Bandweaver

WHITE PAPER

The Economic Benefits Of Distributed Fiber Optic Sensing For Monitoring And Protection of Pipelines

The Economic benefits of Distributed Fiber Optic Sensing for monitoring Pipelines

One of the keys considerations asked when procuring or designing a Fiber Optic Monitoring System for monitoring a pipeline is always 'What are the benefits and the potential payback for such systems?'. This information can be hard to actively categorise and quantify, partly due to the wide variety of pipelines (oil, gas, chemical, water…) but also due to the difficulties in understanding where or when a leak or intrusion event may occur.

This article discusses this topic and uses a few key data points in order to quantify certain elements of this argument.

What are the applications for Distributed Fiber Optic Sensing within pipelines?

There is a range of applications where distributed fiber optic sensing is employed for protection of pipeline assets

- Leak detection of pipelines from erosion and corrosion. Depending on the product within the pipeline and the potential size of the leak either of the following technologies may be applicable:
  - Distributed Temperature Sensing (DTS)
  - Distributed Acoustic Sensing (DAS)
- Accidental Third Party Interference (TPI) from road construction using DAS
- Detection and Prevention of malicious pipeline tampering (sabotage or theft) using DAS
- Pipeline PIG tracking using DAS
- Detection of seismic activity using DAS
- Perimeter and access Intrusion Detection Systems (PIDS) for compressor stations, pumps stations, refineries, chemical plants and other critical assets

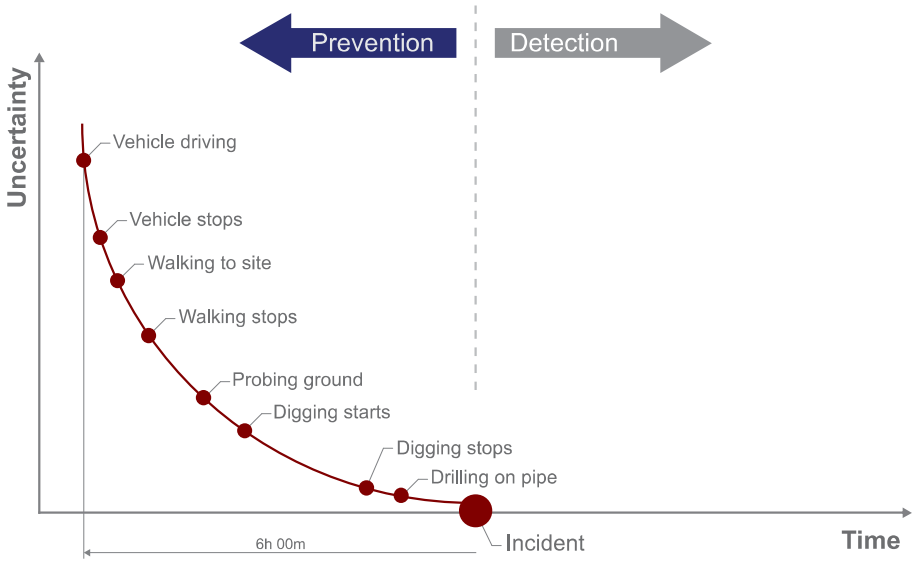
Due to variable project size and the importance of specific monitoring applications to a specific scheme means, the benefits both operationally and in monetary terms will differ from application to application and from site to site.

What are the potential benefits?

A compromised pipeline can be extremely damaging to a pipeline operator. In addition to loss of revenues and production downtime the operator is also exposed to causing significant environmental impact and the potential reputation damage and litigation that can be associated with such events. This highlights the need for an effective and pro-active asset management and protection strategy. Distributed fiber optic monitoring can be an extremely effective tool within an operators asset protection strategy.

Some of the potential benefits of this technology are detailed below:

- Protection of reputation – prevention of leak occurring through detection of third party events (construction, sabotage..) which greatly reduces risk of leak occurrence and subsequent fines and damage to reputation.
- Early detection of leaks (corrosion, erosion…) leads to increased compliance, reduced risk of fines and lower insurance premiums.
- Optimization of planned maintenance program and reduction in unscheduled downtime (effective tracking and monitoring of PIGs)
- Improved security, lower potential for malicious or accidental Third Party Intrusion (TPI) or product theft
- Reduced downtime leading to improved return on investment and delayed capital spending
- Ease of installation, lowering overall cost of ownership (can utilise existing telecommunications infrastructure)



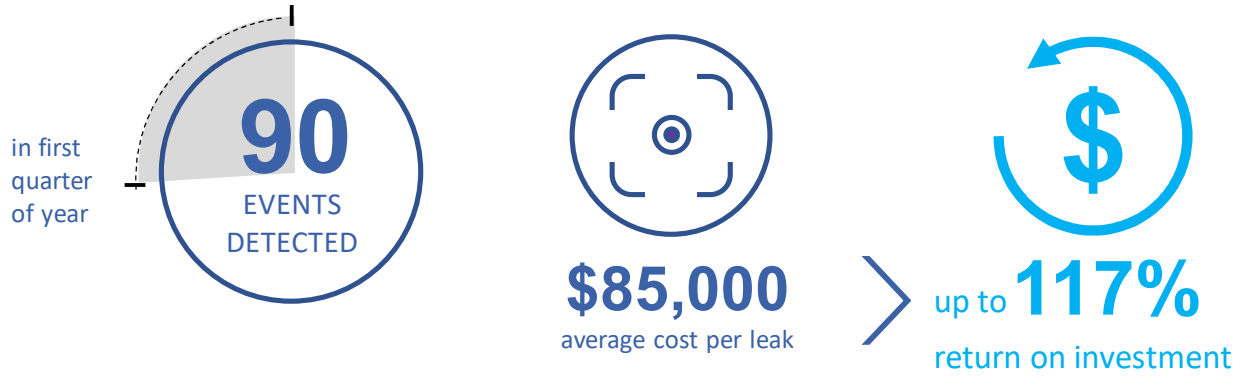
EXAMPLE ONE: Return on Investment Calculation - DAS Prevention of Construction Damage

This specific pipeline operator[1] in Asia operates a natural gas pipeline in an area where there is a lot of construction activity with multiple contractors working along the length of the 145km section that. One of the pipeline operators key concerns was of accidental damage to the pipeline through unauthorised construction activity.

In the subsequent three months following the installation and commissioning of the DAS system, there were approximately 90 unauthorised construction events over a 3 month period that were detected by the Horizon DAS. Of these 90 events at least one of these would have led to a catastrophic leak.

If we assume an installation cost for the DAS of $2-5/m then the total cost for the installation is circa $300-750k for this length of pipeline (approximately 0.5% of total pipeline construction costs for a 42 inch pipeline)[2]

PREVENTION OF CONSTRUCTION DAMAGE



If we take the average clean up cost of leak to be $85,000[3] , which does not include potential fines and loss of product or downtime. Then the annualised Return on Investment for this system is in the range of 47-117%

[1] *Ref: Bandweaver Case Study*
[2] *Ref: https://aer.ca/PennWest-CostPipelineFailure.pdf*
[3] *https://sari-energy.org/oldsite/PageFiles/What_We_Do/activities/GEMTP/CEE_NATURAL_GAS_VALUE_CHAIN.pdf*

EXAMPLE TWO: Preventing Pipeline Theft

It is shown[4] that Nigeria loses around 55,000-300,000 barrels of oil per day through crude oil theft ($20bn per year) and one of the key methods for this theft is direct hacking or tapping into pipelines.

If we look at one single operator SPDC, they alone reports losses[5] of 6,000-25,000 barrels per day through spills due to third party interference. SPDC operates a network of 6,000km[6] implying a loss of 1-4 barrels per day per km. At an oil price of $60 per barrel this implies losses of $21-91k per km per year.

DAS is a very effective method of preventing pipeline theft as almost all theft events will have an associated acoustic signature (walking, digging, drilling, theft flow…) and so DAS typically has a very high rate of detection. However, if we take an extremely conservative approach and say that DAS prevents just 10% of events.

If we assume an installation cost of DAS of $2-5 per km then the DAS will pay for itself in less than 24 hours with the assumption of only a 10% effective detection rate.

PREVENTION OF PIPELINE THEFT

To put it into further context the DAS is cost neutral if detects only 0.02% of theft events. Given that it's effective detection rate is orders of magnitude larger than this, it makes for a very compelling economic argument.

[4] *https://www.researchgate.net/publication/324137351_ILLEGAL_OIL_BUNKERING_AND_OIL_THEFT_IN_NIGERIA_IMPACT_ON_THE_NATIONAL_ECONOMY_AND_THE_WAY_FORWARD*
5 https://www.shell.com.ng/media/nigeria-reports-and-publications-briefing-notes/security-theft-and-sabotage.html
6 https://www.shell.com.ng/about-us/what-we-do/spdc.html

CONCLUSIONS

The above examples show some calculations for specific scenarios and particular products and so are specific to these particular environments. However, there are many other leak mechanisms (erosion, corrosion, seismic activity, mechanical failure….) and different types of pipelines (water, chemical, heated pipelines….). For each specific scenario, a situational based analysis would need to be carried out to evaluate which is the best technology for risk mitigation.

Distributed fiber optic sensing is very versatile and has a number of different detection mechanisms of which acoustic vibration (DAS) and temperature (DTS). It is not always the most effective technique and has certain restraints. However, in certain scenarios as illustrated it can be an extremely powerful tool and there can be considerable economic benefits.

About Bandweaver Technologies

Bandweaver has been providing advanced fiber optic monitoring sensors and integrated technologies since 2002. Their technology portfolio covers a wide range of sensors including distributed Temperature Sensors (DTS) and Distributed Acoustic Sensors (DAS) and integrated smart intelligent software solutions. Within the Power and Utilities sectors, Bandweaver's distributed fiber optic acoustic and temperature sensing systems provide the operator with real time critical information on their network. This assists in reducing planned and unplanned maintenance and avoiding catastrophic failure along with managing risk effectively.

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