omnisens securing
pipeline integrity

Lynx

omnisens
Securing asset integrity

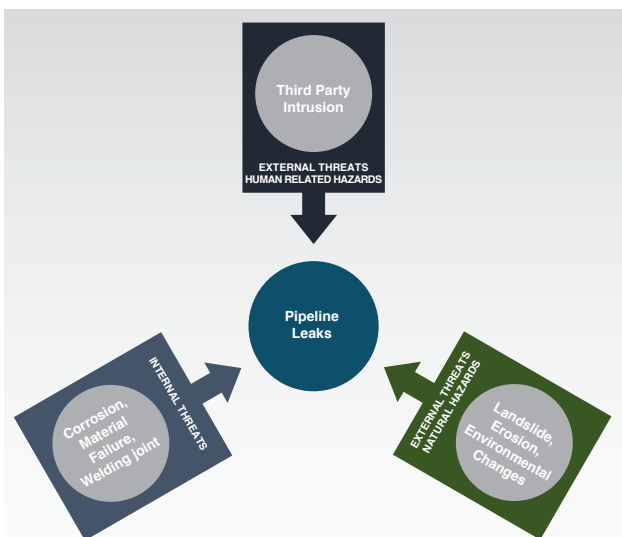# Omnisens Lynx Pipeline Monitoring Solutions

> Prevent pipeline damage through earliest detection of threats
> Detect leaks, ground movement and third party intrusion

WHY MONITOR PIPELINES?

If pipelines leak the consequences are tragic for people, the environment and reputations, hence operators have built up a range of technologies and tools to ensure pipeline integrity.

Fiber optic distributed sensing uses an external fiber optic cable, often included during pipeline installation for communications, to detect leaks, ground movement and third party intrusion. Including an Omnisens Lynx system transforms a fiber optic cable into a continuous, real time monitoring system at minimal extra cost. This valuable technique helps operators detect the earliest stages of threats to the pipeline, giving them time and information to respond before disaster strikes.

Earliest detection of threats is key to pipeline integrity monitoring

WHY CHOOSE OMNISENS LYNX?

Omnisens Lynx is a fiber optic distributed sensing system which detects, locates and profiles small temperature, strain or vibration changes along the entire length of a fiber optic sensing cable continuously in real time. These changes denote a leak, ground movement or intrusion. Omnisens proprietary monitoring software ensures that detected events are intelligently analyzed so that alerts are efficiently communicated and false alarms minimized.

The system comprises:

Omnisens DITEST interrogator: provides powerful and robust measurement and location functions. The measurements of temperature and strain are computed, annunciating alerts when project specific criteria are exceeded for any zone along the pipeline. A small temperature anomaly (early sign of a leak) or fiber strain (first indication of ground movement) can be located to within a few meters over the entire monitored distance.
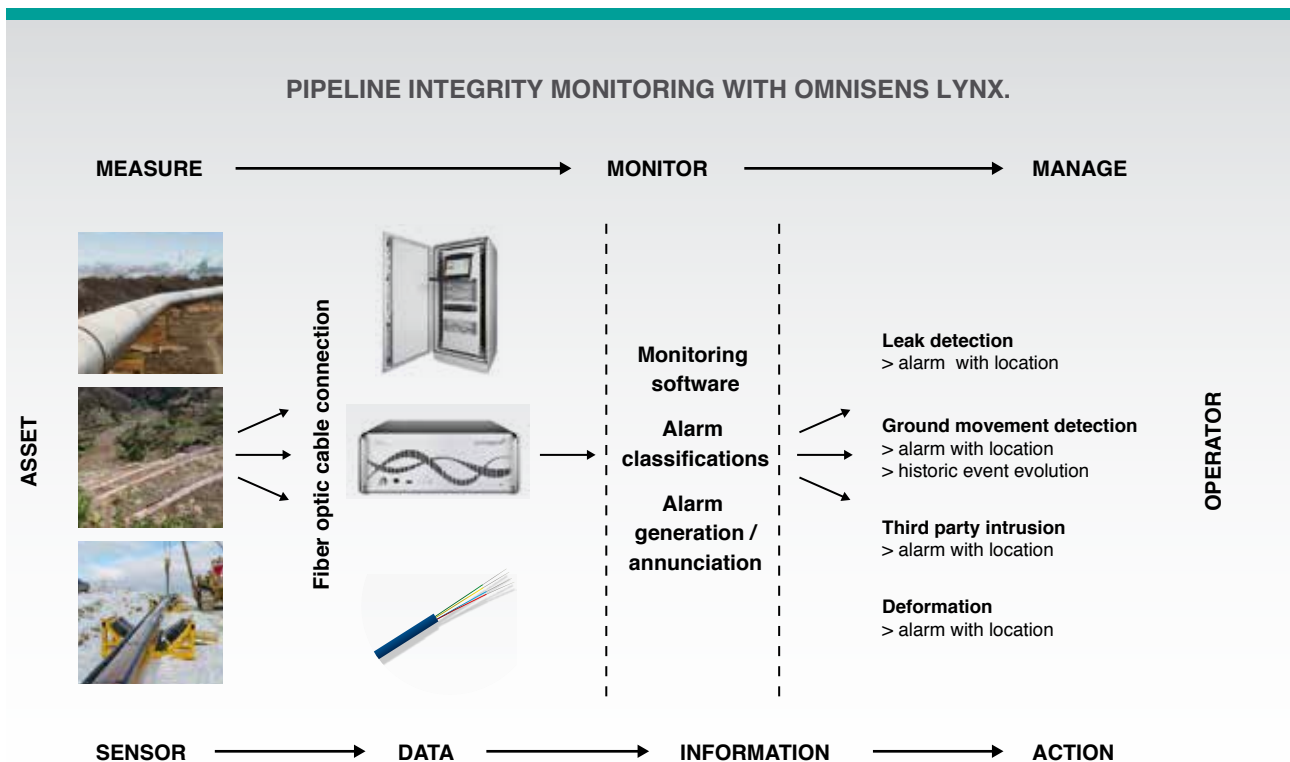
Omnisens DIVA interrogator: detects and analyses vibrations around the pipeline right-of-way enabling accurate and efficient event detection/localization and classification into threat and non-threat events. All activities in the pipeline ROW (normal or unauthorized) are detected, localized and defined as threat or non-threat depending on the measured vibration characteristics.

Monitoring software for processing temperature, strain and vibration data, generation of alerts as well as data handling and storage in a proprietary database.

Interface and communication to third party systems via TCP/IP communication or relays.

Sensor: usually a standard single mode fiber optic telecommunications cable installed with the pipeline.

Omnisens Map: 'see at a glance' GIS interface which identifies the location of an alert on the route associated to its KPs and GPS coordinates and enables visualization of event evolution.

PIPELINE INTEGRITY MONITORING WITH OMNISENS LYNX.

MEASURE ⟶ MONITOR ⟶ MANAGE

ASSET

Fiber optic cable connection

Monitoring software

Alarm classifications

Alarm generation / annunciation

Leak detection
> alarm with location

Ground movement detection
> alarm with location
> historic event evolution

Third party intrusion
> alarm with location

Deformation
> alarm with location

OPERATOR

SENSOR ⟶ DATA ⟶ INFORMATION ⟶ ACTION

The Omnisens Lynx system forms one element of the operator's integrated security system. It provides continuous high sensitivity monitoring with no 'dead' zones to detect and locate:

> very small, developing (incipient) leaks

> early signs of ground movement, such as landslide, subsidence and the effects of other geohazards.

> seasonal changes impacting surrounding soil, (e.g.: flooding, freezing, thawing)

> early signs of soil erosion

> Right-of-way (ROW) third party intrusion (authorized and non-authorized)

> position of pipeline smart pigs.

PIPELINE LEAK DETECTION

How it works

Leaks from a pipeline cause temperature changes in the surrounding soil.

Omnisens Lynx analyses the temperature all along the pipeline, with meter accuracy, to detect and locate small leaks (patent pending). Statistical algorithms process many parameters in order to discriminate leaks from normal seasonal temperature and climate variations.

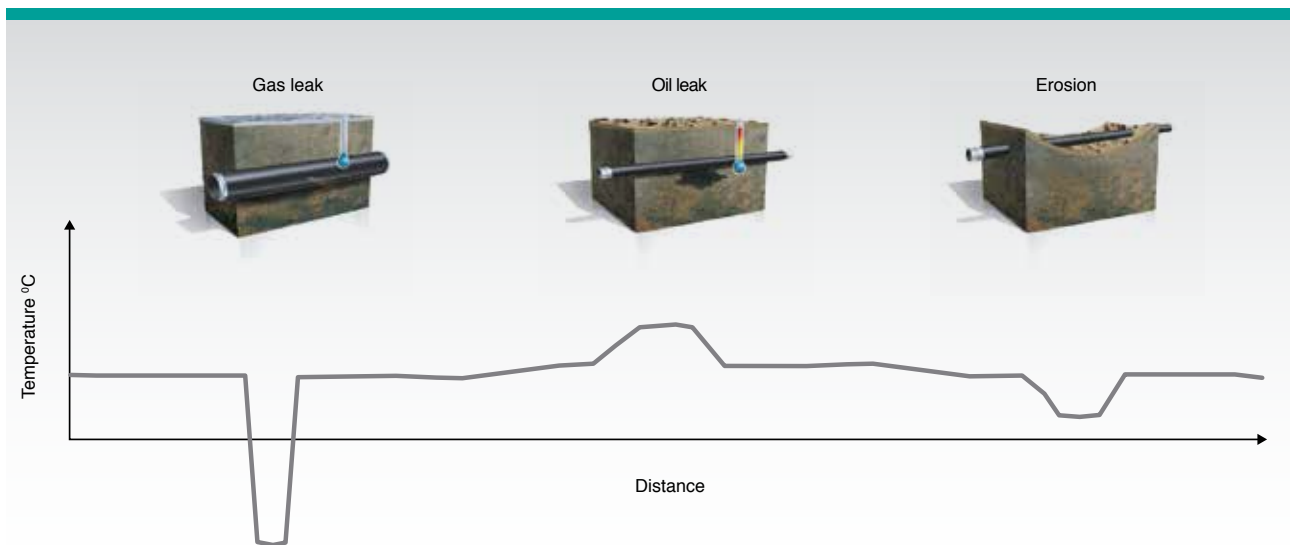### Leak detection - gas pipelines

A cold spot develops rapidly when gas leaks. Following a localized temperature change (1-2 meter long) a temperature gradient develops in the soil around the pipeline surface. The cooling effect (directly related to the gas type and pressure) is independent of the soil temperature and the magnitude of the cooling effect remains the same whatever the ambient soil temperature.
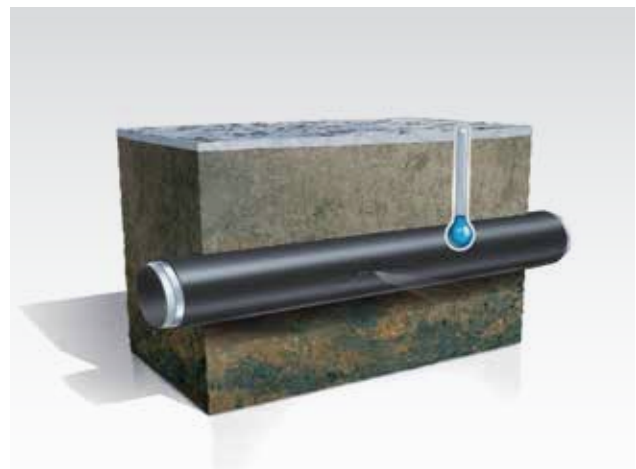
Leaks from gas pipelines result in a temperature decrease in the surrounding soil.
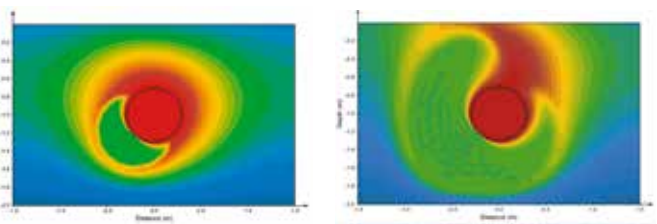
Simulations showing the rapid temperature changes occurring after a leak at 7 o'clock/0700 hour position in a gas pipe.

The fiber optic sensing cable alongside a pipeline detects small temperature changes. The temperature characteristics of the change indicates its most likely cause.

Leak detection – Liquid phase pipelines

Most liquids are warmer than ambient soil temperature so when they escape a temperature event is generated which will be detected by the fiber optic sensor installed nearby

Leaks from oil and other liquid pipelines usually result in a temperature increase in the surrounding soil.

Ground movement detection

Ground movement can cause damage to the pipeline right-of-way, which in turn threaten the integrity of the pipeline.

To provide highly sensitive, cost effective and robust monitoring to any one or all of these threats, Omnisens Lynx offers a comprehensive threefold solution:

> Distributed temperature detection
> Distributed strain detection
> Distributed vibration detection.

Detection and monitoring of the development of landslides, creep, subsidence and erosion phenomena is achieved using combined strain and temperature measurements. By including a fiber optic strain sensor, ground displacement of a few centimeters is detected and located to within a few meters anywhere along the pipeline/fiber optic sensor. Seismic and related phenomena (e.g. earthquake, volcanic activity) can be inferred from vibration detection.

When the earth around the pipeline moves the fiber optic sensing cable is strained, resulting in an alarm.
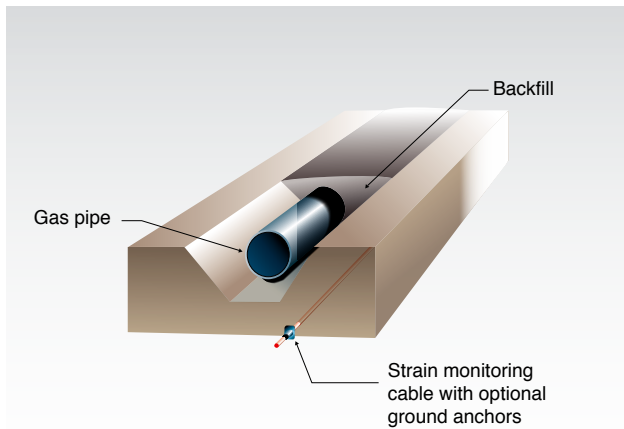
Deployment of ground movement sensing cable in seismic, swamp and unstable zones. It can be retrofitted in a separate small trench if necessary.

Vibration intensity response to intrusion

A change in temperature may indicate other events which could affect the pipeline and/or its right-of-way. Erosion of the soil around the pipeline can cause a temperature change, as does water intrusion from flooding or the change of soil condition between frozen and thawed. Omnisens Lynx detects these temperature changes and an alarm showing their location will be generated. The operator can investigate that part of the pipeline and mitigate against further damage.

To cater for the different challenges of each pipeline route, Omnisens Lynx offers the flexibility to monitor these various threats in combination or separately. This choice means a comprehensive and cost effective integrity monitoring solution can be designed, whatever the threats may be.

Third party intrusion detection
Certain activities, e.g.: construction and unauthorized digging, pose an immediate and real threat to all concerned. Omnisens DIVA detects, locates and classifies vibrations caused by third party intrusion in real-time along the entire monitored length of the pipeline.

Disturbances create microscopic stresses or vibrations in the soil to which standard telecoms cable (optical fiber sensing cable) is sensitive. Interpretation using complex algorithms classifies these to determine whether the signal is an abnormal event or normal environmental/ambient condition.

Omnisens DIVA acts as a continuous, wide frequency bandwidth microphone to "monitor" distinctive frequencies generated by different events along the pipeline right-of-way. Even a large number of simultaneous events can be classified with a manageable volume of data so that 'normal' and 'abnormal' events can be quickly differentiated.

Sensitive enough to detect an intrusion before it becomes a threat, Omnisens DIVA can detect, for example, the arrival of a digger before it starts to dig. When a security event is detected, an alert is triggered and displayed on Omnisens Map (or other GIS) and communicated to the pipeline's SCADA or other third party system.
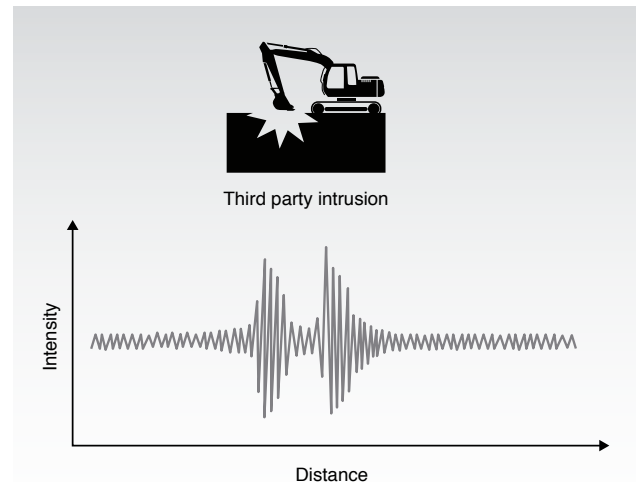

No threat to the pipeline

A threat to the pipeline

Pig tracking
Vibrations created during pigging propagate in the surrounding soil. Using a fiber optic cable laid nearby the pigs can be tracked in real time using the Omnisens DIVA. For pig tracking campaigns a portable system is available.

Pipeline Deformation

To detect pipeline deformation or buckling, the optical fiber strain sensor is attached to the pipeline itself, so that any movement is coupled to the fibers. The extension and compression of the fibers during movement are detected and will signal an alert.
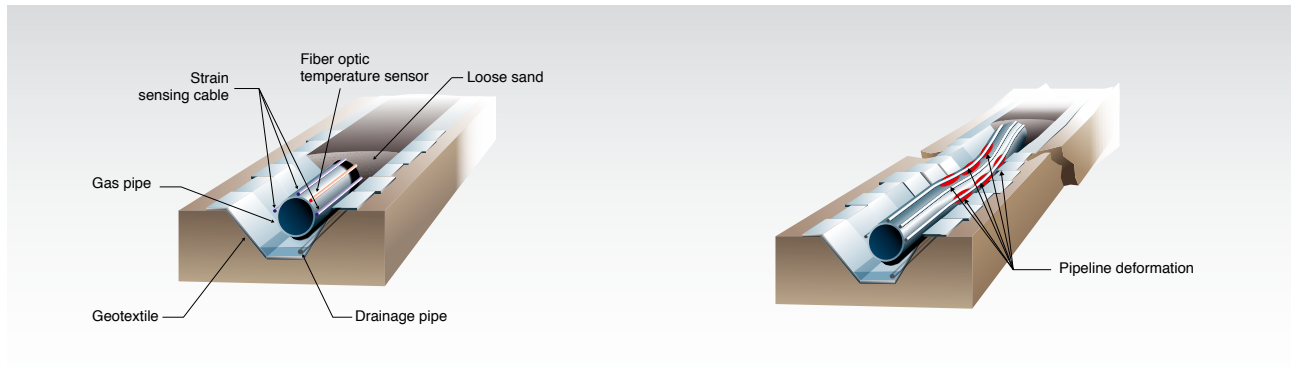

Showing how the fiber optic strain and temperature sensing cables were employed in active fault zones to detect pipeline deformation.

Fiber optic cable selection

Omnisens can provide:

> guidance on fiber optic sensing cable selection and installation procedures, with or without installation service

> fiber optic sensing cable options for various harsh environments or installation in conduits

> telecommunication grade single mode fiber optic cables for leak and intrusion detection.

> strain sensing cable combining tensile strength with maximum strain sensitivity for ground movement detection.
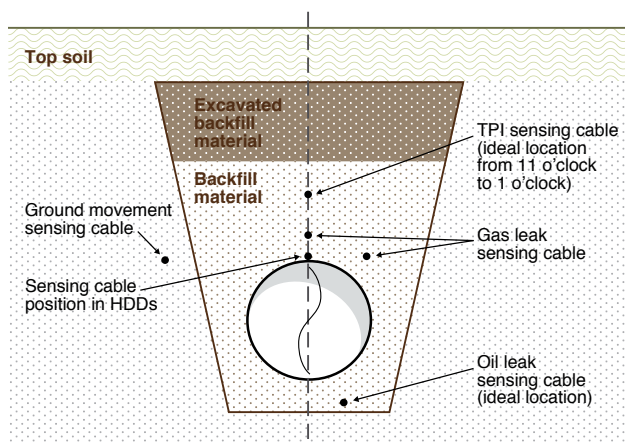
Cross section of pipeline trench showing different sensor cable locations depending on application and type of pipeline (gas or liquid phase).

OMNISENS MAP

Providing 'see at a glance' visualization of the entire asset, showing alerts and events, Omnisens Map provides the default interface for Omnisens Lynx. Consisting of a Geographical information System (GIS) which provides real-time information about pipeline integrity threats, it displays all detected and classified events on a map where the pipeline route is represented. Event logs and history are available.

> Dynamic map view of the pipeline and defined zones

> Real-time information about the zone status and conditions (e.g. min/max temperature, etc.)

> Date and time stamps with location (GPS coordinates of all recorded events)

> Information tools

> Status information of all connected interrogators

> System historical logs
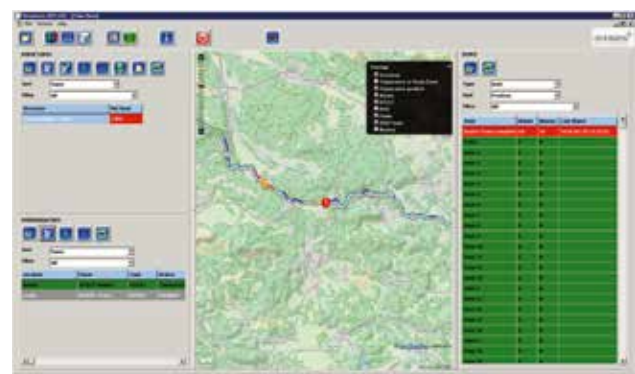
Omnisens Map: an event, or events, occurring along the pipeline is displayed as an alarm on the graphic representing the asset. Details of the event are shown in a zoom window.

OMNISENS SERVICE

Application engineering

> Sensing system design, monitoring system tests and validation.
> Integration into third party systems, (SCADA), communication connectivity and redundancy
> Installing pipeline geographical coordinates into Omnisens Map

Commissioning and installation

> System configuration, zone and alert optimization
> On-site acceptance testing
> Remote access set-up and operator training.

Service contracts

A range of services is available to ensure continuous availability of the monitoring system, including post commissioning support and data interpretation services.
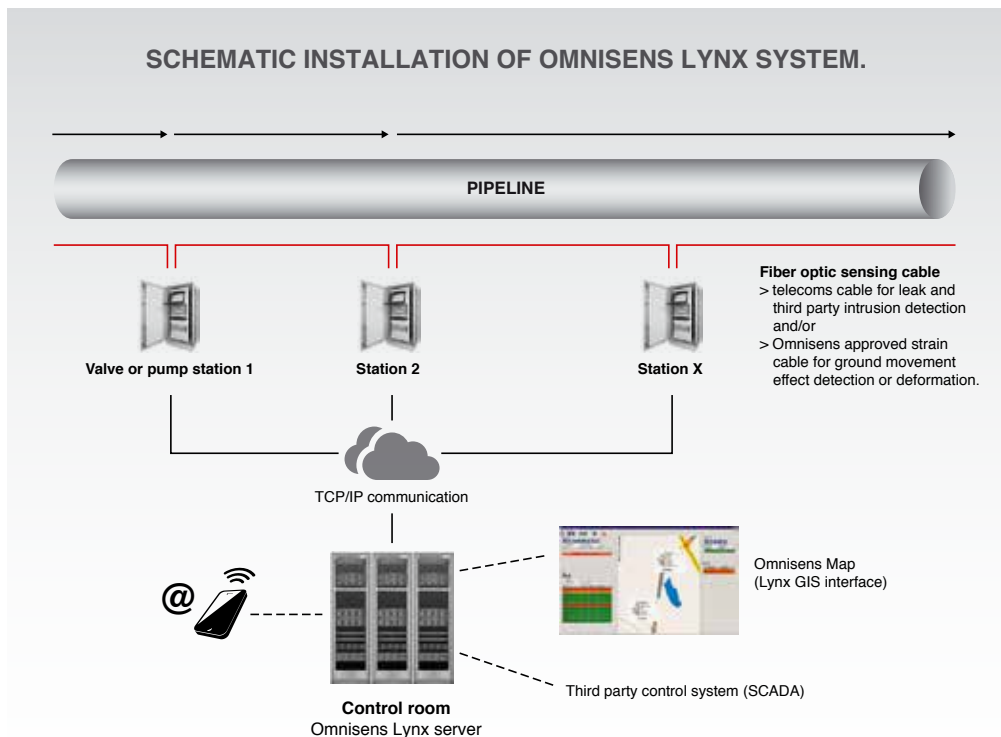
OMNISENS LYNX SUMMARY

Performance: Omnisens Lynx combines the measuring performance of Omnisens DITEST (for the earliest detection of leaks and/or ground movement) and Omnisens DIVA (for intrusion detection) with Omnisens Map user Interface to provide a cost effective pipeline integrity monitoring solution.

Omnisens DITEST and DIVA interrogators monitor distances in excess of 40 km. The spatial resolution is set during configuration and stays the same along the distance range. High optical budget gives an optical fiber installation margin.

Sensitivity: Incipient temperature (leak), strain (ground movement) and vibration (intrusion) events can be detected and localized early, giving the operator time to take action.

Communication: Status and detected events can be communicated in real time to a range of third party systems. Omnisens follows Information Security Management guidelines to ensure information integrity, availability and traceability.

Cost effective and flexible: If fiber optic cable is being installed with the pipeline, using some of the fibers to provide leak and intrusion detection is done at minimal additional cost. A 'fit for purpose' sensing cable is required for ground movement detection.

SCHEMATIC INSTALLATION OF OMNISENS LYNX SYSTEM.

PIPELINE

Valve or pump station 1   Station 2   Station X

Fiber optic sensing cable
> telecoms cable for leak and third party intrusion detection and/or
> Omnisens approved strain cable for ground movement effect detection or deformation.

TCP/IP communication

Omnisens Map (Lynx GIS interface)

Third party control system (SCADA)

Control room
Omnisens Lynx server

Omnisens Lynx provides simultaneous detection of leaks, ground movement and intrusion.

Alerts can be sent to SCADA via TCP or relays.

References:
S. P. Siebenaler, G. R. Walter, "Detection of small leaks in liquid pipelines utilizing distributed temperature sensing," 9th International Pipeline Conference, Calgary, Canada Sept 24-28 IPC2012-90144.

C. Borda, M. Niklès, E. Rochat, A. Grechanov, A. Naumov, V. Velikodnev, "Continuous Real-time Pipeline Deformation, 3D Positioning and Ground Movement Monitoring along the Sakhalin-Khabarovsk-Vladivostok Pipeline," 9th International Pipeline Conference, Calgary, Canada Sept 24-28 Paper IPC 2012-90476.

F.Ravet, C.Borda, E.Rochat, M.Niklès "Geohazard Prevention and Pipeline Deformation Monitoring Using Distributed optical fiber sensing" Proceedings of the 1st International Pipeline Geotechnical Conference, Bogotá, Colombia July 24-26, 2013, IPG2013

ABOUT OMNISENS

Omnisens is a leader in long-range, accurate monitoring for the energy industry. Using fiber optic-based Brillouin sensing, which it pioneered, together with highly qualified, dedicated application, commissioning and customer service teams, Omnisens offers continuous, reliable monitoring of pipelines.

Based in Switzerland, Omnisens operates throughout the world, either directly or through specialized solution providers. System installation and support is provided either from the dedicated team in Switzerland, where the DITEST interrogators are manufactured, or from qualified and trained local specialists.

MISSION

Omnisens provides fiber optic based monitoring solutions for electricity, oil and gas transport, helping customers secure the integrity and optimize the performance of their asset.

VISION

Recognized for the reliability and performance of their dedicated solutions, Omnisens is seen by industry leaders as an expert and trusted partner in asset integrity monitoring.

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Certification

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