ViaLite®

GPS Data Time-Stamping

Case Study 014

This case study describes an onshore gas/oil field seismic monitoring system that uses a novel GPS-over-Fibre network to generate real-time, coherent seismographs.

Introduction

The integrity and stability of safety-critical structures such as bridges, dams, viaducts, and high-rise buildings in regions of the world prone to earthquakes or volcanic activity requires extensive use of seismic monitoring networks (SMN). Systems engineers also use SMN to monitor seismic events at petro-chemical facilities and energy generating sites, as well as major oil and gas, and mining exploration sites.

Structural integrity can also be compromised by a number of external natural mechanisms such as temperature cycling, wind, and ice formation. When combined, these climatic elements induce structural mechanical stresses and strains that can cause severe fatigue. In such cases monitoring systems are useful in mapping out structural integrity and assisting in maintenance schedule definition.

Network Synchronisation

There have been major advances in broadband transducer technology (including seismometers and geophones), high dynamic range digitisers, and evolving data acquisition and telemetric networks. This has led to sophisticated systems being developed to monitor structural deformation.

A typical SMN deployment comprises a network of ‘field stations’ linked to an online central processing and data storage office via a terrestrial or off-air telemetry platform.

Each station is linked to an array of field-deployed transducers via data acquisition units and multi-channel digitisers. The resulting telemetry platform transfers data continuously to the data centre using a standard duplex serial interface over radio, telephone or satellite communication links.

A Network Management System (NMS) guarantees effective data capture, processing and storage. The NMS can monitor seismic events in real-time, and map the extent of the disturbance.

Crucial to mapping the extent of any seismic disturbance, is the synchronisation of the data generated by the monitoring transducers. This is achieved by time-stamping the transducer data output using the 1pps time reference from GPS. In field application where site coverage is extensive, delivering a GPS signal over standard coaxial copper links is not possible and an optical fibre transport solution is necessary.

GPS in Monitoring Networks

Case Example - Gas/Oil Field Seismic Monitoring

Figure 1 illustrates a typical onshore gas/oil field seismic monitoring system. Some field sites may require a monitoring grid of several square kilometres containing in excess of 200 geophones.

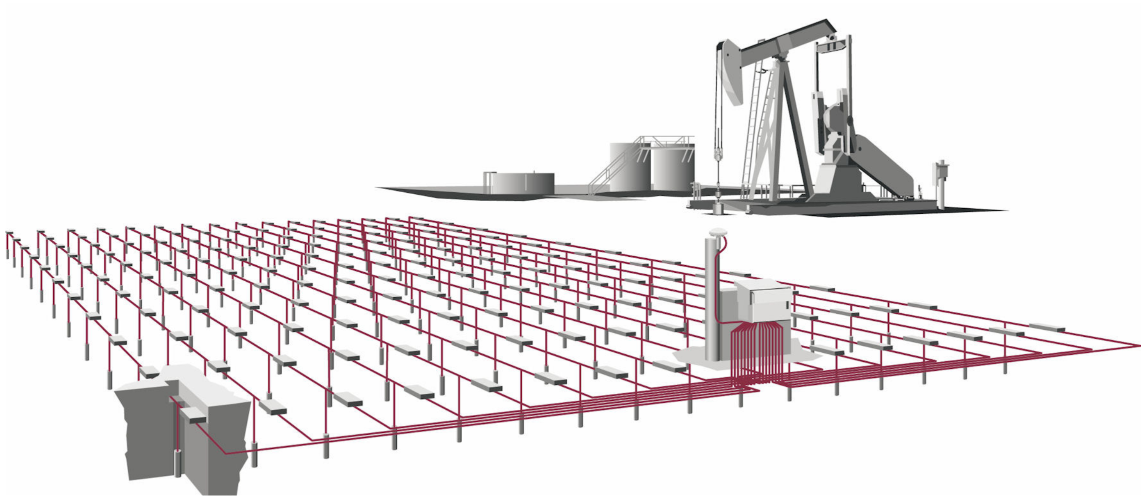

Figure 1 - Oil field overlaid with an array of geophones connected by fibre.

The actual seismic monitoring system comprises an array of geophones and data acquisition units; multi-channel recorder, field processor, and NMS. The recorder digitises the acquired analogue signal from the buried geophone, and time-stamps it using an integral GPS receiver before passing it on to the field processor. In this way, a real-time acquisition and processing system can record all in-coming signals and generate a coherent seismograph of the site.

ViaLite GPS-over-Fibre is an innovative fibre optic transmission platform that delivers an accurate GPS timing reference to each geophone, enabling effective data time-stamping over large monitoring mesh networks. The physical fibre layer comprises Passive Optical Network (PON) components designed to distribute optical signals over a mesh-type network.

The ***ViaLite*** GPS-over-Fibre system, shown in Figure 2, has been designed to transport off-air GPS timing reference signals over an optical 'star-type' distribution network that comprises passive optical splitters, tap-couplers, and a remote head-end.

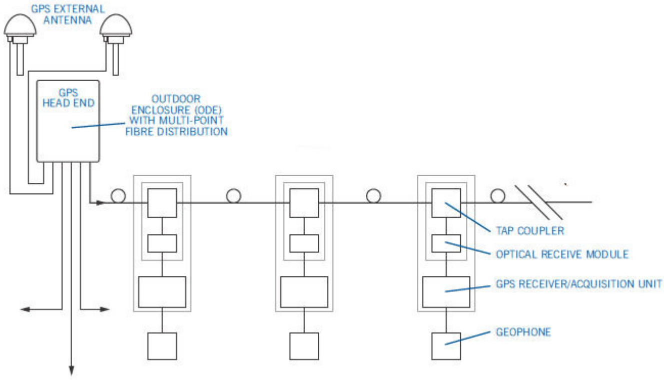

Figure 2 - Schematic of a GPS-over-Fibre deployment.

The GPS head-end shown in Figure 2 behaves as a distribution node. It receives off-air L1/L2 GPS reference signals and converts it into an optical signal (see Figure 3 'How it works') prior to distribution across a matrix of geophones via a point-to-multipoint single mode fibre optic network.

Opto-electrical GPS receivers integrated inside each data acquisition unit linked to individual geophones, delivers vital timing information that facilitate accurate data time-stamping, resulting in real-time, coherent seismographs of the site.

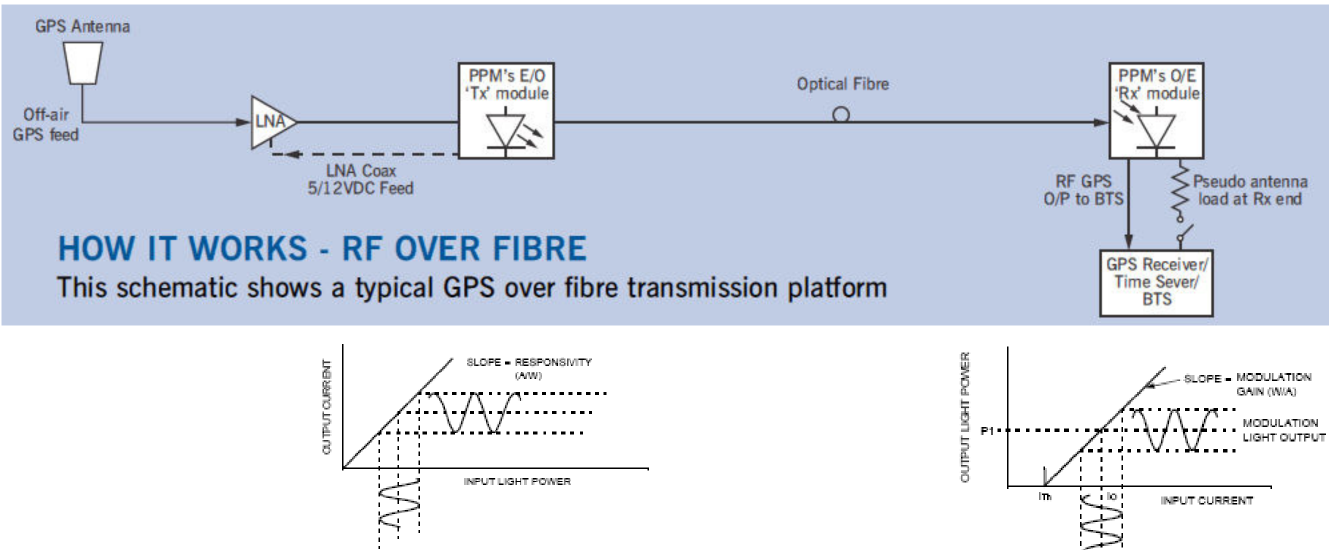

Figure 3 – How it works, GPS-over-Fibre.

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