Control

SOFTWARE

EcoStruxure™ Power Monitoring Expert

Power Management software

EcoStruxure™ Power Monitoring Expert helps maximize system reliability and optimize operational efficiency to increase your profitability.

EcoStruxure™ Power SCADA Operation

High performance SCADA software system for electrical distribution monitoring and control

With its high availability, redundancy, high speed data acquisition and alarming, it is aimed at very large sites with many devices and high availability requirements.
The software gives operators exceptional knowledge and control of their network through an intuitive, interactive and customizable interface. With fast, consistent access to actionable information, Power SCADA Operation operators are more effective at protecting and optimizing their electrical distribution network, improving both its efficiency and productivity.

EcoStruxure™ Power SCADA Operation with Advanced Reporting & Dashboards

High performance SCADA software system for electrical distribution monitoring and control with historical dashboards and reporting applications

Advanced Power Monitoring Expert reporting and dashboards embedded in Power SCADA Operation.

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  www.cyber-sciences.com
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  - "Overview of IRIG-B Time Code Standard" (ref. TN-102)
  - "Overview of DCF77 Time Protocol" (ref. TN-103)
  - "Overview of 1per10 Time Protocol" (ref. TN-104)

- **Oralia Technical Note**
  www.orolia.com
  - "Differences Between NTP and SNTP" (ref. TN06-101)

- **Schneider Electric Application Note**
  www.se.com
  - "Time Synchronization and Protection and Control" by Henri Grasset (ref. 998-2095-02-01-19AR0_EN)

- **EndRun Technologies White Paper**
  www.endruntechnologies.com
  - "Precision Time Protocol (PTP/IEEE-1588)" (ref. PTP-1588)

Useful Documentation

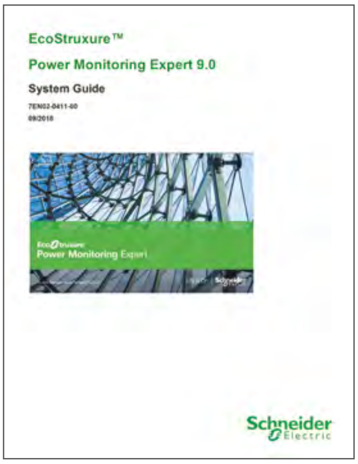
Design Guide

Digital Applications for Large Buildings and Critical Facilities

The Digital Applications Design Guide provides comprehensive details on the building blocks of EcoStruxure Power: the IoT applications are driven by a software layer to control the traditional electrical distribution infrastructure. Developed to help engineering consultants and designers, this guide is an invaluable resource for specifying, designing and prescribing EcoStruxure Power architectures capable of performing one or more of the business-driven applications described within.

IEC EcoStruxure™ Power Design Guide
Ref: ESXP2G001EN
12/2019
https://go.schneider-electric.com/WW_201903_Digital-Applications-for-Large-Buildings-and-Critical-Facilities-A09116_EA-LP-EN.html?source=Advertising-Online&sDetail=Digital-Applications-for-Large-Buildings-and-Critical-Facilities-A09116_WW

System Guides

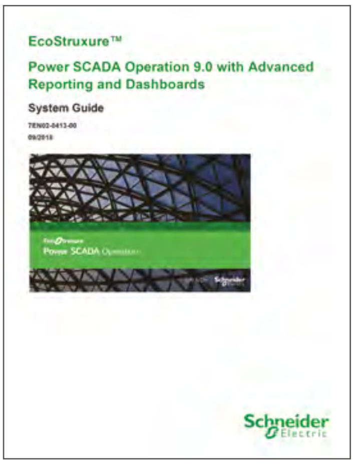


EcoStruxure™ Power Monitoring Expert 2020

Power Monitoring Expert system design, deployment and usage.

System Guide
Ref: 7EN02-0426-00
PowerMonitoringExpertSysGuide
09/2018

https://www.se.com/en/download/document/PowerMonitoringExpertSysGuide/



EcoStruxure™ Power SCADA Operation 2020 with Advanced Reporting and Dashboards

Power SCADA Operation system design, deployment and usage.

System Guide
Ref: 7EN02-0432-00
PowerSCADAOperationSystemGuide
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https://www.se.com/en/download/document/PowerSCADAOperationSystemGuide/

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An industry leading portfolio of offers delivering sustainable value

Green Premium™

More than 75% of our product sales offer superior transparency on the material content, regulatory information and environmental impact of our products:

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- Industry leading # of PEP's*
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The Green Premium program stands for our commitment to deliver customer valued sustainable performance. It has been upgraded with recognized environmental claims and extended to cover all offers including Products, Services and Solutions.

CO_2 and P&L impact through… Resource Performance

Green Premium brings improved resource efficiency throughout an asset's lifecycle. This includes efficient use of energy and natural resources, along with the minimization of CO_2 emissions.

Cost of ownership optimization through… Circular Performance

We're helping our customers optimize the total cost of ownership of their assets. To do this, we provide IoT-enabled solutions, as well as upgrade, repair, retrofit, and remanufacture services.

Peace of mind through… Well-being Performance

Green Premium products are RoHS and REACh compliant. We're going beyond regulatory compliance with step-by-step substitution of certain materials and substances from our products.

Improved sales through… Differentiation

Green Premium delivers strong value propositions through third-party labels and services. By collaborating with third-party organizations we can support our customers in meeting their sustainability goals such as green building certifications.

*PEP: Product Environmental Profile (i.e. Environmental Product Declaration)

Legal information

Electrical equipment should only be installed, operated, serviced and maintained by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

As standards, specifications and designs change from time to time, please ask for confirmation of the information given in this publication.

Notes

Notes

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