

Fiber Optic Distributed Acoustic Sensing for Pipeline Security and Leak Detection



PIPELINE MONITORING AND SECURITY

The oil & gas industry is currently facing a serious challenge in assuring spill and accident free operations of pipelines and associated infrastructure.

To help meet the challenge of a zero incident target, the oil & gas industry must improve its technologies and ability to monitor their systems for safety in real time – permanently and distributed along the length of the pipeline network.

RaySense Fiber optic pipeline monitoring and security products are designed to provide a complete monitoring with no gaps, automated, real-time pipeline solution for prevention and corrective control of the most undesirable and dangerous events that can occur to pipelines, such as leaks and third party interference (TPI).

These systems are designed to protect oil/gas/liquid pipelines and utility right of way corridors against TPI, including illegal tapping and unauthorized excavation, by providing an early warning of these TPI activities – it is a preventative solution.

The ability to detect small leaks is a further advantage offered by fiber optics.

ADVANTAGES OF FIBER OPTICS

Main advantages offered by this technology over competitive systems include:

- The longest monitoring capability in the market
- Multi platform monitoring.
- High sensitivity along the whole cable
- Monitors both TPI and geo-hazard activity
- Early Detection of small leaks with world's only ultrasonic capability
- System operates in real-time, no post-processing
- No power required in the field, Total immunity to EMI / RFI / Lightning strikes.
- Simple to install
- High reliability – Near zero field maintenance
- Long service life (greater than 20 years)
- Resistant to most environmental effects (humidity, high temperature, etc.)
- Very cost-effective solution

RBtec's RaySense Technology



RAYSENSE DISTRIBUTED VIBRATION SENSOR

RBtec has a unique Distributed Vibration Sensor (DVS) system that is practical and effective in the prevention of oil or gas spills due to its unique ability to detect, locate and classify vibrations caused by physical activity (such as third party interference), while simultaneously monitoring for early-stage leaks, along the entire length of the pipeline, in real-time.

In comparison with other competing technologies, RaySense is distinguished by the following main operational capabilities:

1. This unique technology acts as a continuous microphone, It operates over an extremely broad frequency range (3Hz to 500kHz) and is the world's first and only distributed ultrasonic detector. As a result, it can detect and locate early-stage leaks, directly and much earlier than other cable-based systems.
2. It is effective at discriminating different patterns of interferences and environmental/traffic noises from potentially dangerous operational events/threats. By reducing nuisance alarms, it alarms for events of true concern with an increased degree of confidence and thus allows for automatic response mechanisms with a practical degree of responsibility.

ADVANTAGES OF RAYSENSE

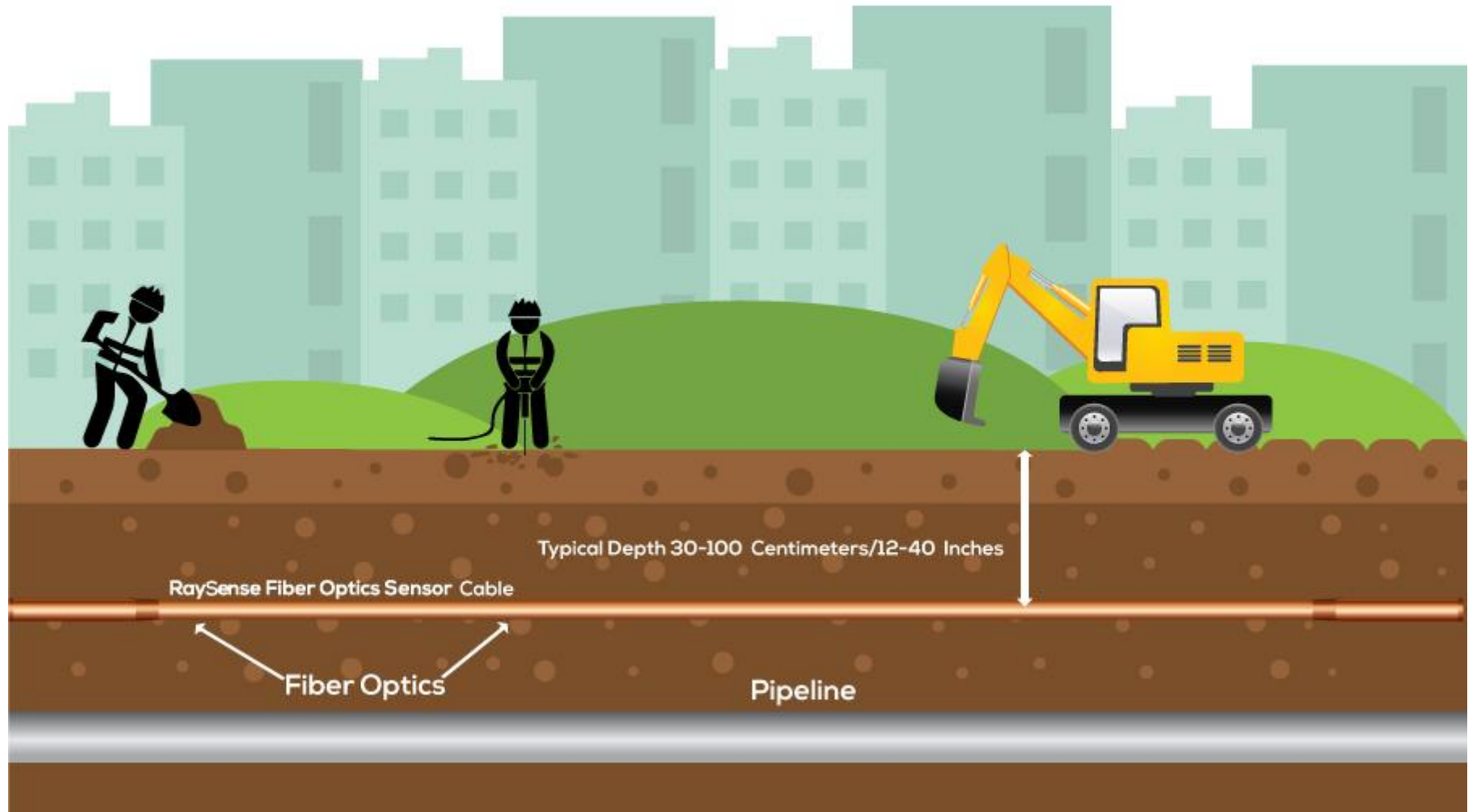
The features of the RaySense system are:

- Double sensitivity over all other currently available transmissive interferometers.
- The same system can monitor Pipeline, fence, walls and underground.
- 500 kHz bandwidth, an unprecedented wide frequency bandwidth, which covers the low range associated with TPI events and the very high range (ultrasonics) associated with early leak detection (nearest competitor has 20kHz).
- Seven configurable (physical) levels of sensitivity at any point along the same cable in order to optimize its performance in different field conditions.
- Dedicated, integrated hardware using FPGA and DSP microprocessors (i.e., faster, more reliable, more robust, lower power consumption) - not based on commercial computers, no cooling required.
- Advanced processing software operates automatically for minimizing nuisance alarms.
- Ultra-high speed data acquisition and real-time automated processing simplifies operation, significantly reduces amount of data produced (KB/MB vs GB/TB) and enables more events to be simultaneously processed – reducing computing power and post-processing requirements.
- Extra fibers in the cable can be used for variety of extra singlemode fiber functions, such as telecoms, SCADA, CCTC transmission, PIDS integration, etc.
- Significantly lower cost, at least 30% less than the nearest similar competitive product.

Fiber Optic Pipeline Monitoring and Security Systems



PLACEMENT OF FIBER OPTIC CABLE



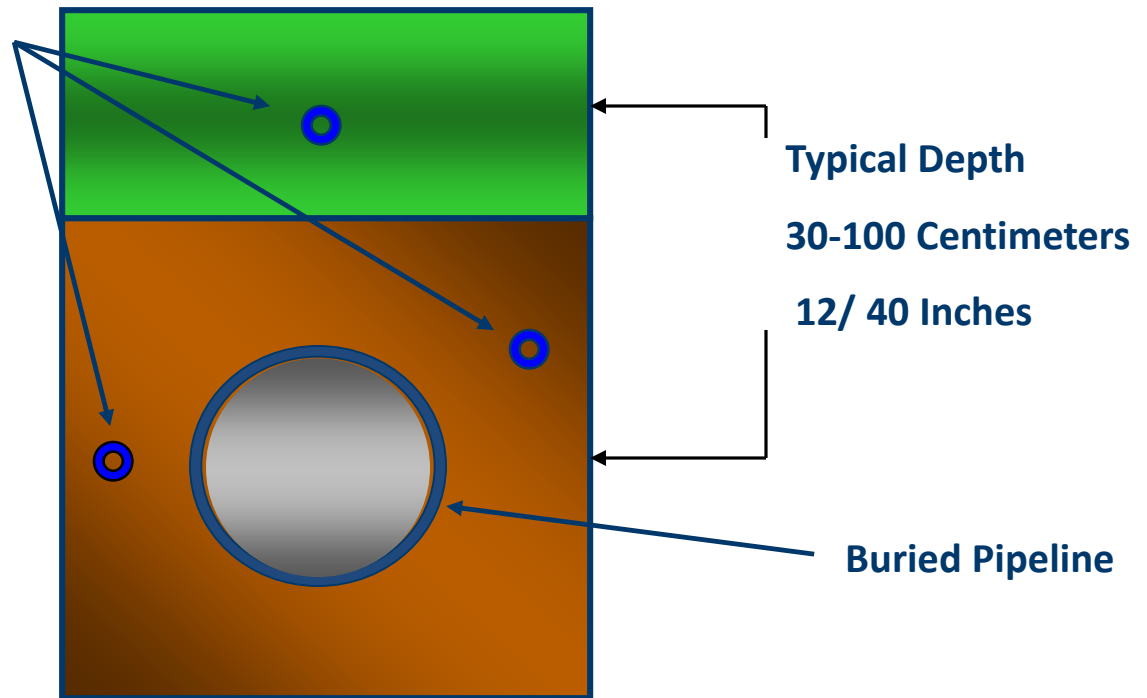
**Surface activities are detected by the highly sensitive
buried sensor cable**

PLACEMENT OF FIBER OPTIC CABLE

Location of cable is variable.

Three optional locations shown.

Only one cable is required.



RaySense

A New Generation Fiber-Optic
TPI and Leak Detection System for
Pipelines



RAYSENSE DISTRIBUTED VIBRATION SENSOR

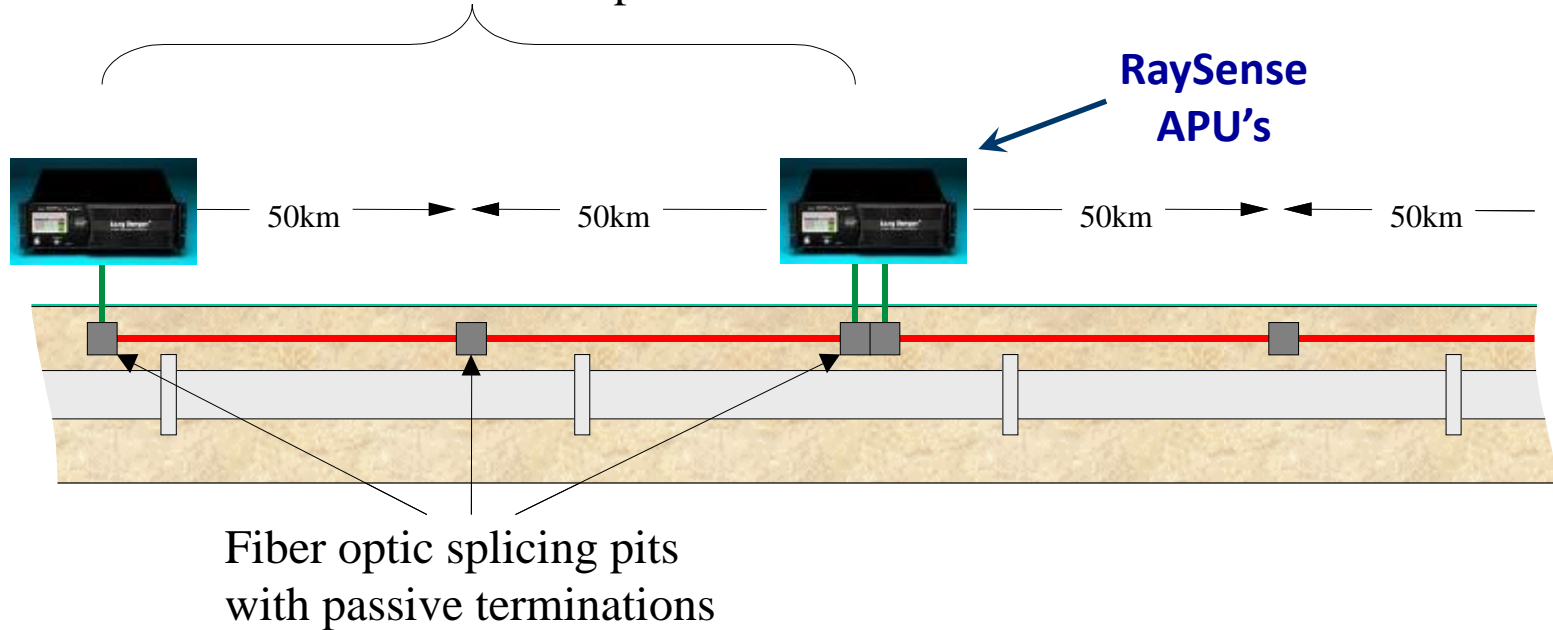
RBtec has a unique Distributed Vibration Sensor (DVS) system that is effective in the prevention of oil or gas spills due to its unique ability to detect, locate and classify vibrations caused by physical activity (such as third party interference), while simultaneously monitoring for early-stage leaks, along the entire length of the pipeline in real time.

This unique technology acts as a **continuous microphone**, up to 50km in length, designed to “monitor” over an unprecedented quasi-DC to 500kHz bandwidth, to very distinctive frequencies generated by acoustic TPI and ultrasonic leak events, while discriminating between normal and ambient conditions.

This is by far the widest frequency bandwidth available for any distributed fiber optic sensing technology, and is the world’s first distributed fiber optic ultrasonic sensor. Consequently, this technology is capable of monitoring far beyond the normal frequency bandwidth of conventional DAS systems, which are typically <2kHz for a 40km reach. Another significant differentiating advantage of this transmissive, hybrid interferometer technology is that its frequency response and location resolution/accuracy are not degraded with increasing distance, unlike conventional DAS systems.

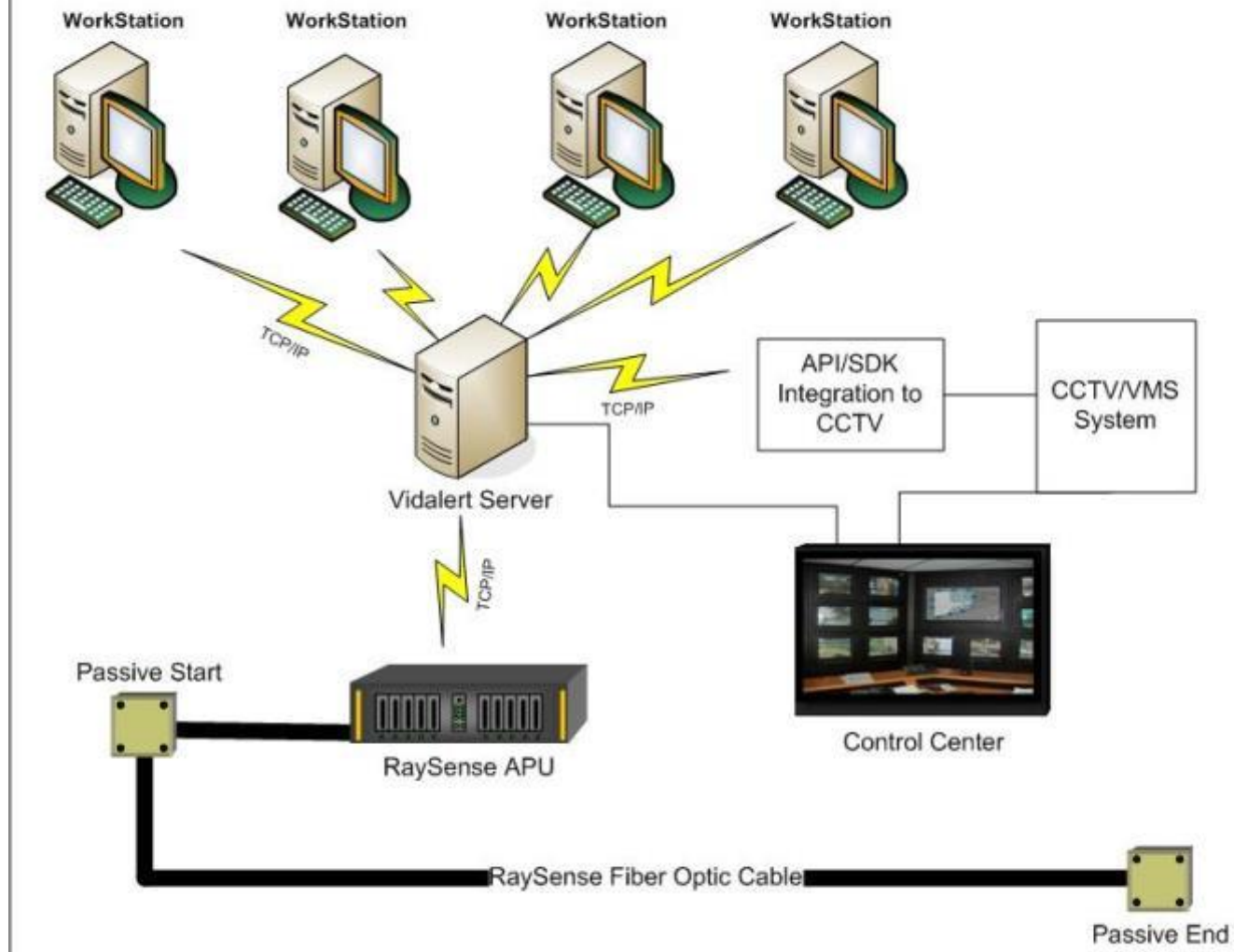
RAYSENSE LONG-HAUL CONFIGURATION

Distance between powered locations is 100km of cable



For long-haul pipeline applications, additional APU's can be placed every 100km of cable, usually coinciding with compression or pump stations along the pipeline.

System layout



WHAT IS THE RAYSENSE DVS?

The world's first locating, ultrasonic distributed vibration sensor (DVS)!

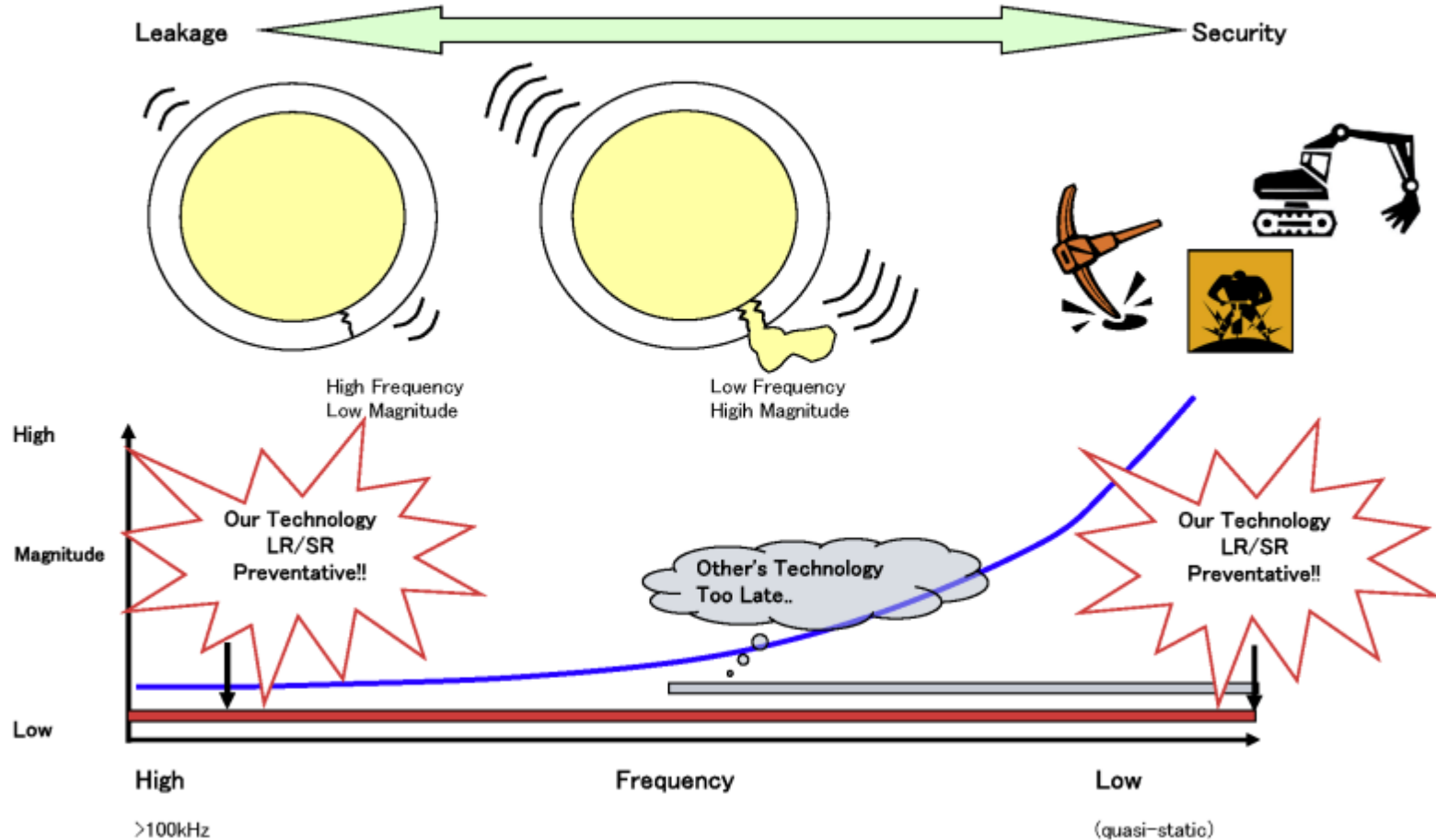
- It possesses a very significant capability by acting as a **continuous microphone** designed to “monitor” over a quasi-DC to 500kHz bandwidth, to very distinctive frequencies generated by TPI and leak events, while discriminating between normal and ambient conditions.
- **TPI** events occur in the low frequency range of quasi-DC to 5kHz.
- **Leaks** of interest occur around 80kHz for gas pipelines and around 40kHz for oil/water pipelines, when the leak is small (pin-hole leak). As the hole increases in size, the frequency lowers to a point where audible sound is made and physical vibrations can be felt.
- All currently available, competing fiber optic based technologies are limited to a 10-20kHz range, which makes it impossible to detect early, small leaks of pipelines.
- The **RaySense** technology, with its 500kHz bandwidth, is uniquely capable for early leak detection (**prior** to audible sounds and physical vibrations being generated).

INFORMATION IN THE FREQUENCY DOMAIN

RAYSENSE WIDE-BANDWIDTH CAPABILITY

Feature of RaySense

1. Leaks can be detected from the high frequencies at the cracking stage.
2. Third Party Interference (TPI) detection is detected from the low frequency signals.



INFORMATION IN THE FREQUENCY DOMAIN

RaySense – at 50km – frequency bandwidth of 3Hz to 500kHz



Other transmissive Technologies – at 40km – maximum frequency bandwidth of 20kHz



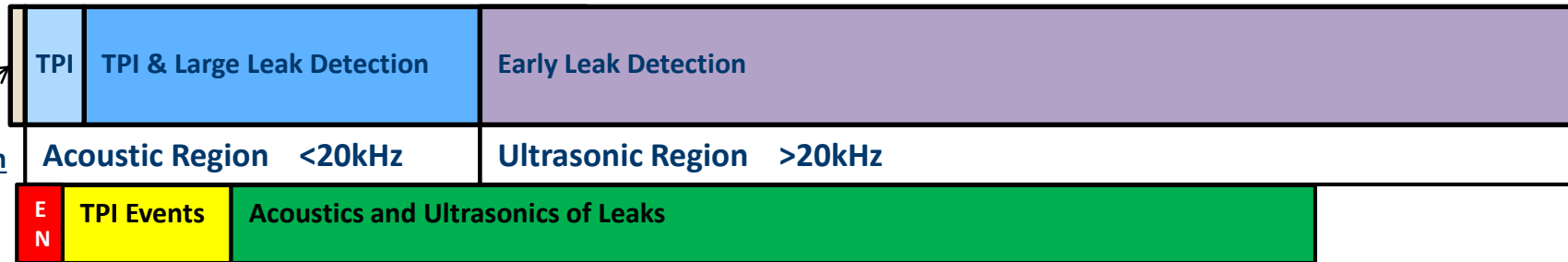
DAS Technologies – at 1km – typical maximum frequency bandwidth of 10kHz



DAS Technologies – at 40km – typical maximum frequency bandwidth of <2kHz



✕ DTS/DSS Technologies



<10Hz Region

DTS and
Geotechnical
Applications

Environmental
Noise

LR HAS HIGH PERFORMANCE OVER COMPETITIVE TECHNOLOGIES

	RaySense LR Technology	C-OTDR
Principal of signal to detect	LR uses hybrid transmissive signal, so signal is large.	Back Scatter signal is used, so signal is very small.
Resolution	Resolution is 6-20M/20'-65' depend on soil condition through out 50KM/32miles. Resolution itself is very precise, 1-3 meter only if directly contacting the fiber. Signal spread over the soil, so area of disturbance itself covers a larger space.	More and more distance, resolution goes down. 1 meter resolution up to 5KM, and then 10-20 Meters on 40 KM distance.
Sensitivity	Double sensitivity. Cable can put in conduit, even losing 20% sensitivity, it is still 160% compared with other sensors.	Sensitivity will alter depend on longer distance. Sensing speed will slow down since system has to emit photonic signal and wait for return.
Multi platform monitoring	The LR can monitor pipeline, fences, walls and buried applications with the same processor.	The system can monitor only one application.
Handy-cap to handle huge data	No - LR has no handy-cap with data size. So much big data analysis and algorism can be built.	Yes - C-OTDR has to handle huge data, so cannot make big data analysis unless hardware will be powerful. Massive data storage is vital.
Cost of hardware	Very low cost for high performance.	Very high cost.
Bandwidth	Entire Length of 50KM, 500K HZ bandwidth. Only technology to offer to detect up to Ultrasonic region.	Change bandwidth depend on length. It will goes down to 2K Hz in case of 40KM.
Responding speed	No change depend on length	Much longer, slower to complete calculations.
Cable	LR requires 3 normal single mode fibers in a cable. Specially designed fiber cable changes sensitivity for different soil conditions.	Single cable, no special cable solution to improve sensing capability.



RBtec Ltd.

Email: Info@rbtec.com

www.rbtec.com

THANK YOU!

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