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?
Pulse of light

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

- 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.
Principals of DAS

Pulse of coherent light → Optical Amplifier → Optical Detector

Rayleigh scattering ≈ 80dB/m

Acoustic Signal

Single Mode Optical Fibre (9µm core)

20 µs for 2 km
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

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>25,000km proven performance on pipelines

Application Areas
- Oil & Gas
- Transport
- Defence & Security
- Telecommunications
- OptaSense Offices

OptaSense Offices
- 40km N Alberta
- 2,000km USA
- 550km Mexico
- 230km Colombia
- 250km Nigeria
- 250km Yemen
- 400km Iraq
- 1,000km Kazakhstan
- 3,000km Turkey
- 5,000km India
- 120 km Tunisia

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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 on critical export cable (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
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

Cost

OptaSense Intrusion Detection

OptaSense Detection

Detect threats before they come within damaging range

Minimum cost of an incident

Incident

Time

Prevention

Conventional technologies

CPM systems

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Mode 1: Negative Pressure Pulse

Example: Valve induced pressure wave in a flowing branch tap

\[ \Delta P = \rho c_0 \Delta v \]

Joukowsky equation limit for an instantaneous leak
Multimode Leak – Performance Spec

Faster and more sensitive than dominant approaches

<table>
<thead>
<tr>
<th></th>
<th>Typical Sensitivity</th>
<th>Response time</th>
<th>Location Accuracy</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Typical</td>
<td>Variances</td>
</tr>
<tr>
<td>Liquid / Buried</td>
<td>200 LPM</td>
<td>5 min</td>
<td>1 min to 20min</td>
</tr>
<tr>
<td>Gas / Buried</td>
<td>2000 SLPM</td>
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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 performed 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

- 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

- 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

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