Case Study

RELYUM

RELY-SYNC-HSR/PRP-PCIe: a unique cost-effective solution for seamless integration in digital substations.

This win-case illustrates how a third-party technology provider can overcome the complexity of introducing a new monitoring system in a time-aware high-availability infrastructure, with a cost-effective independent solution that provides seamless integration and supports the standards of the Electric sector.

Customer Snapshot

- AP Sensing
- Leader in optical sensing technology (distributed temperature, acoustic and vibration sensing)
- Based on our HP/Agilent heritage, with over 25 years of optical measurement expertise.

The Challenge

- Seamless integration of new monitoring systems, in a complex infrastructure that supports high-availability networking standards and sub-microsecond synchronization standards.

The Solution

- RELY-SYNC-HSR/PRP-PCIe a multi-media PCIe Redbox-DAN, that acts as an HSR/PRP node of a high-availability network and additionally connects an Ethernet network segment with a HSR/PRP network.

Key benefit

- Supports the most demanding Electric standards: HSR/PRP, PTP IEEE 1588v2.
- Seamless integration in any O.S. using standard drivers.
- Uses CPU independent from server.
- Extra port for connecting an Ethernet network segment.

Today digital transformation is partly based on the highest processing capacity of the current equipment. This powerful computing allows to perform advanced analysis at a reasonable cost. Additionally, it is possible to create a digital model based on the performance of real world's elements and predict future responses upon specific input data. All this new Artificial Intelligence (AI) applied to different aspects of operational systems allows to create new applications based on verticals for these systems.

This is what AP Sensing has done. Based on HP/Agilent heritage, with over 25 years of fiber optic measurement leadership, the company stands for top quality and well-designed solutions for distributed optical sensing (DTS, DAS, DVS). One of these innovative solutions is aimed at the Electric sector and in particular at the power generation and transformation centers.

Today's power grid needs to operate at the highest possible safe capacity level. To protect the infrastructure, high safety margins are applied which can limit the efficient use of the power cable infrastructure. Real-time thermal monitoring balances the need for asset protection and network performance optimization.

Distributed Temperature Sensing (DTS) provides continuous monitoring of high power cable temperatures, detecting hotspots, delivering operational status, condition assessment and power circuit rating data (Real Time Thermal Rating - RTTR, Dynamic Cable Rating - DCR).

DTS utilizes the Raman effect to measure temperature. An optical laser pulse sent through the fiber results in some scattered light reflecting back to the transmitting end, where it is analyzed.

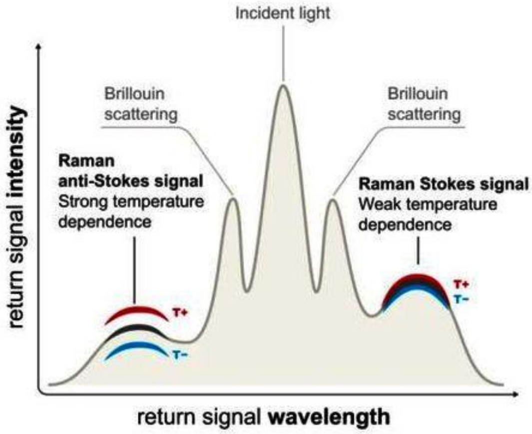


Figure a

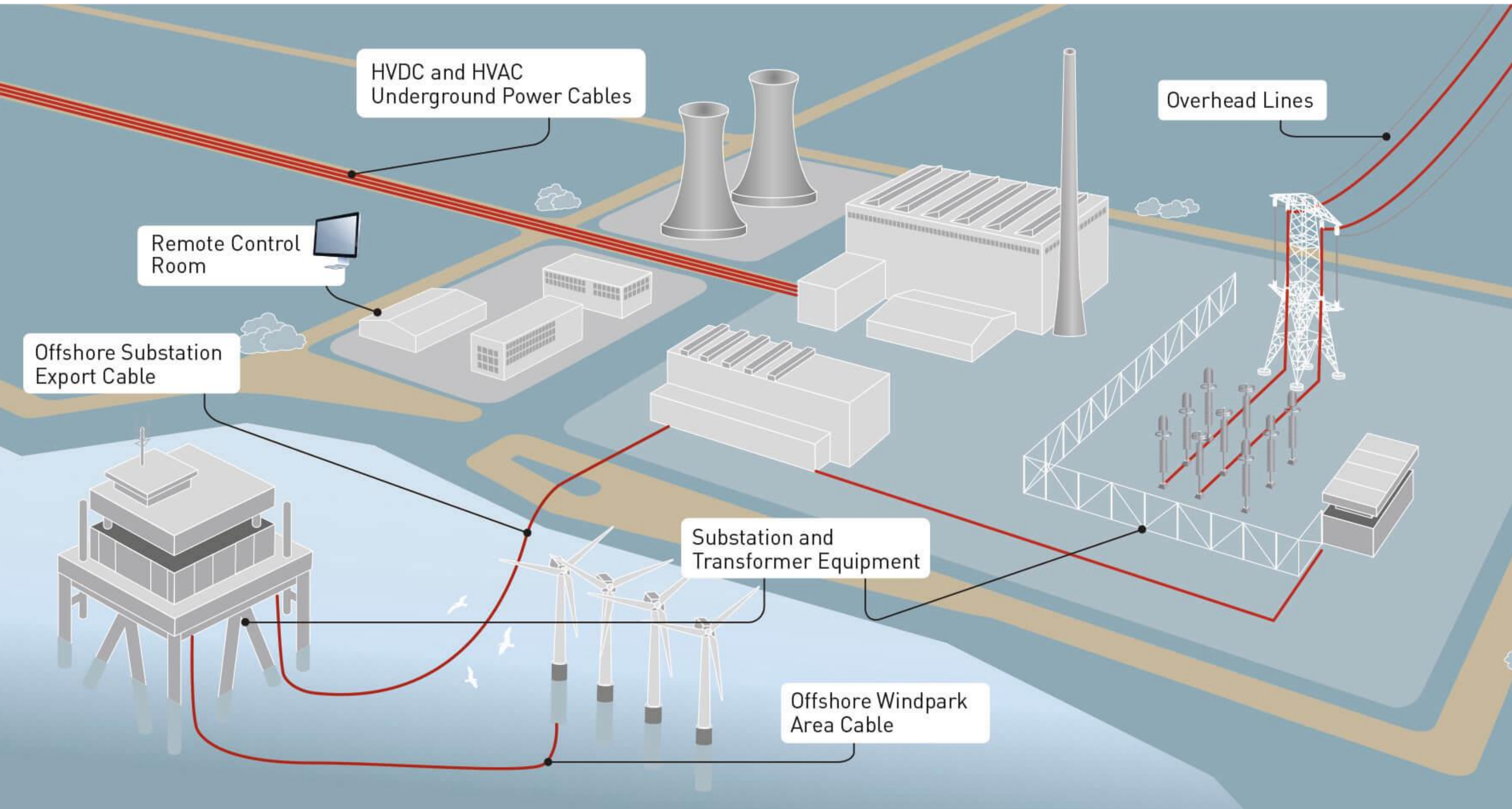
The intensity of the Raman scattering is a measure of the temperature along the fiber. The Raman anti-Stokes signal changes its amplitude significantly with changing temperature, the Raman Stokes signal is relatively stable.

The position of the temperature reading is determined by measuring the arrival timing of the returning light pulse similar to a radar echo (Figure a). This method is called OTDR (Optical Time Domain Reflectometry).

AP Sensing uses the Raman OTDR technology with some unique techniques such as code correlation technology and a single receiver design for both Stokes and anti-Stokes. This approach results in outstanding system reliability (immune to the effects of strain, which can lead to anomalous readings), accurate measurements and high performance.

On the other hand, Distributed Acoustic Sensing (DAS) provides fault detection as well as TPI (third party interference) protection both on land (digging and drilling) and subsea (anchor drop and drags). This helps to optimize the transmission and distribution networks and reduces operational costs.

These systems detect vibrations and capture acoustic energy along the optical fiber. The fiber functions as if there were thousands of microphones installed. Classification algorithms are used to detect and locate, for example, intrusion activities.



Various DAS / DVS technologies are used in the market. Depending on the application and project requirements AP Sensing is able to offer the most suitable technology, fully integrated into AP Sensing's software suite.

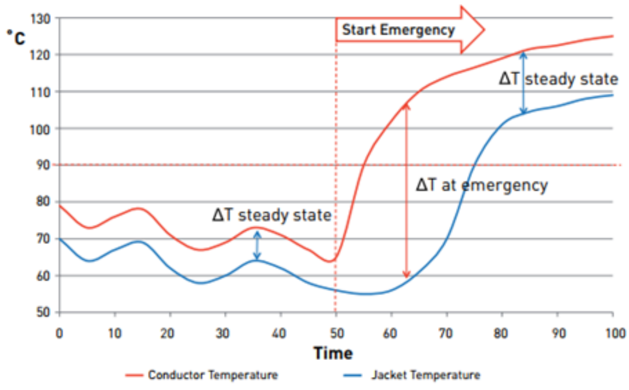


Figure b

In 2017, AP Sensing was for implementing one of its monitoring systems in Saudi Arabia, specifically in 5 digital substations of the local Utility.

Its customer had implemented high-availability networks in the control and station bus of its facilities and the contractor had to adapt its communications to the existing network.

Nowadays, high-availability networks for critical systems is a must. From the technical point of view, the most advanced solutions ensure non-packet-loss in case of single network failure and "Plug & Work" operation.

Furthermore, customers demand interoperable and standardized solutions in order to avoid a proprietary vendor approach. In this sense, the International Electrotechnical Commission (IEC) has worked intensively to define High-Availability Ethernet based solutions.

The two protocols that ensure zero-delay recovery time in case of a network failure are: High-availability Seamless Redundancy (HSR, IEC 62439-3-Clause 5) and Parallel Redundancy Protocol (PRP, IEC 62439-3-Clause 4).

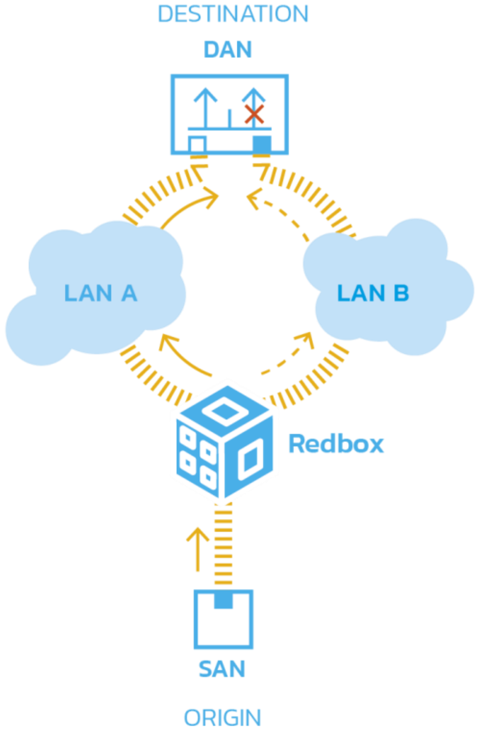


Figure c

PRP (Figure c) redundancy is implemented in the nodes rather than in the network. Especially adapted nodes (Dual Attached Nodes – DANs) are connected to two independent Ethernet networks (LAN A and LAN B) and send the same frames over both networks.

One of the requirements state by the Utility was using PRP communications based on hardware, instead of a software based implementation of the protocol.

The benefits of a hardware implementation of PRP are **low latency, high throughput and the most important thing, more robustness** based of the independence of the solution from the CPU of the device. Also, a hardware based PRP avoids a software implementation of the standard IEEE 1588 on the host CPU. This software would be required even for the Transparent Clock operation required for all switched IEEE 1588 frames. This overhead is a remarkable risk for simple PRP software implementations.

The Utility had deployed in those 5 substations a high-quality hardware PRP network and wanted that all the end point devices performed at the same level. On the other hand, one of the concerns of AP Sensing was having to deal with complex communications that could affect the performance of its applications.

After a thorough testing of the RELY-SYNC-HSR/PRP-PCIe card (Figure d), AP Sensing validated the solution as the most stable platform for the project that the company was developing in the Arabian Peninsula.

Figure d

One of the main benefits of the device was its **independence from the Operating System** installed in the computer where it was hosted. This characteristic simplified the integration needed in each new implementation and provided important **cost savings** in every new project.

Additionally, the customer was able to integrate and monitor the new device in its network with successful results.

The configuration used in the project (Figure e) was based on a single RELY-SYNC-HSR/PRP-PCIe card that provided three **configurable SFP ports**.

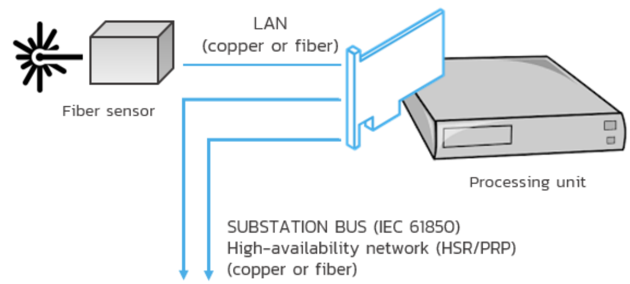


Figure e

One of them was connected to the fiber sensor through a 1000 Base X Fiber SFP, allowing high speed data reception from fiber sensors. The other two SFP ports were used to connect the processor unit to the PRP network through 100 Base FX fiber SFPs, converting the **processor unit in a dual attached node** of the substation network and avoiding the need of additional networking devices.

Relyum equipment heart is based on a multi-core **programmable SoC electronic architecture**, satisfying the most demanding needs of Data acquisition, computing and networking application in the Edge. The embedded CPUs are ARM processors that share the same silicon die with a leading-edge FPGA. This reconfigurable logic enables ad-hoc hardware cores for low-latency secure networking and parallel Data pre-processing, along with other liquid hardware microservices.

Therefore, another key benefit of this technology is the ability to be **upgraded remotely in order to implement new releases of the standards**.

"Our customer wanted a reliable PRP hardware solution and choosing RELYUM's product we managed to meet its requirements and to gain its trust. Additionally, we were able to seamlessly integrate our system in a complex infrastructure."

Ricardo Vanegas
- AP Sensing Project Manager.-