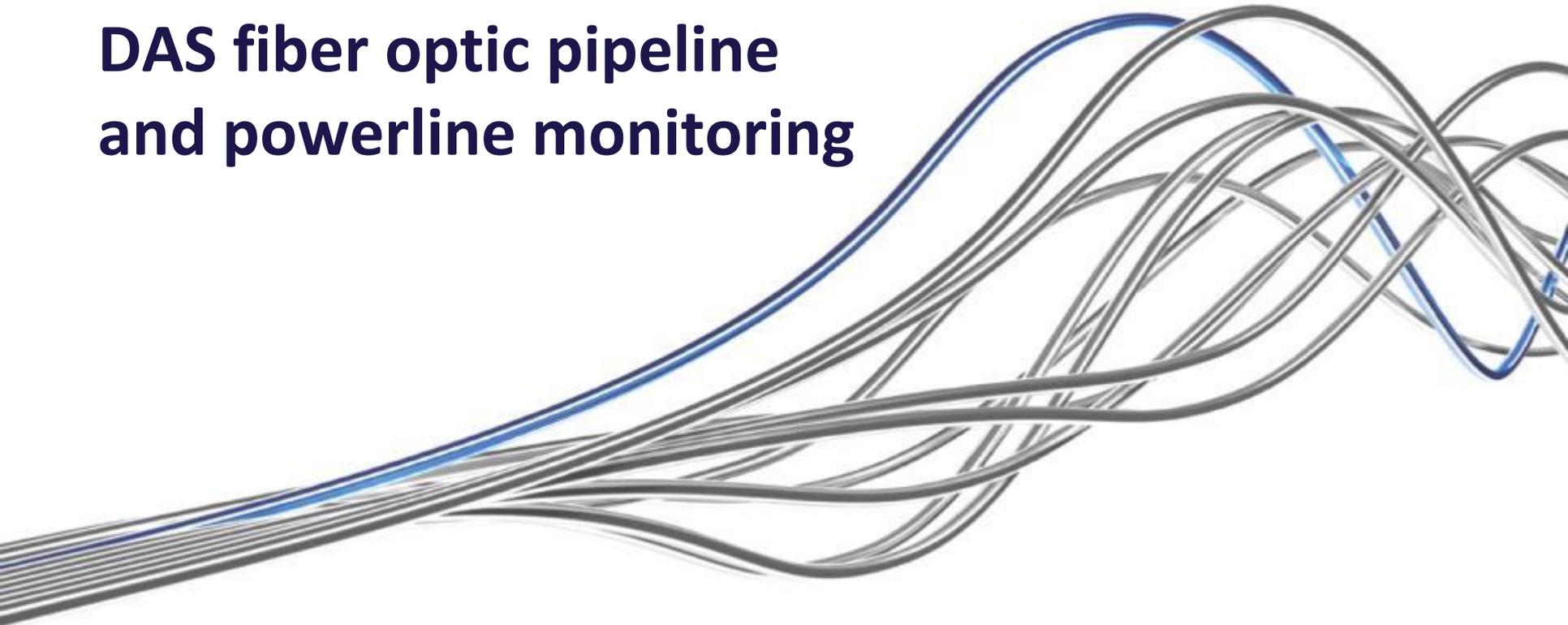




DAS fiber optic pipeline and powerline monitoring

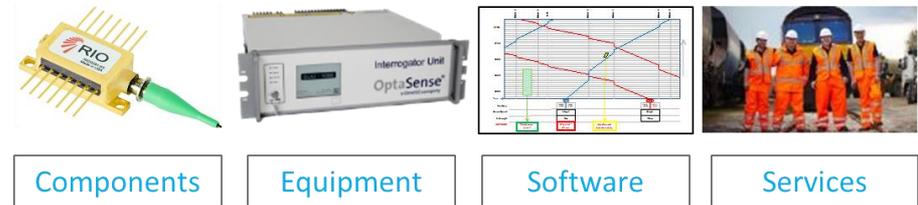


OptaSense®

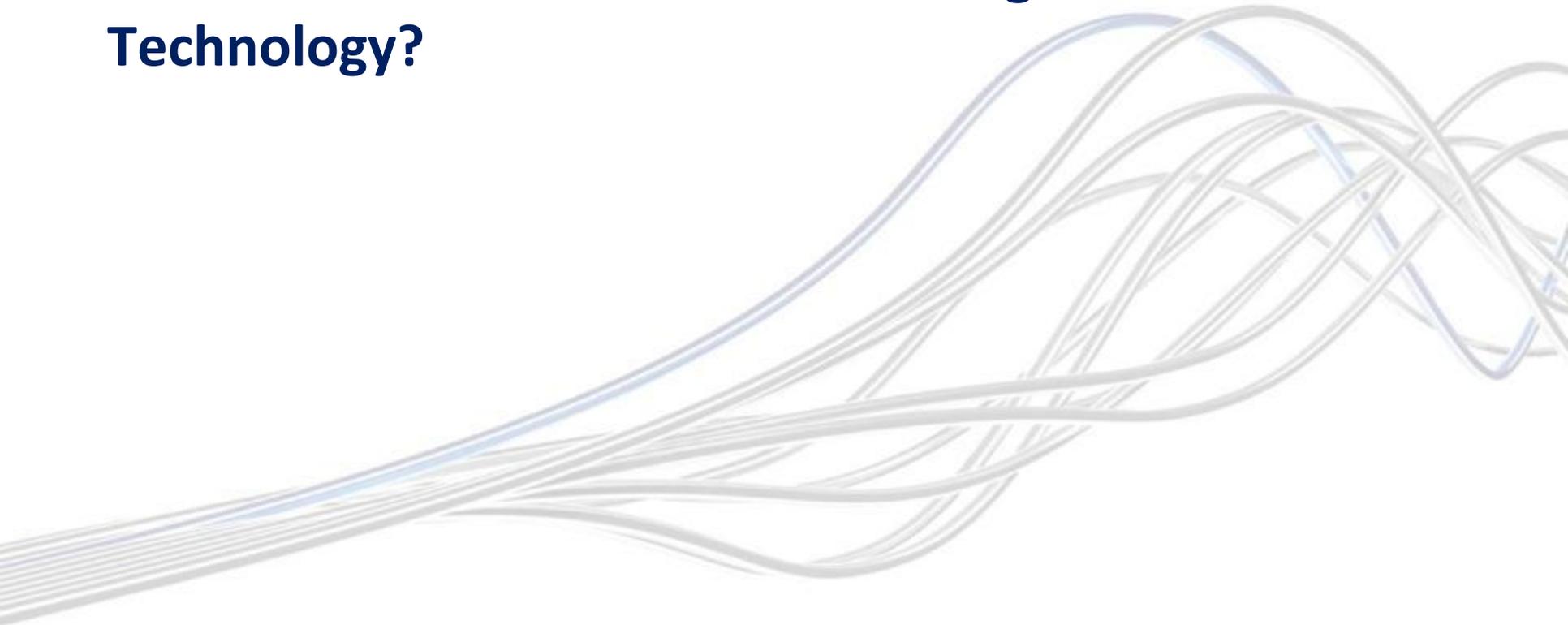
Providing international operations



- Part of the **QinetiQ Group**, a UK based multinational R&D organisation over 1Bn GBP
- **OptaSense** founded in **2007**
- Approximately **160** staff
- Over **150** patents filed
- Headquartered in the UK with offices in USA, Canada, UAE and Australia
- Over **500** systems installed and commissioned in over **50** countries



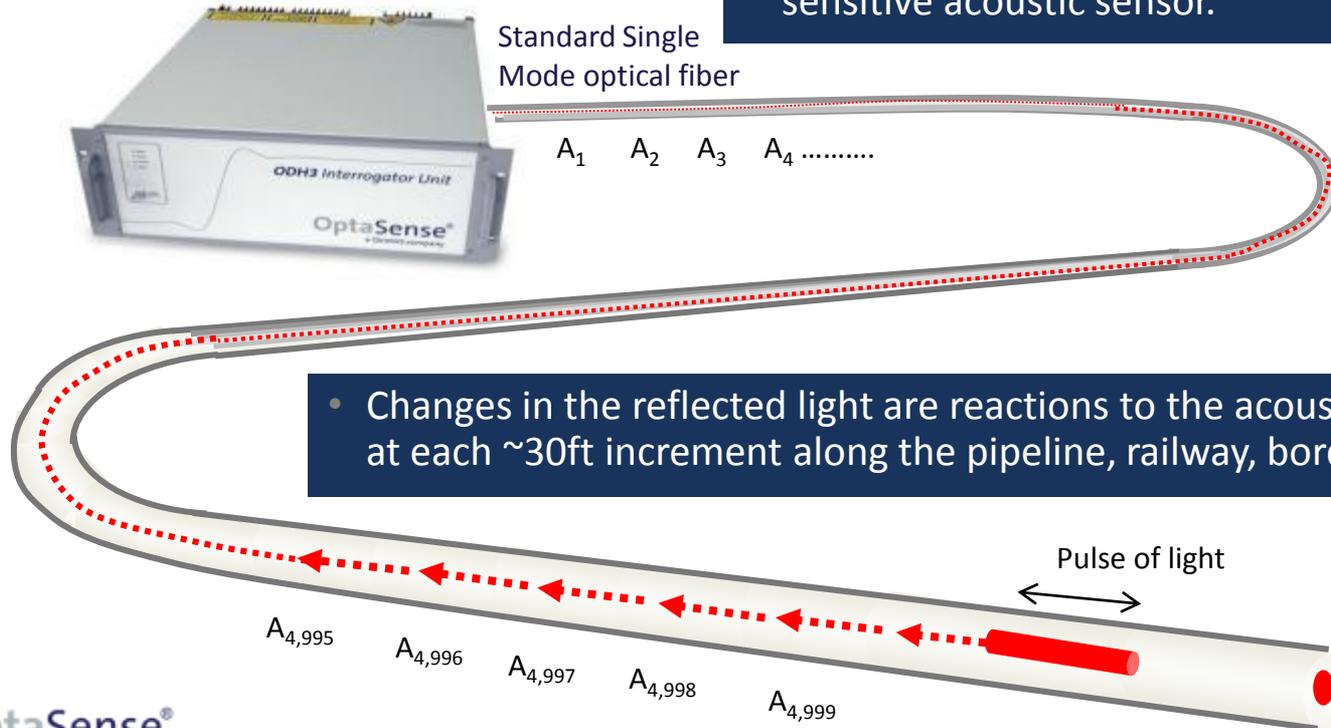
What is Distributed Acoustic Sensing Technology?



Principals of DAS

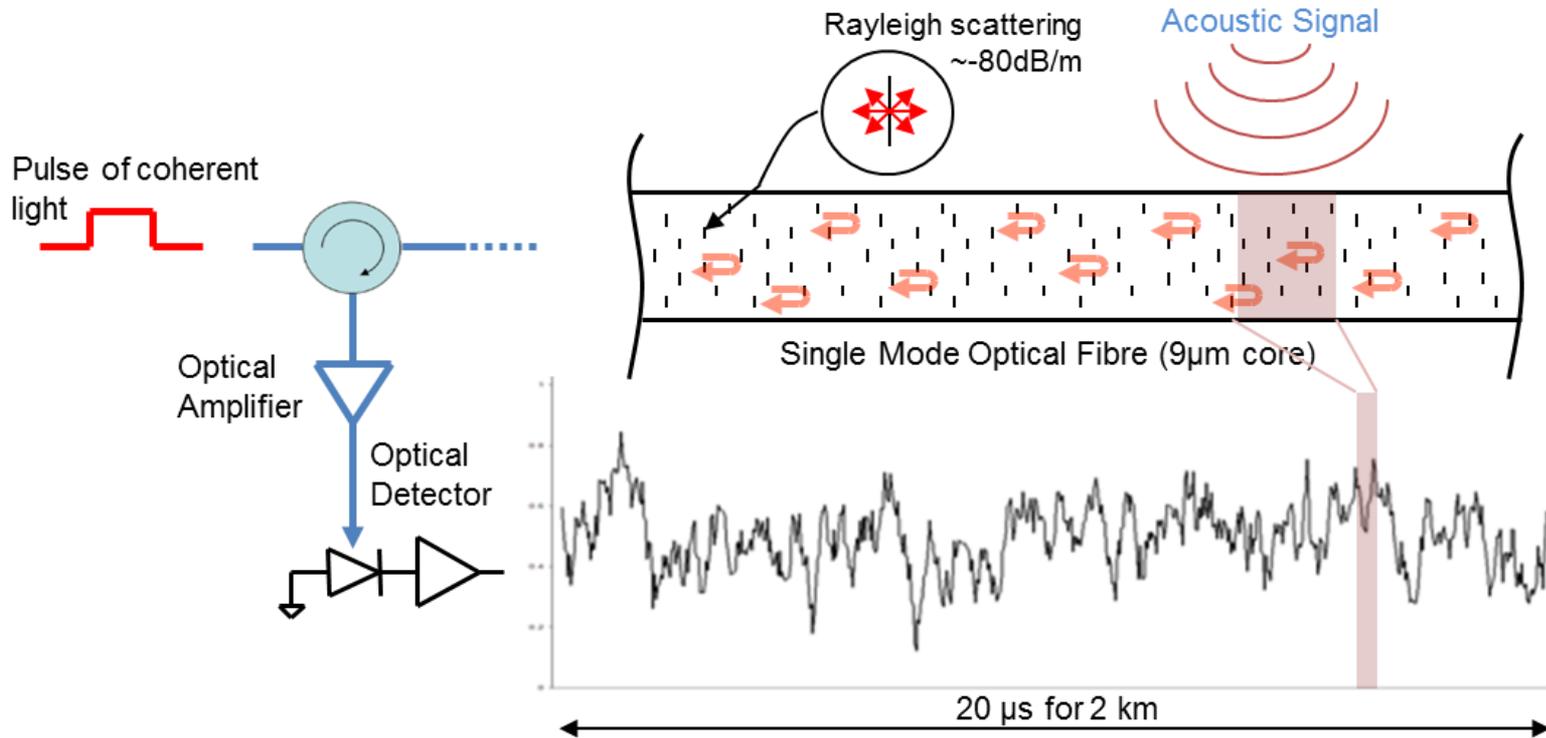
The fiber is the sensor

- OptaSense® employs a Coherent reflection technique which uses the **Rayleigh** backscatter phenomenon of telecoms cable to convert the fiber into a highly sensitive acoustic sensor.



- Changes in the reflected light are reactions to the acoustic activities present at each ~30ft increment along the pipeline, railway, border etc...

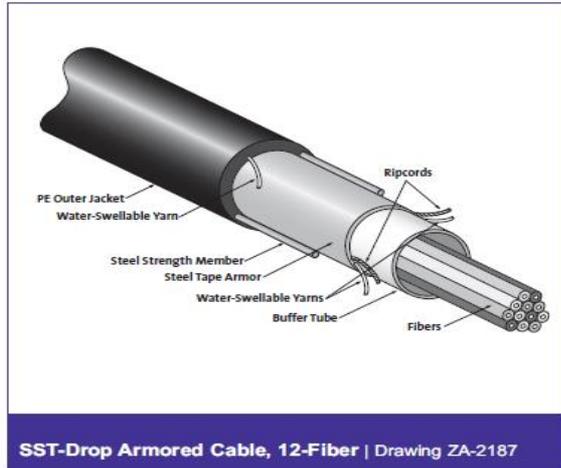
Principals of DAS



About OptaSense®

Convert a fiber optic cable into a listening device every 30ft over long distance

**Standard commercial cable –
up to 25 miles with 1 unit**



OptaSense Interrogator Unit



Oil & Gas



Borders & Perimeters



Defense



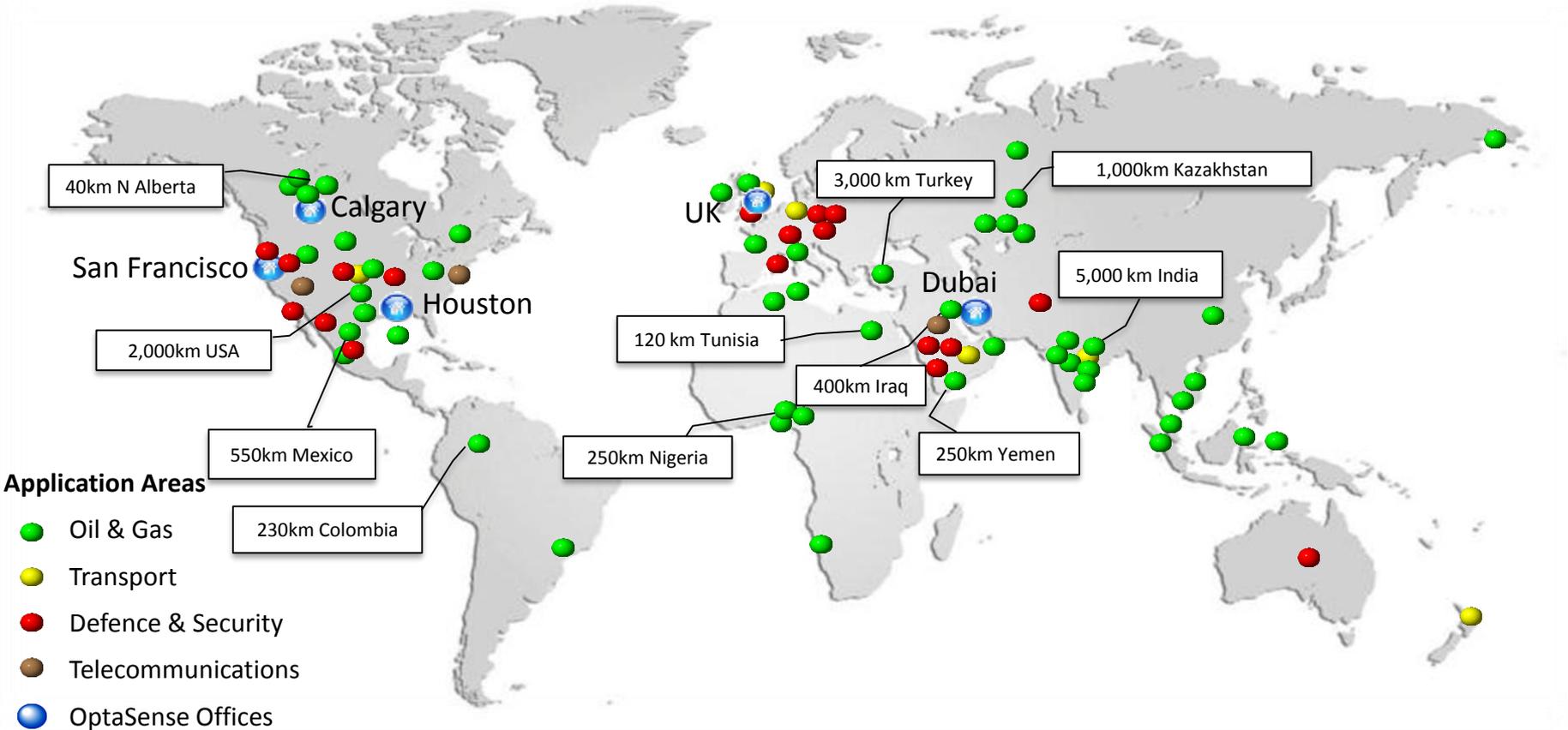
Transport



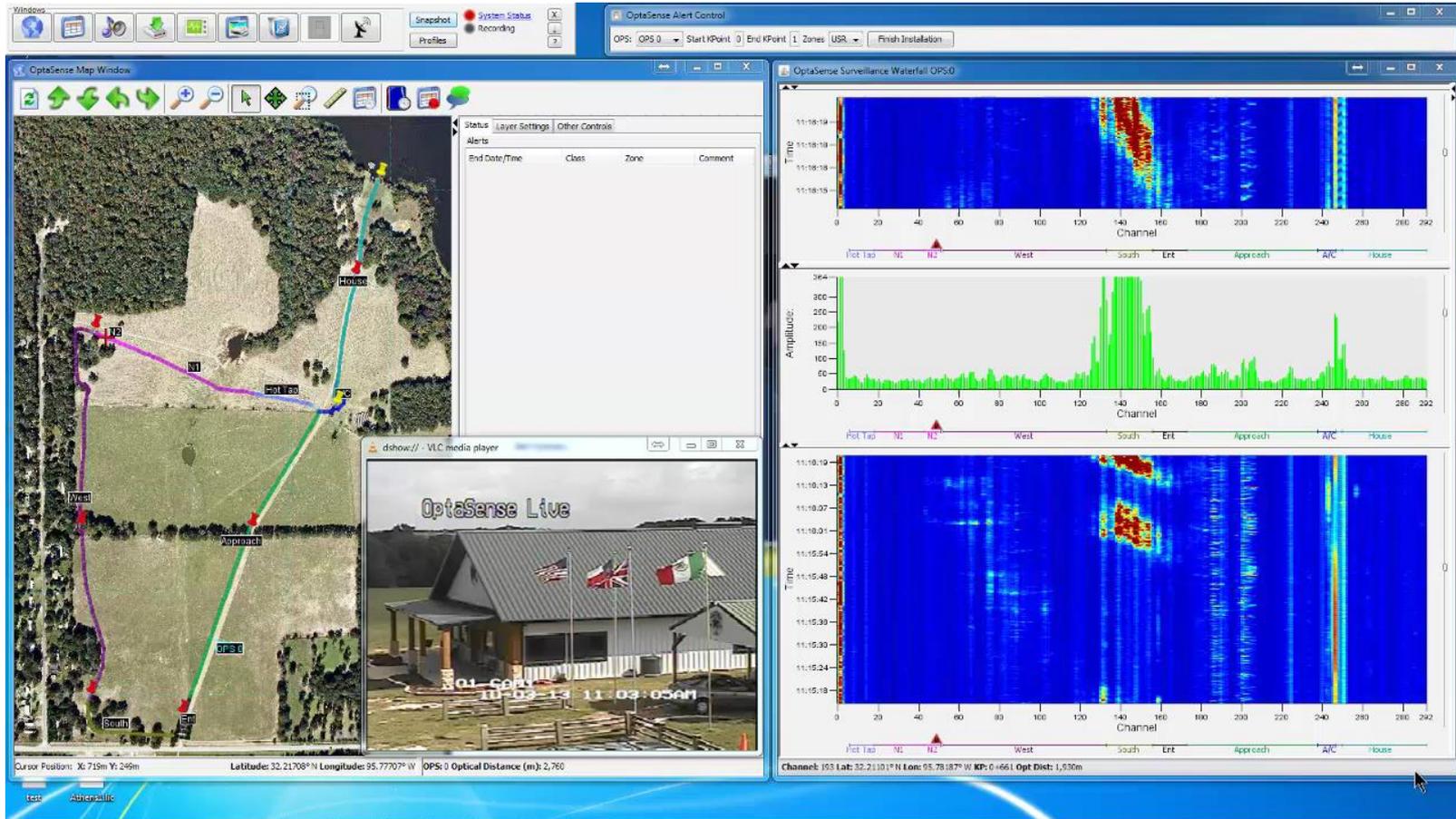
Utilities



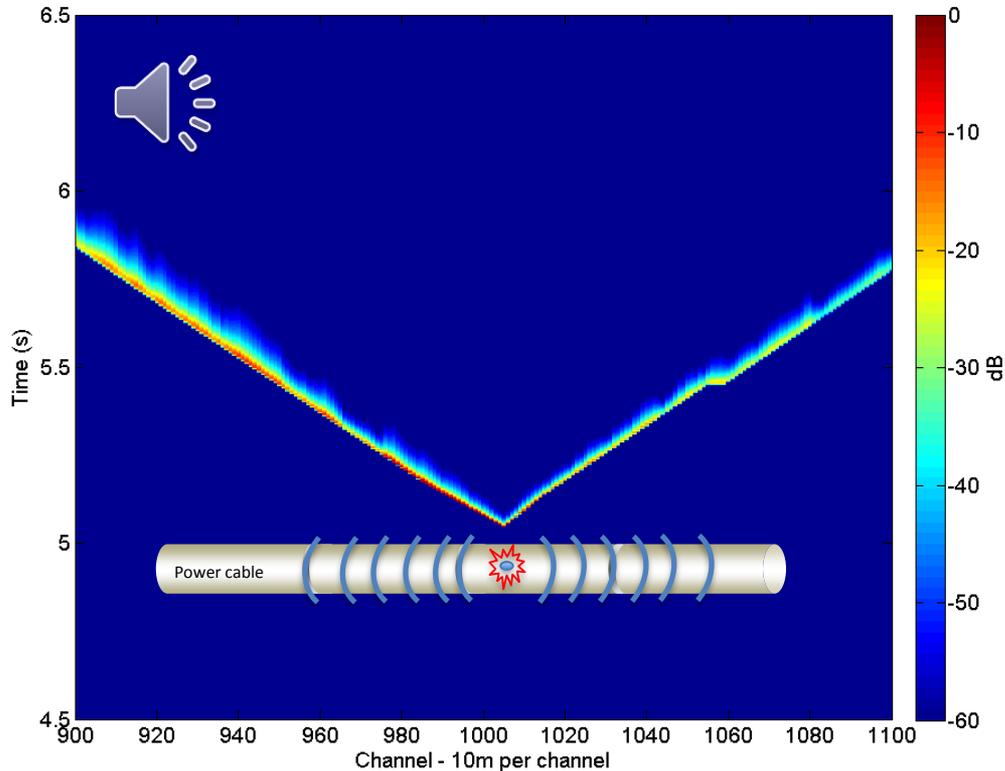
>25,000km proven performance on pipelines



Quick Demo

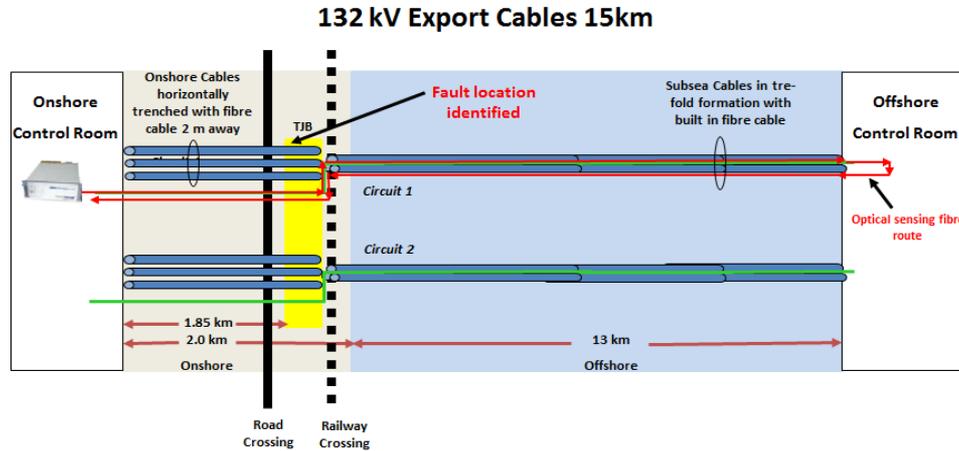


Online fault detection and location



- Acoustic detection of a sudden discharge, seen as a shockwave travelling up and down the fiber - a 'negative pressure pulse'
- A unique signal that can be characterized - part of OptaSense's acoustic signature library for automated alarming
- Location accuracy to 10m or ~30ft, with further geo-calibration possible prior to repair works
- Higher location resolution available at shorter monitoring distances (e.g. ~10ft at 8 miles)

Cable Fault detection case study



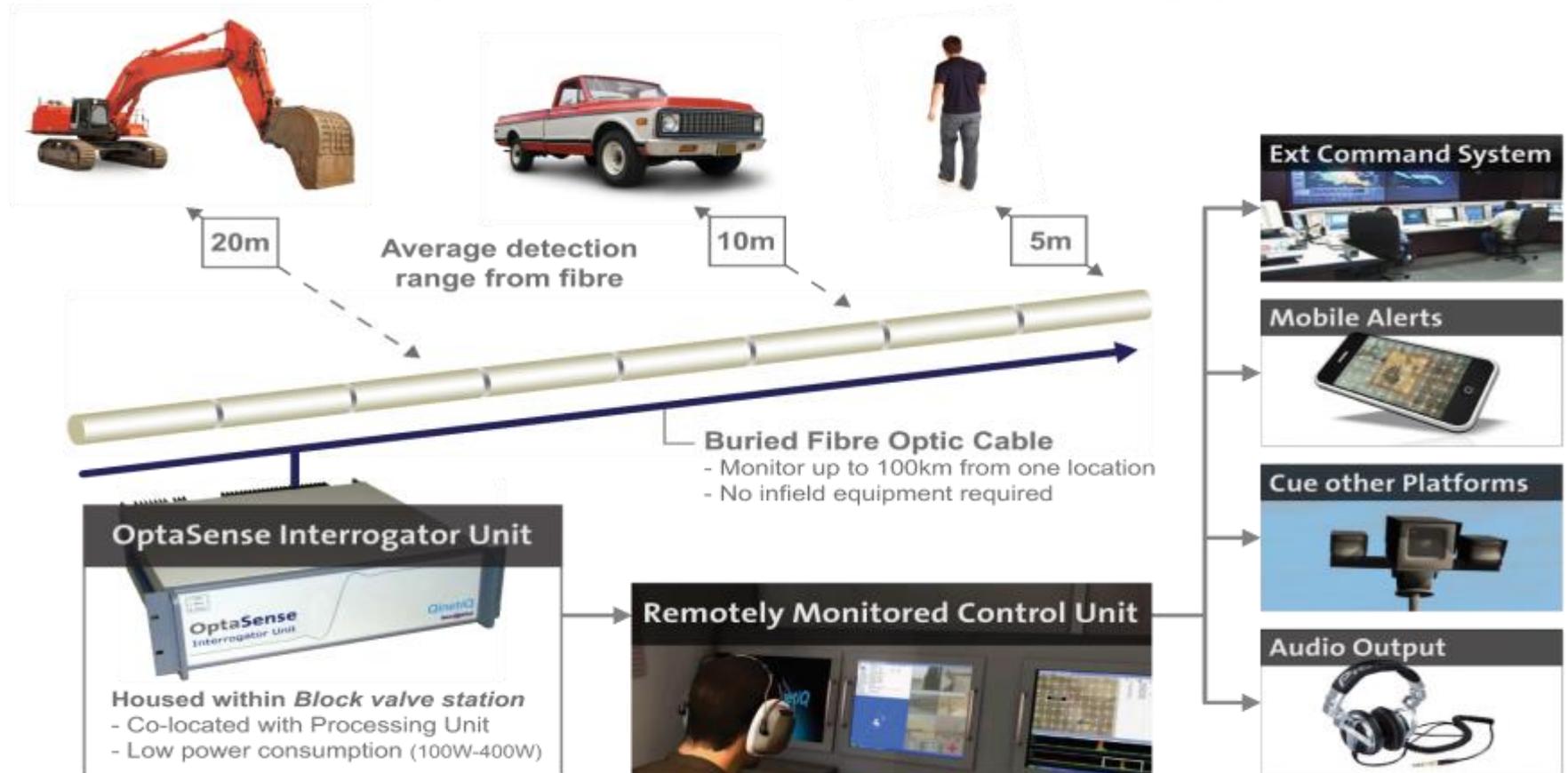
- Offshore wind farm in the UK
- OptaSense called in to investigate location of cable fault (80MW sitting idle and TDR not accurate enough)
- OptaSense connected DAS system to pre-existing fiber

- Using pulse generator (thumper) signal analysis, the fault was detected and located within a day
- Saved the operator millions in downtime (a week instead of months) through rapid fault location / repair
- Online monitoring would have saved even more



System overview

OptaSense can be deployed stand alone or integrated into existing systems

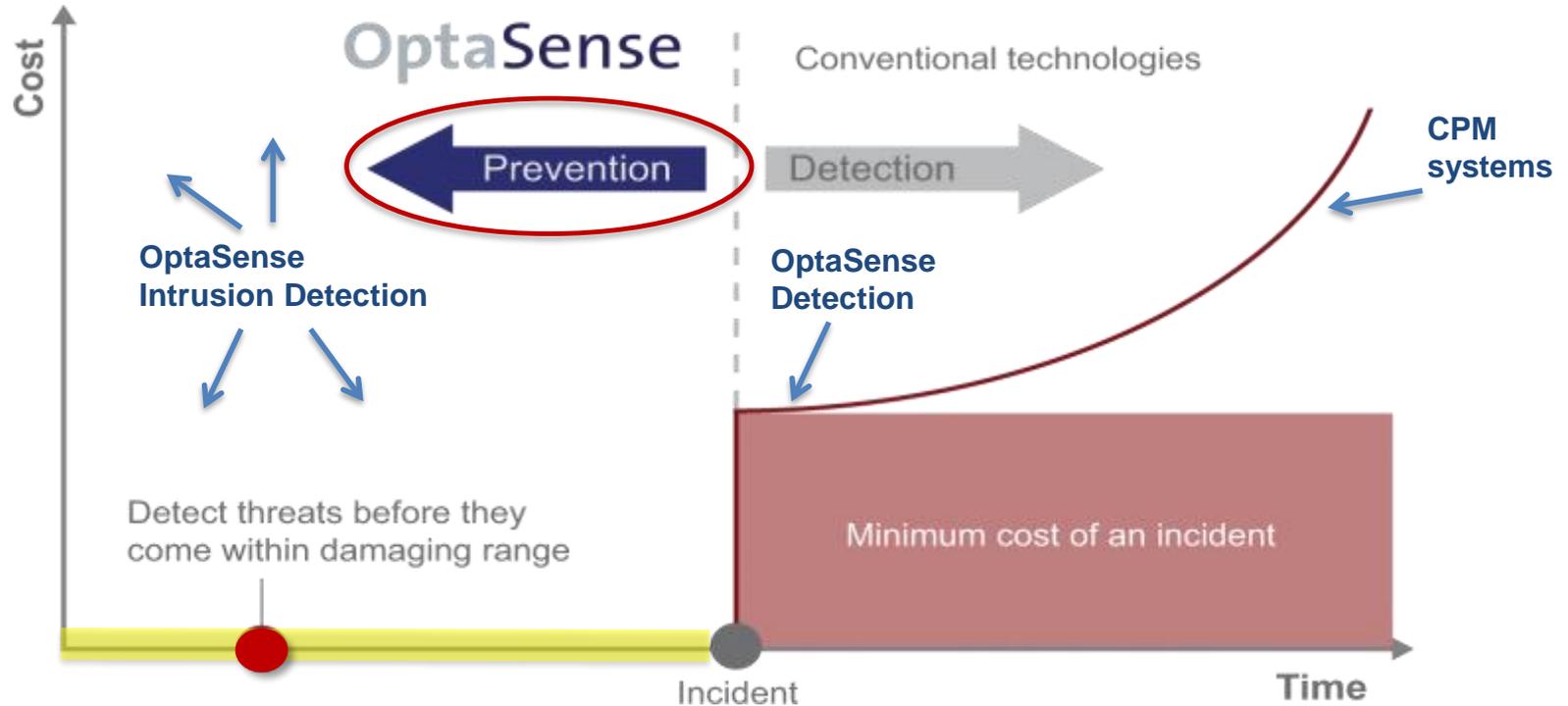


Pylon Intrusion/vandalism detection



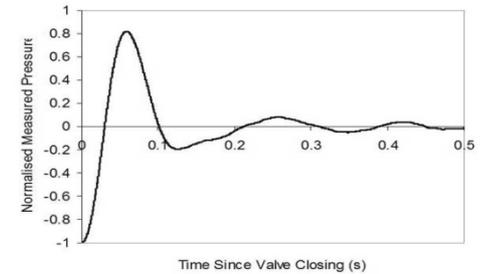
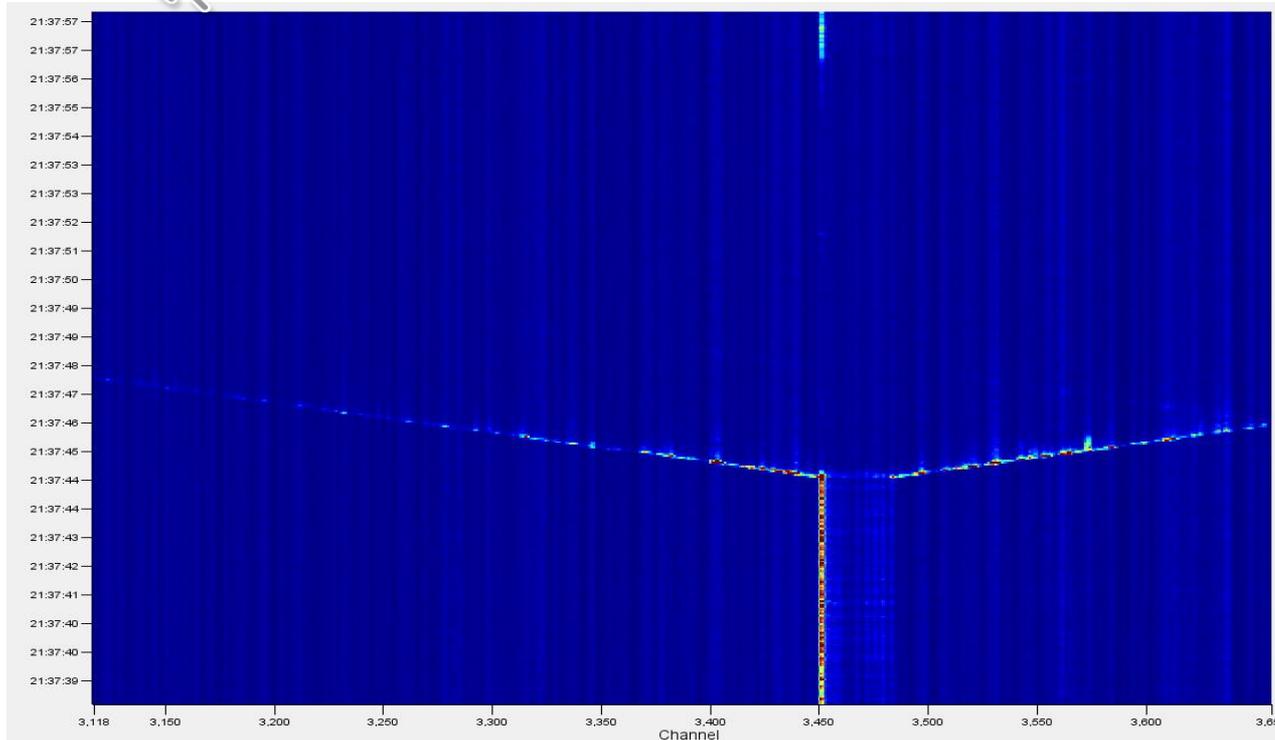
Damage prevention and early detection

Avoid costs altogether or minimize leak impacts



Mode 1: Negative Pressure Pulse

Example: Valve induced pressure wave in a flowing branch tap



$$\Delta P = \rho c_0 \Delta v$$

Joukowski equation
limit for an
instantaneous leak

Multimode Leak – Performance Spec

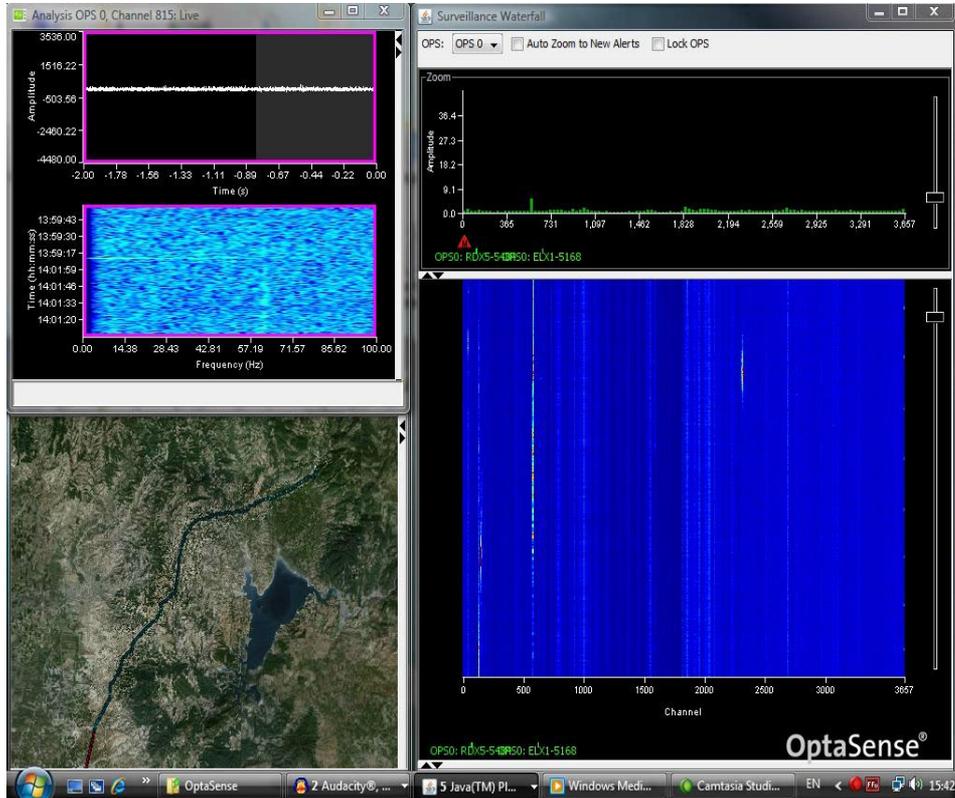
Faster and more sensitive than dominant approaches

	<u>Typical Sensitivity</u>	<u>Response time</u>		<u>Location Accuracy</u>
		<u>Typical</u>	<u>Variances</u>	
<u>Liquid / Buried</u>	<u>200 LPM</u>	<u>5 min</u>	<u>1 min to 20min</u>	<u>±10m</u>
<u>Gas / Buried</u>	<u>2000 SLPM</u>			

Independently verified, this represents around a 10x performance improvement on internal leak detection systems, like CPM. This can mean a 10x lower spill volume.

Earthquake Monitoring

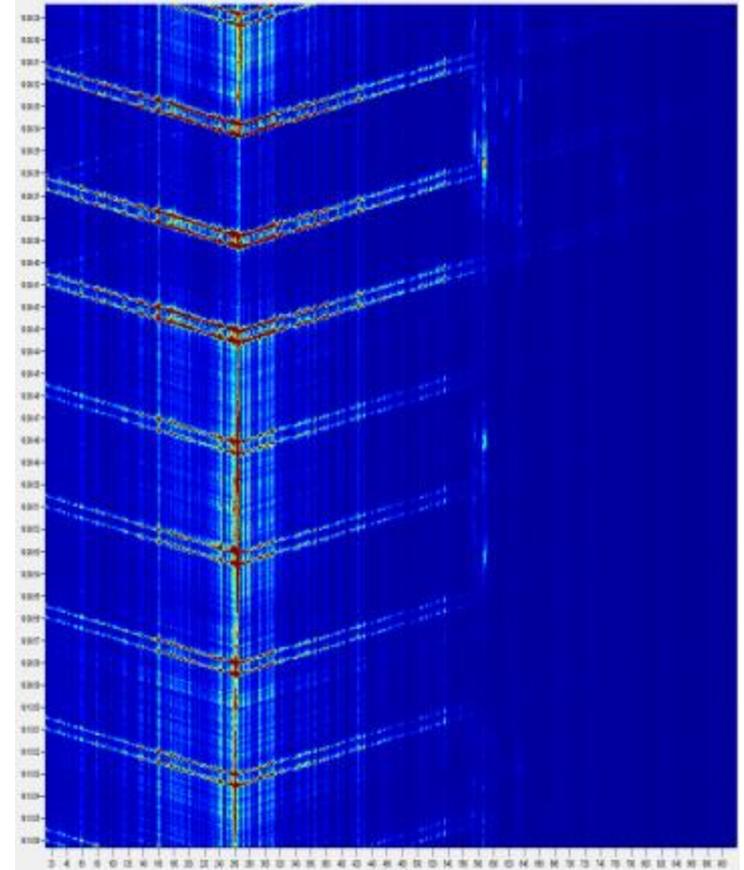
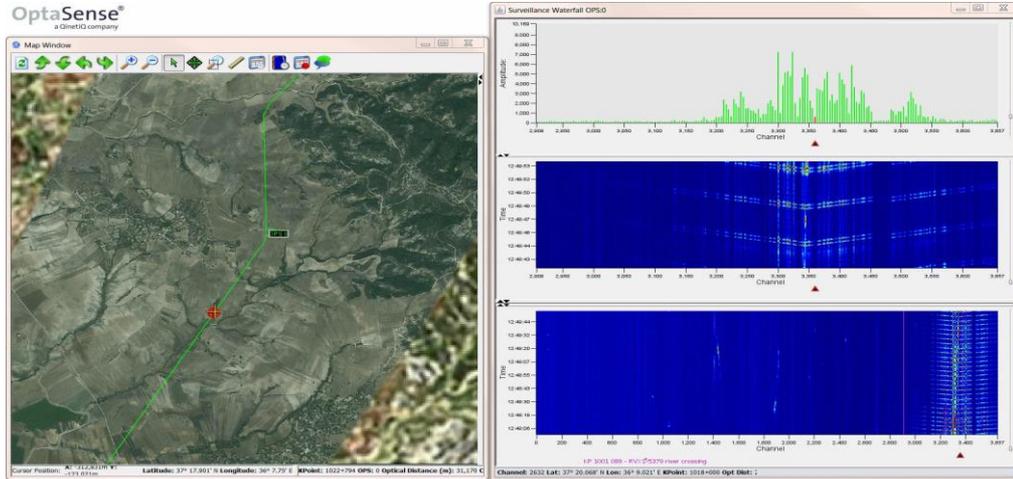
Magnitude 3.8 earthquake in Turkey



- During a routine deployment at a customer pipeline a magnitude 3.8 earthquake was observed and recorded
- OptaSense provided early warning of potential pipeline damage in a seismically sensitive location
- Before and after analysis was preformed in order to focus on inspections

Pig Tracking

Automated detection and tracking of pig in oil pipeline



- The interaction of a cleaning pig / scraper with the side walls and butt welds creates a moving series of pressure pulses
 - Long used for very precise PIG location ID

Monitoring critical energy supply routes into Europe

1,100 miles

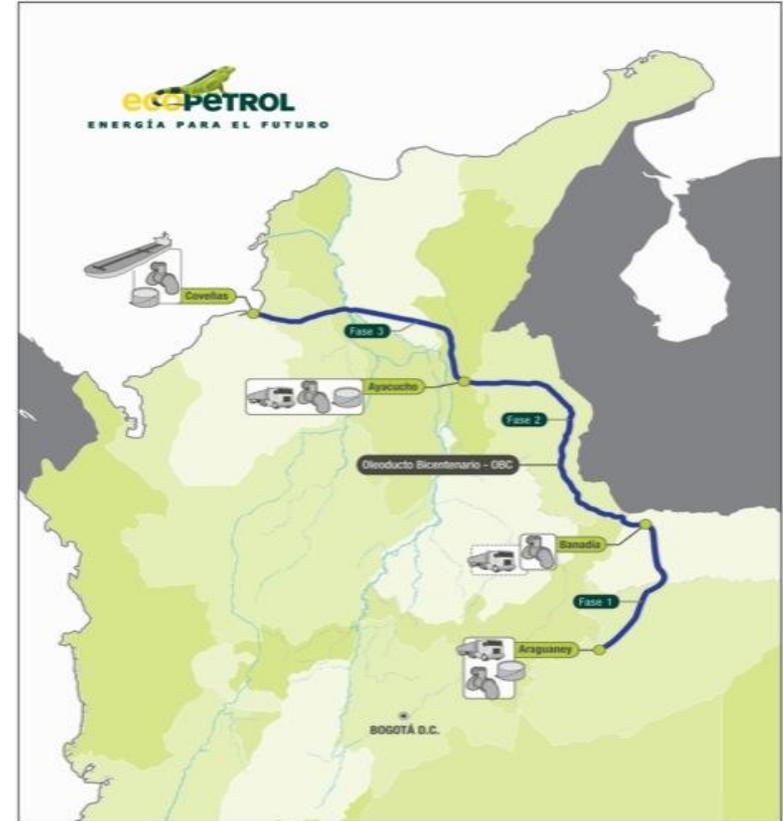
- **Details:**
 - 1,800km gas pipeline
 - 164 units in a networked system
- **Applications:**
 - Leak detection and security monitoring
 - Scope includes in-line facility perimeter security
 - Scope includes a 30km water crossing
- **Benefits:**
 - Commissioned in 2018



Regional Example – OBC Colombia

150 miles

- **Details:**
 - Oil pipeline
 - Installed in 2014
- **Applications:**
 - Intrusion
- **Benefits:**
 - “Since installation, OptaSense DAS has detected multiple intrusions on the pipeline, reducing incident rates and overall pipeline risk.”
Operations Director, OBC
- **Won an ASME global pipeline award 2015**



Integration with Control Systems

Information integration achieved at multiple levels

Alert Activity

- DCS / SCADA

Alert Detail

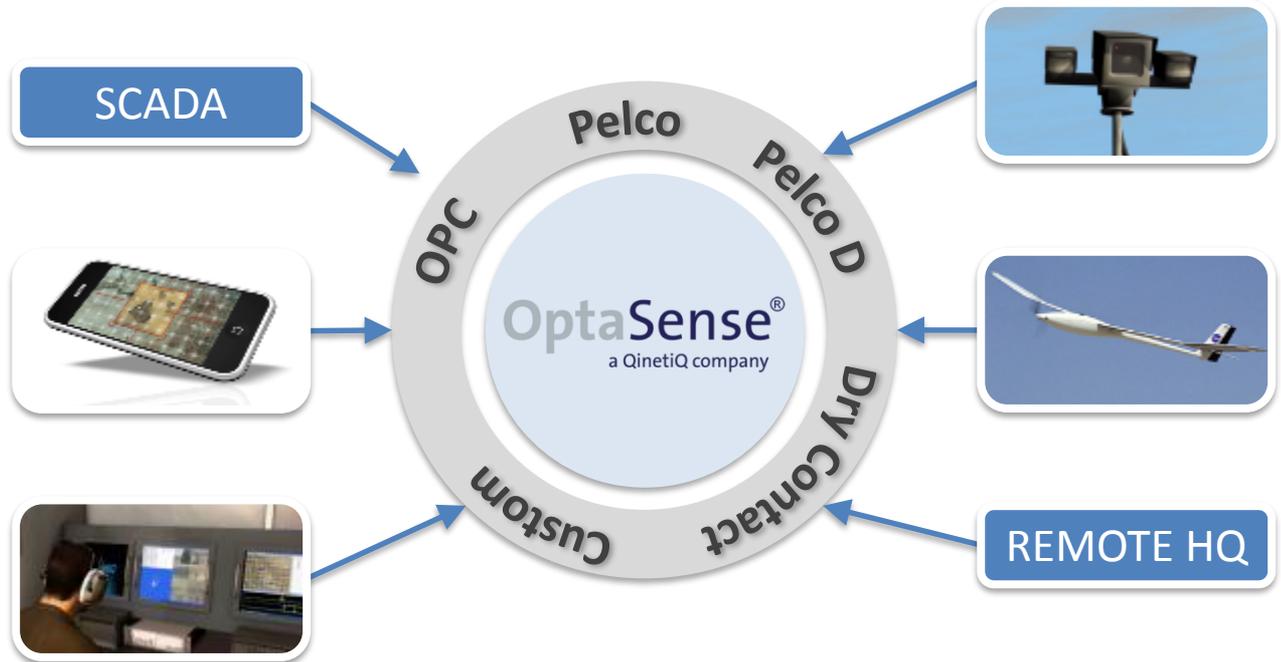
- HTTP / OPC

Duplex Integration

- Flexible GUI Control
- Display control

External Systems

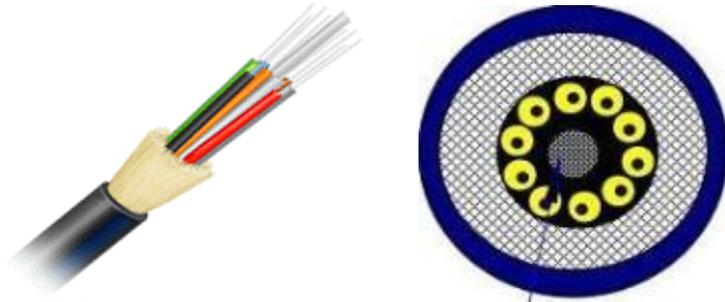
- SMS
- Emails
- Dry Contact



Standard Communication Cable

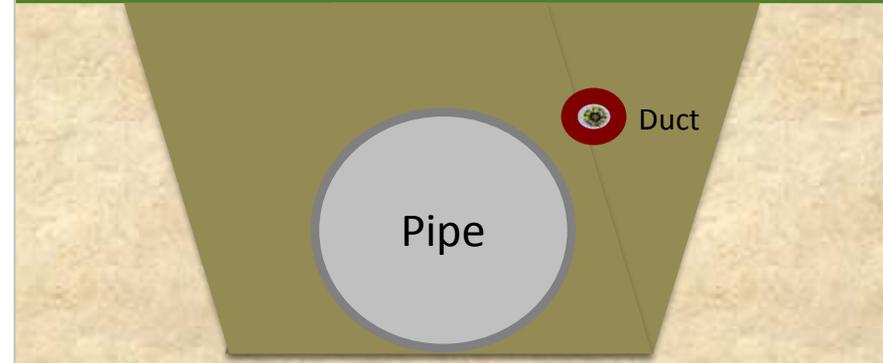
Fiber proximity relative to the asset is important

Standard single mode fiber optic cable



- Gel-filled single mode cable, armored if direct buried or minimal armor if installed in conduit.
- System can be retrofitted to existing Telecoms / SCADA cable (10dB budget per 25 mile segment)
- One fiber used for sensing, the rest can be used for communications
- The system is covert and inert, immune to EMI
- Cheap and robust over long distances – expected life of 30 + years, minimal annual fee

Fiber located in close proximity for Leak Detection



- Can be installed either direct buried or in a HDPE / PVC conduit
- Installation within 3ft of the pipeline is preferred for LEAK, 6-10ft away is acceptable for INTRUSION
- There are conventional industry techniques for HDD, conventional bores and other crossings
- Typically upper hemisphere of the pipe for gas leak detection, lower hemisphere for liquid but proximity to the pipeline is more important

Summary – Value delivered

DAS is emerging as the most capable pipeline monitoring technology

Cost savings: Reducing the cost of asset ownership

- Avoid the costs of pipeline damage through prevention techniques
- Reduce the total spill volume (combine sensitivity and accuracy), minimizing costs
- Understand your pipeline better and make more informed PIM decisions year on year

Improved safety: Proven to reduce incident rates and impact

- Existing clients have seen a quantifiable drop in incident rates over time
- Environmental impact can be avoided or minimized with prevention or rapid detection
- DAS complements the shift to high data networks, increased automation and the IoT

Trusted Partner: A collaborative approach

- By far the largest installation base of fiber optic monitoring systems globally
- Experience has been re-invested into product development and project management approach. We apply this experience, knowing every project has unique requirements