Ears on Wells

By Sreerema Banoo

The Distributed Acoustic Sensing Technology presents the unique ability to monitor real-time behaviour and performance of reservoirs by listening to it. This breakthrough technology addresses cost-related challenges in reservoir monitoring and management.

Mention fibre-optic technology, and the first thing that comes to mind is its use in the telecommunications industry. After all, these fragile strands of glass fibres support a large part of the world's internet, entertainment and telephone systems, and have transformed the way we network and communicate. Let's face it, without fibre-optic technology the Netflix we know today would not exist.

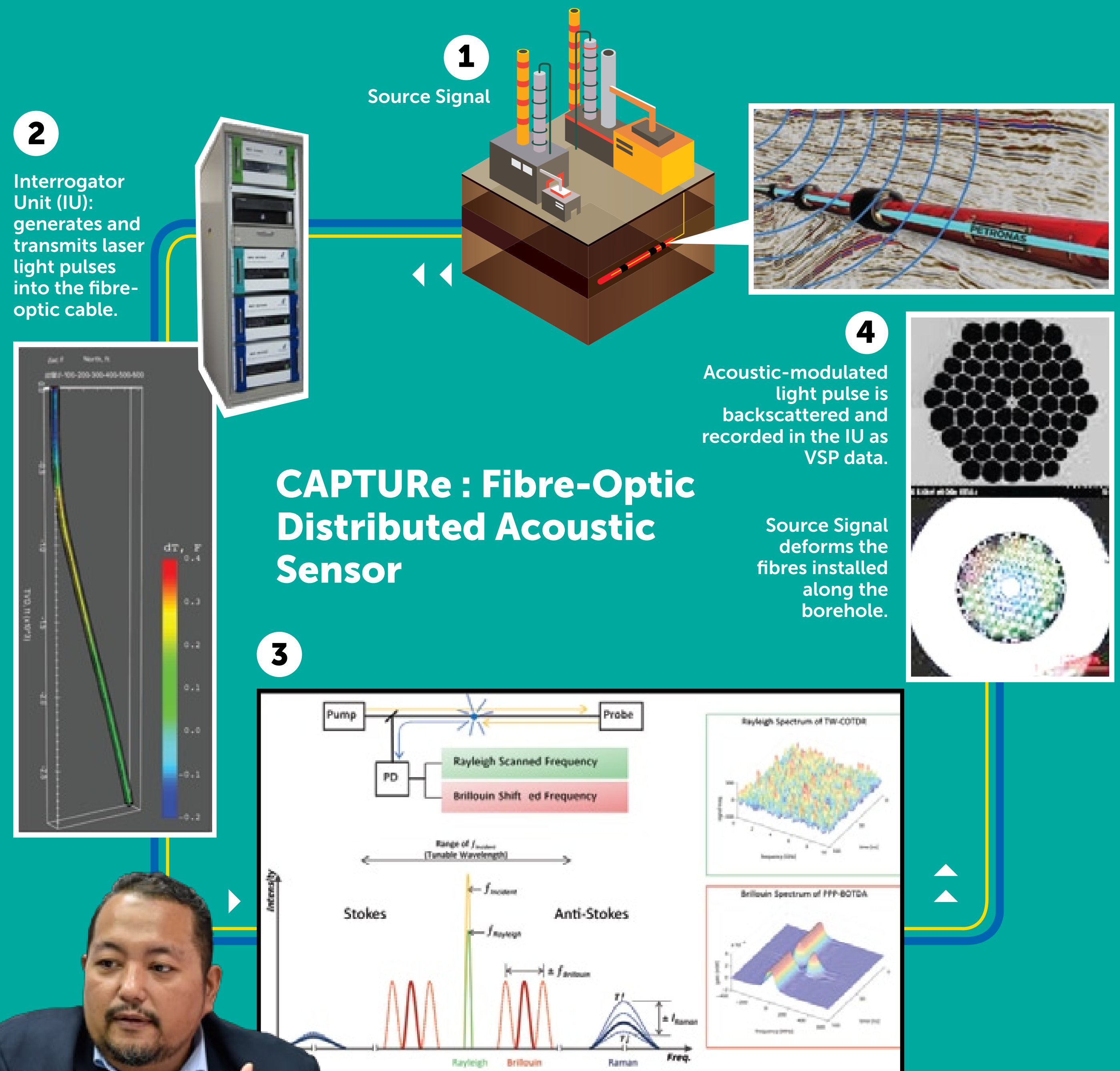
The application of fibre-optic technology also goes beyond the communication or data transmission sectors. In the medical field for example, fibre-optic technology allows doctors to diagnose, monitor and treat patients more easily and at greater comfort for patients.

Although fibre-optics has already been used in the oil and gas industry in the form of distributed temperature sensing (which is already an established well monitoring technique), there are other ways it can be applied as part of the industry's continuous quest to explore and produce hydrocarbons safely and efficiently, with as little environmental impacts as possible. At a time when the industry is faced with challenges on all fronts, technological breakthroughs are a boon.

A breakthrough in subsurface surveillance

The most recent of these applications is the utilisation of fibre-optics for distributed acoustic sensing, or in simple terms, as listening devices along the wall of a well or pipeline.

Head of R&D Exploration Technology at PETRONAS Group Research and Technology, Dr Ahmad Riza Ghazali says distributed acoustic sensing heralds a breakthrough in subsurface surveillance and monitoring. "Fibre-optic cables can be installed inside a well and along pipelines – allowing us to monitor in real time the flow of hydrocarbons, if there is bypass oil, and detect leakages or problems on the pipeline by pinpointing the exact location of the leak or problem area," he says.



Dr Ahmad Riza Ghazali

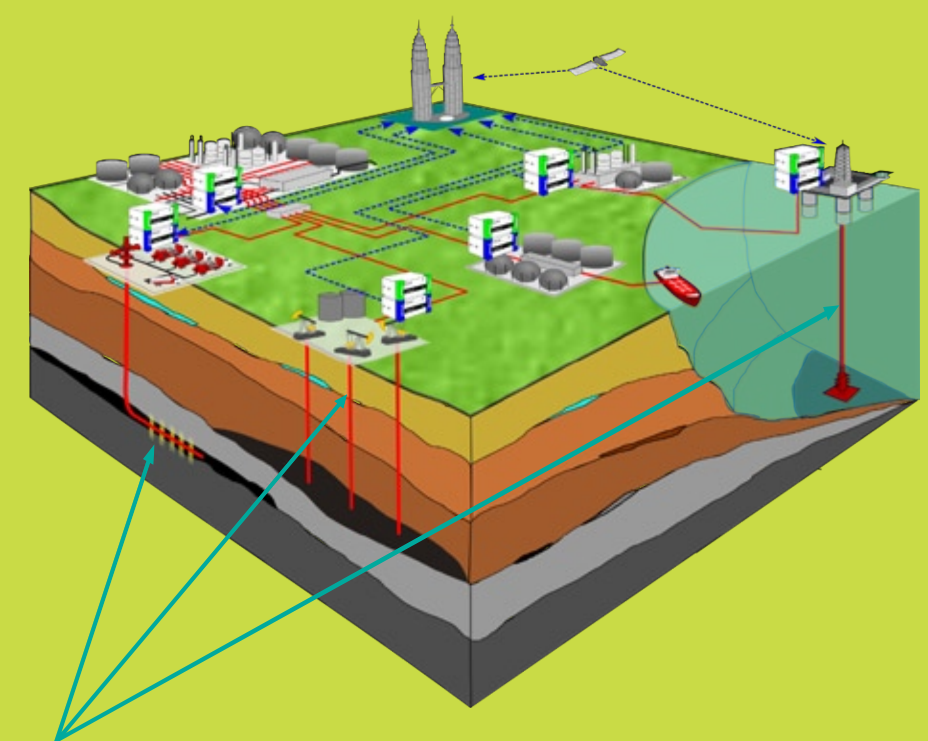
Data obtained is critical in reducing exploration and development risk. It also helps manage costs by identifying oil and gas prospects more accurately, trimming drilling costs, and placing wells more effectively.

Placed along the length of a well or pipeline, distributed acoustic sensing essentially turns fibre-optic cables into millions of tiny microphones that allow the operator to listen to what's happening along the length of that well or pipeline.

Acoustic sensing works by sending laser energy pulses to the optical fibres and analysing the naturally occurring Rayleigh backscatter (which is scattered light that returns directly to the source).

Light pulses, interact with the materials that make up the optical fibres as they travel – creating small changes in the amount of light that is reflected within the optical fibres. This change in the reflected light can be measured and quantified to indicate both the specific location along the fibre where the change in reflection occurred and the magnitude of its change – allowing for precise measurements.

PETRONAS uses integrated sensors to monitor and optimise reservoir performance, subsurface imaging and assure asset integrity.



PETRONAS Fibre-Optic Multi-Sensor

"There are essentially three components involved in distributed acoustic sensing – an interrogator unit, the fibre-optic cable and the subsurface being analysed," explains Ahmad Riza. During a seismic survey, the interrogator unit will be coupled to the fibres under test – which acts as a kind of receiver - and optical or laser pulses will be sent to the optical fibres. "Due to the impurities in the fibres a small amount of light from a pulse will create backscatter from every location along the length of the fibres, which is then carried back to the interrogator unit," he describes. Because vibrations or disturbances – indicating leaks, for example - along the length of the fibres will change the characteristics of the backscatter, these changes can then be recorded and analysed.

A key tool in multiple initiatives

At PETRONAS, distributed acoustic sensing was deployed in April 2016 at the Bokor field in Sarawak, to resounding success, says Ahmad Riza. Fibre-optic cables were installed in three wells and over a period of one and a half months 56,000 marine airgun pulses were sent onto the fibre-optic cables, and the resulting backscatter received and recorded. "The data was then processed and subsurface images produced," he continues.

The tests conducted by PETRONAS, according to Ahmad Riza, demonstrated that the seismic data could be acquired without having to shut down production. In an industry where time is money, that the tests were conducted successfully without any loss in production is certainly a feather in PETRONAS' cap.

For PETRONAS, distributed acoustic sensing marks a milestone in its seismic imaging capabilities. The use of distributed acoustic sensing will allow for more effective reservoir monitoring. This includes evaluating and monitoring the reservoir's properties and productivity as well as integrating it into the shutdown prevention and maintenance plan.

For example, the technology can be used to mitigate imaging problems related to the so-called gas clouds. A gas cloud is an area where there is gas accumulation in the subsurface, which can result in poor subsurface seismic images.

"This will also be a key tool in our production monitoring, enhanced oil recovery and CO_2 management activities," Ahmad Riza adds.

Going forward, he says there are plans to develop multi-sensor fibre-optic specialty cables to measure elastic wavefield, temperature, pressure, chemical, resistivity and acquire seismic data. PETRONAS is working with strategic technology partners in developing this new multi-sensor specialty fibre-optics. He adds that distributed acoustic sensing can also be applied at surface pipelines or within a chemical complex to detect leaks, as well as be deployed at its unconventional oil and gas fields.

Currently, other than advancement on the distributed acoustic sensing, PETRONAS is developing the real-time proactive monitoring based on this photonic technologies. The full integrated system comprises an advanced interrogator unit and specialty multi-sensory armoured fibre-optic cables. Behind the box, there are hundreds of advanced algorithms ready for future fields.