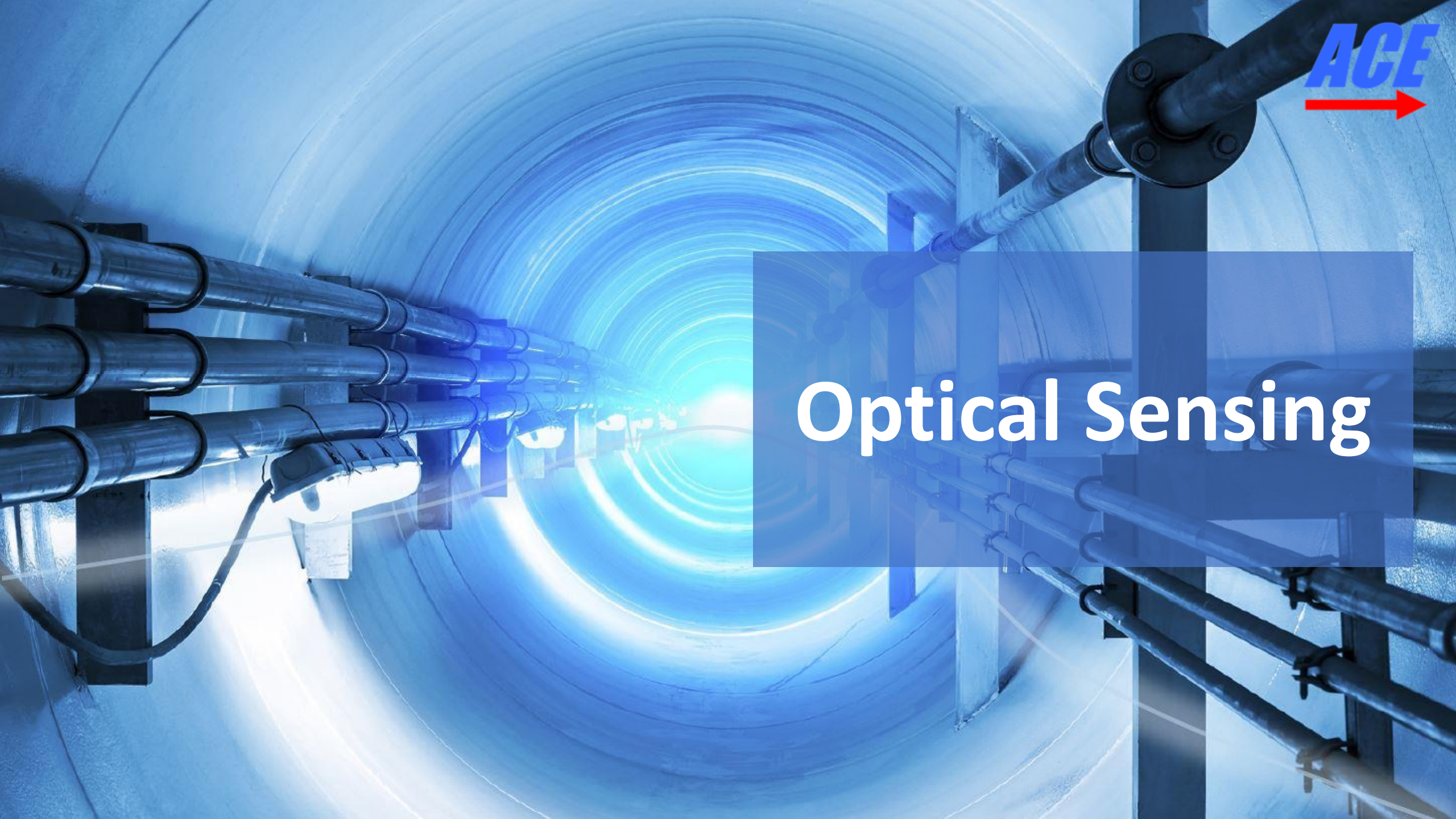


Optical Sensing

Pipeline

Detect about Pipe Leak

Horizon Distributed Acoustic Sensing (DAS)

The key technology used for the intrusion monitoring detection is the Horizon Distributed Acoustic Sensing (DAS) which is developed, supplied and serviced by ACE.

This compact, low-power, user friendly sensing system is the ideal solution for medium to long range (5-100km) industrial monitoring applications where reliability, safety and seamless system integration are essential.

T-Laser Distributed Temperature Sensor (DTS)

For industrial monitoring applications where reliability, safety and seamless system integration are essential, the compact, low-power, user friendly T-Laser DTS is the ideal solution.

The T-Laser DTS has been designed with safety in mind and has been tested to some of the industry's most rigorous standards. The system can be used in many monitoring fields such as: tunnel fire detection; power cable monitoring; oil and gas (upstream and downstream); pipeline monitoring and dam leak detection.

Product	Horizon 5	Horizon 10	Horizon 20	Horizon 50
Range per channel	5km	10km	20km	50km
Number of channels	1 or 2 channels possible			
Ordering Part Numbers	DAS-HZ-02-05-1CH	DAS-HZ-02-10-1CH	DAS-HZ-02-20-1CH	DAS-HZ-02-50-1CH
	DAS-HZ-02-05-2CH	DAS-HZ-02-10-2CH	DAS-HZ-02-20-2CH	DAS-HZ-02-50-2CH
DATA ACQUISITION				
Acquisition Frequency	2kHz default – 1kHz / 2kHz / 4kHz available as standard. 10kHz / 20kHz by special request (for select Horizon Units)			
Event accuracy resolution***	1-5m	1-10m	2-10 m	5m – 10m
OPTICAL				
Laser Wavelength	1550 nm			
Optical Budget	12 dB @ 1550 nm			
Connector Type	FC / APC			
Cable type	G.652 / G.654			
Laser Safety Classification	Class 1M			

Principle of Measurement

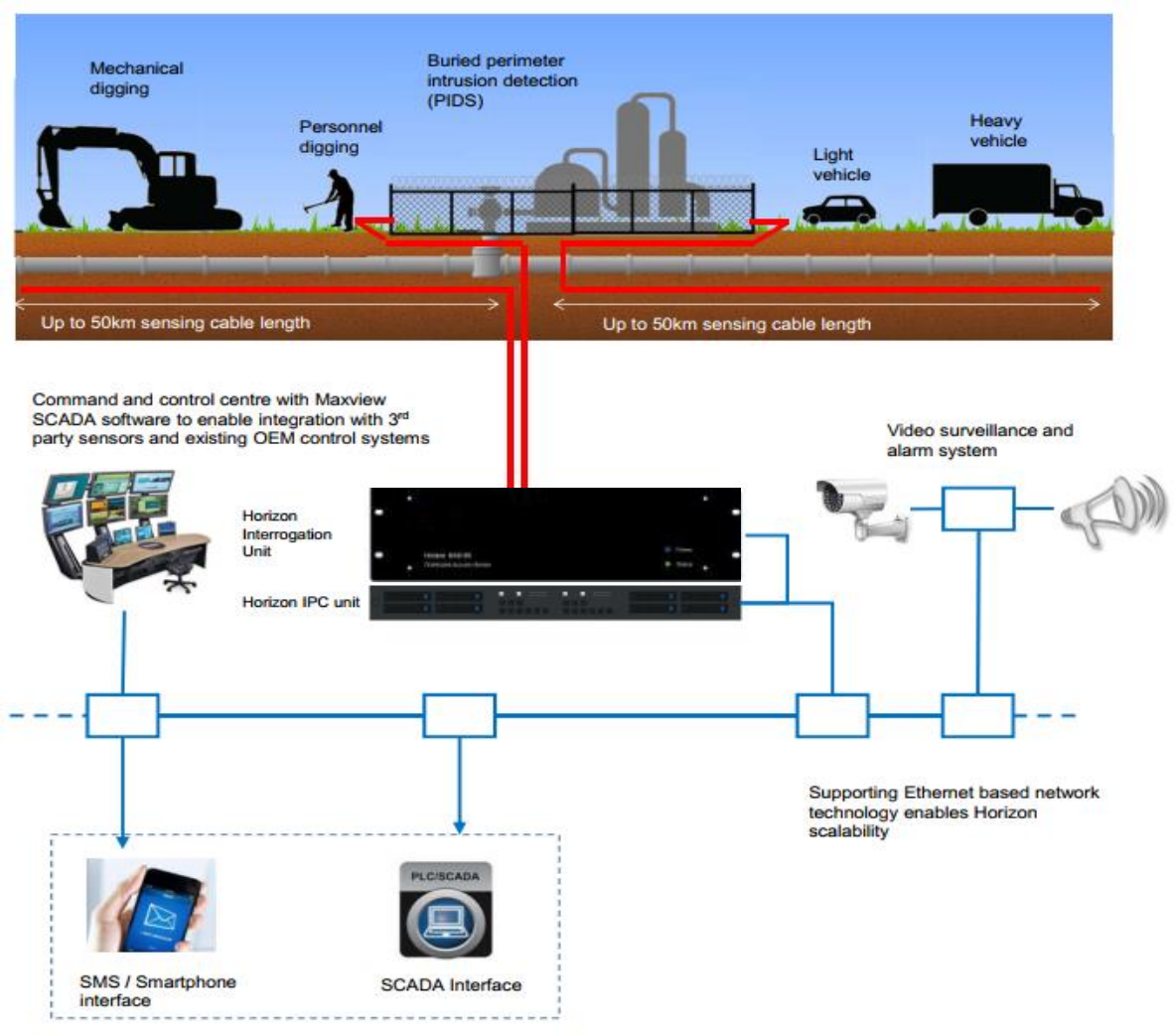
The Optical fiber is the sensor

Every meter along 10km optical fiber can be monitored with one machine, which equals to 10000 traditional sensors

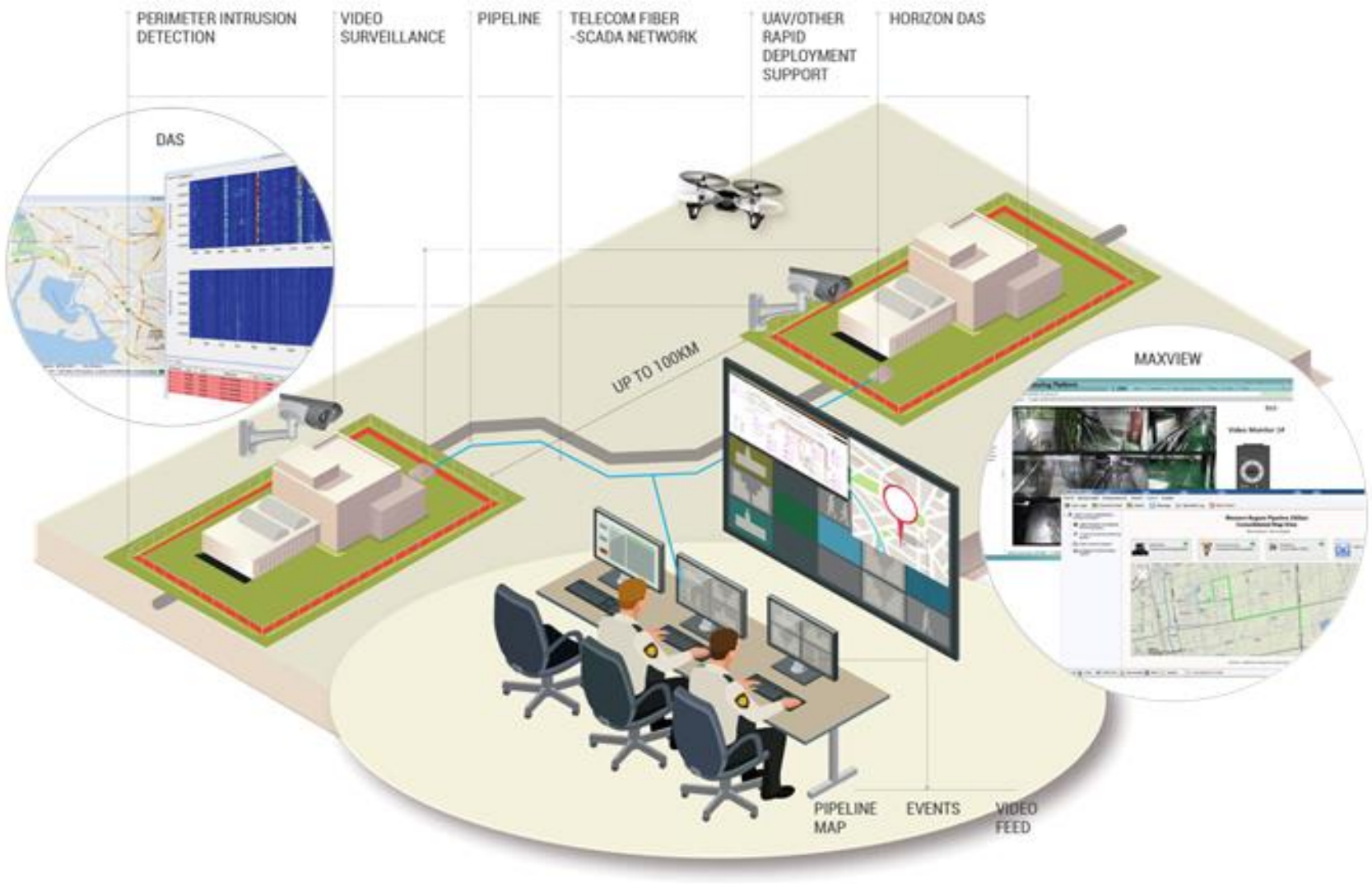
1m optical pulse

T9995 T9996 T9997 T9998 T9999

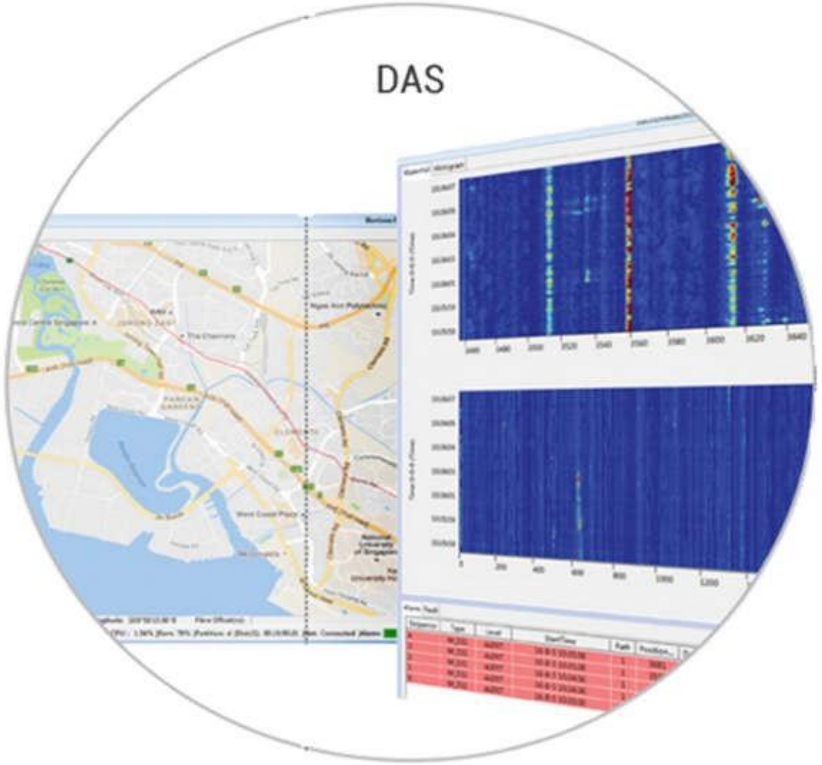
System Architecture

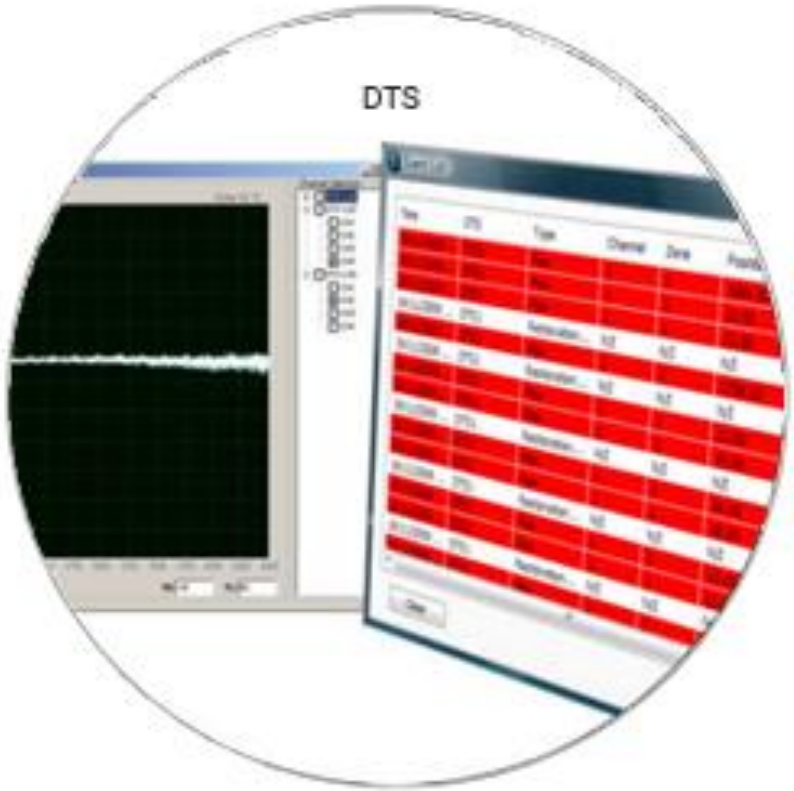


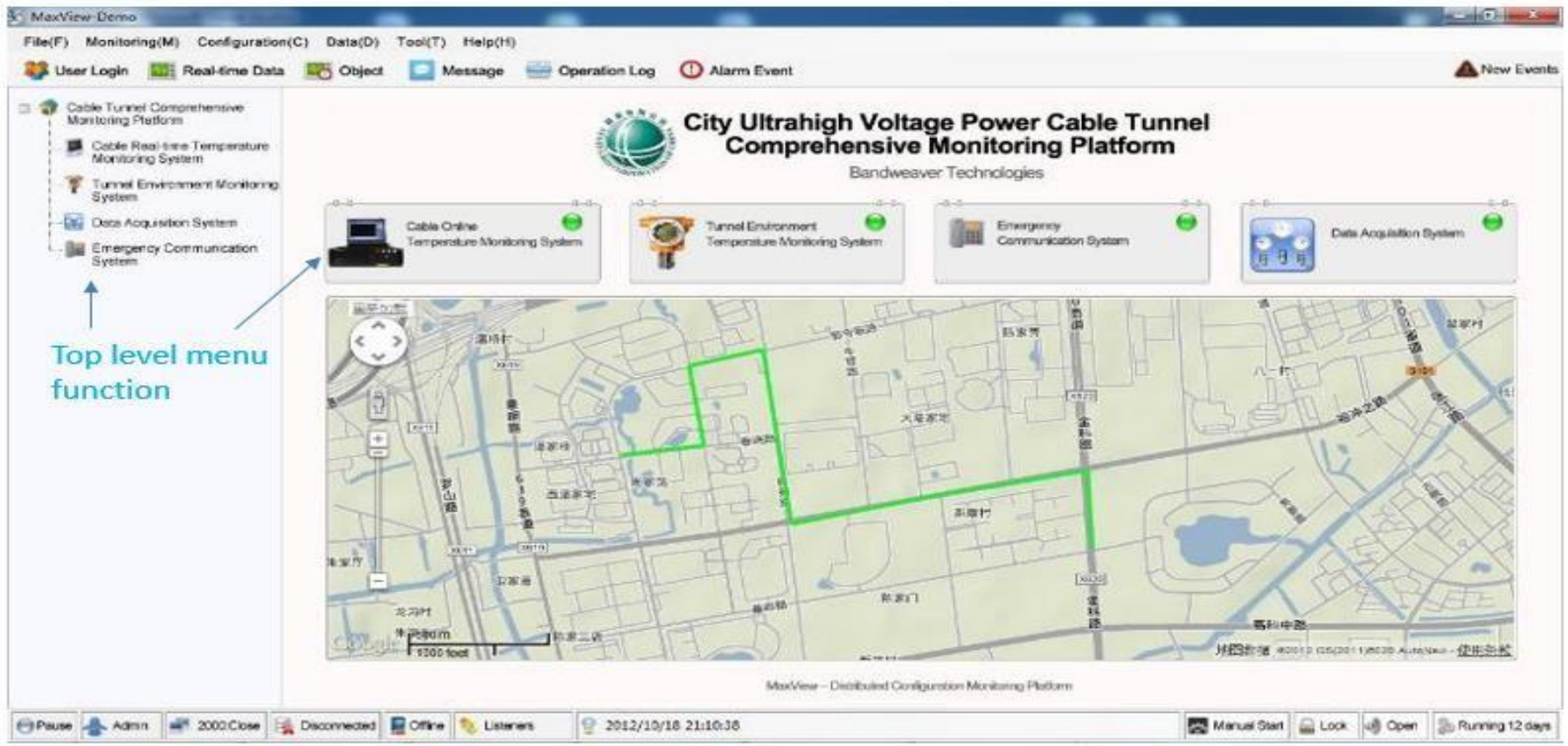
Operation Software and Data Management



User Interface






MaxView-Demo
File(F) Monitoring(M) Configuration(C) Data(D) Tool(T) Help(H)
User Login
Real-time Data
Object
Message
Operation Log
Alarm Event
New Events
Cable Tunnel Comprehensive Monitoring Platform
Cable Real-time Temperature Monitoring System
Tunnel Environment Monitoring System
Data Acquisition System
Emergency Communication System
Top level menu function
City Ultrahigh Voltage Power Cable Tunnel Comprehensive Monitoring Platform
Bandweaver Technologies
Cable Online Temperature Monitoring System
Tunnel Environment Temperature Monitoring System
Emergency Communication System
Data Acquisition System
MaxView – Distributed Configuration Monitoring Platform
Pause
Admin
2000:Close
Disconnected
Offline
Listeners
2012/10/18 21:10:36
Manual Start
Lock
Open
Running 12 days

Product Safety

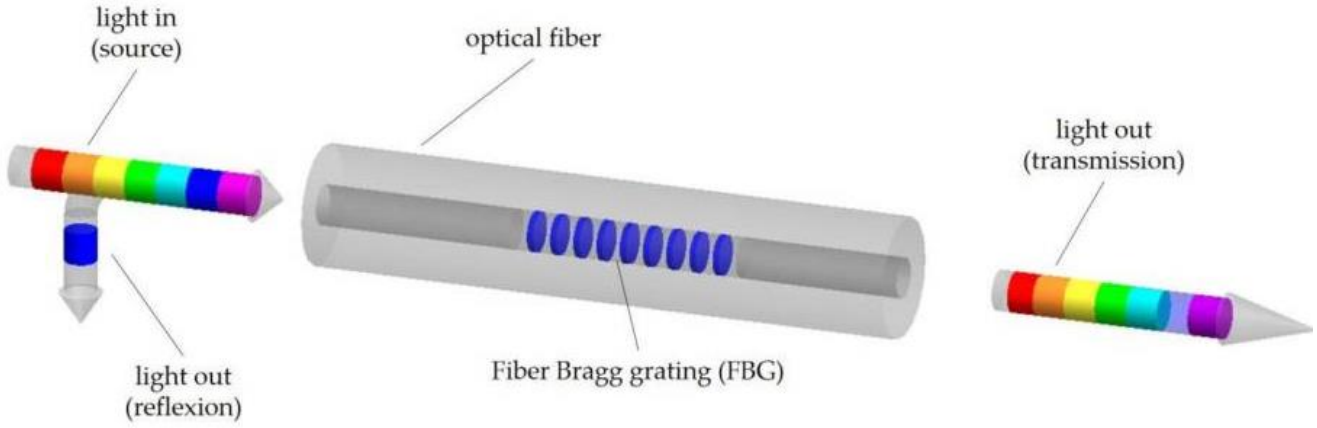
Bandweaver develops products for a variety of different industries across the globe. Bandweaver ensures that products are compliant with leading industrial standards and tests according to wide variety of leading industrial standards. Some of the standards that Bandweaver adheres to include:

- IEC61010-1 electrical product safety
- Laser Safety class 1M
- IEC 60825-1 laser safety
- FDA approval FDA21CFR1040.10 (laser notice 50)
- CE low voltage directive 73/23/EEC
- Fire safety codes: VDS EN54 part 22

For additional information on product safety and environmental testing please contact your local Bandweaver representative.

Fiber Bragg Grating (FBG)

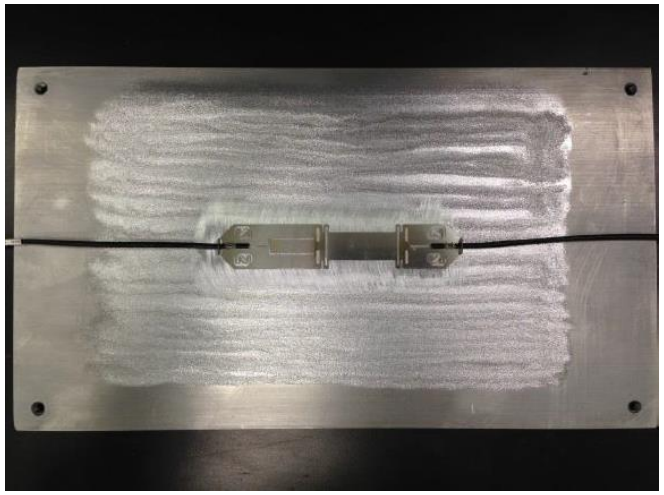
The sensor is designed using a Bragg grating inscribed into a single-mode optical fiber as the sensing element. FBGs have been one of the most widely researched optical components within the last decade. They have found manifold applications in telecommunications, laser, and sensor technology. The sensor applications of FBGs alone cover many fields, such as structural health monitoring, monitoring of conditions in electrical plants, and physiological activity monitoring.



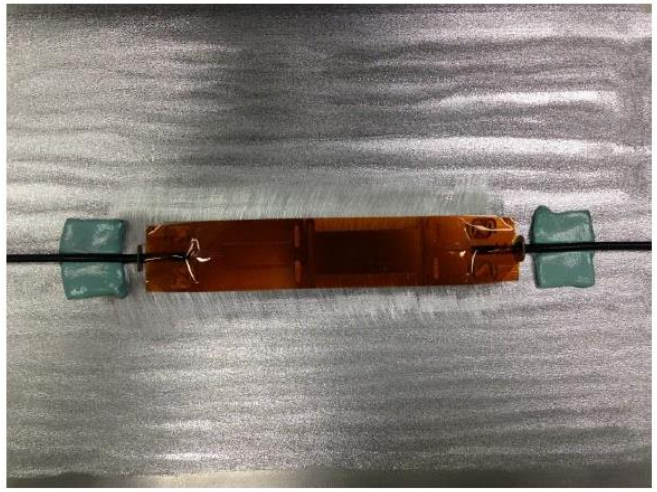
Optical Strain Gauge

Protect for pipe corrosion

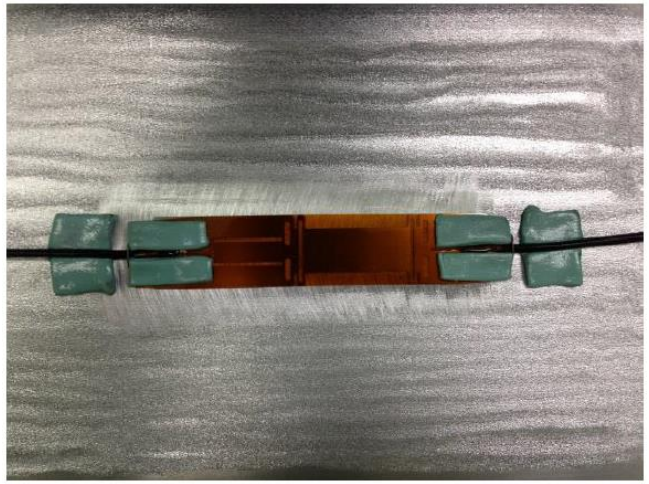
Install at surface of pipe



Surface Prep Area

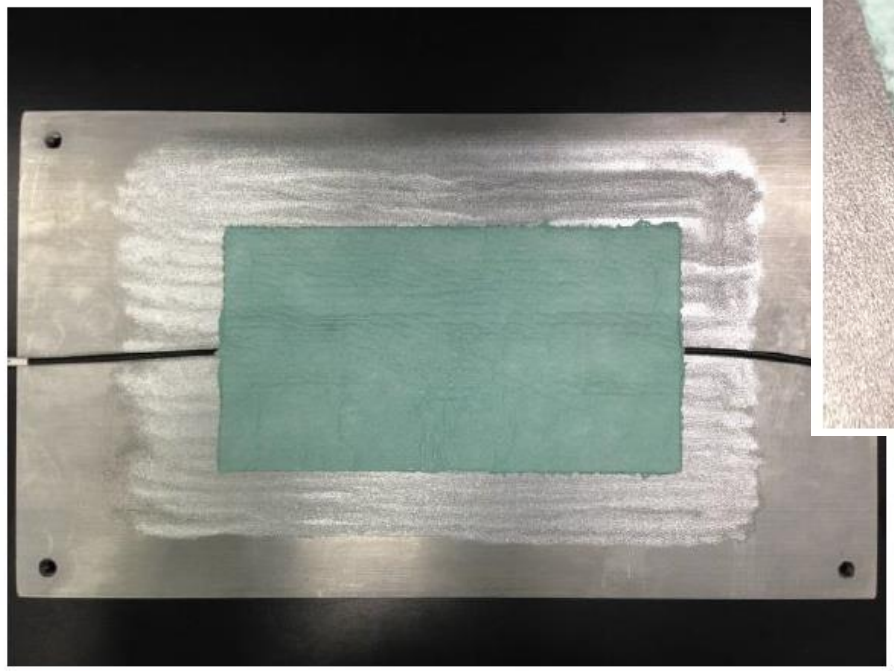


STOPAQ Paste Under Cable

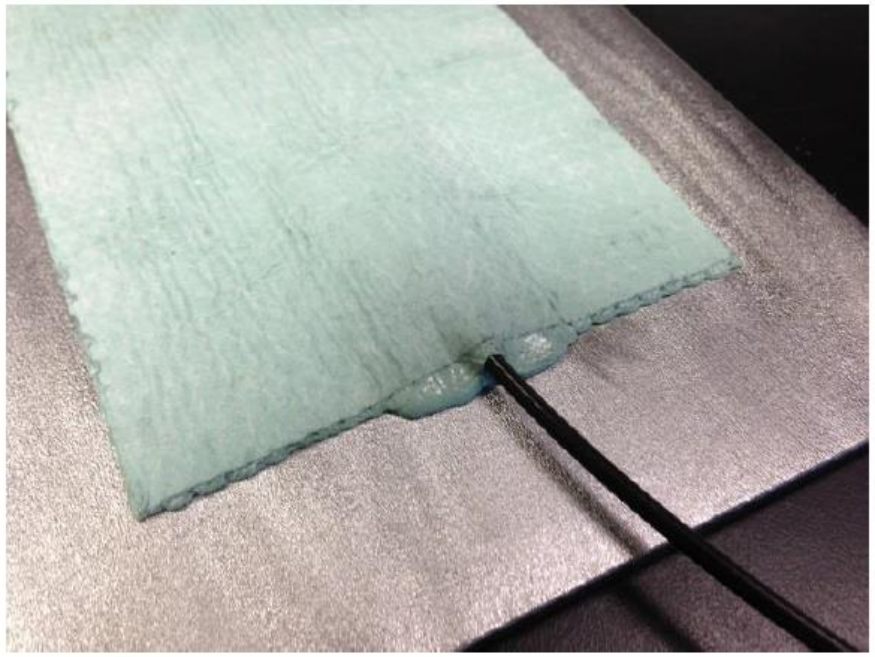


STOPAQ Paste on End of Gage

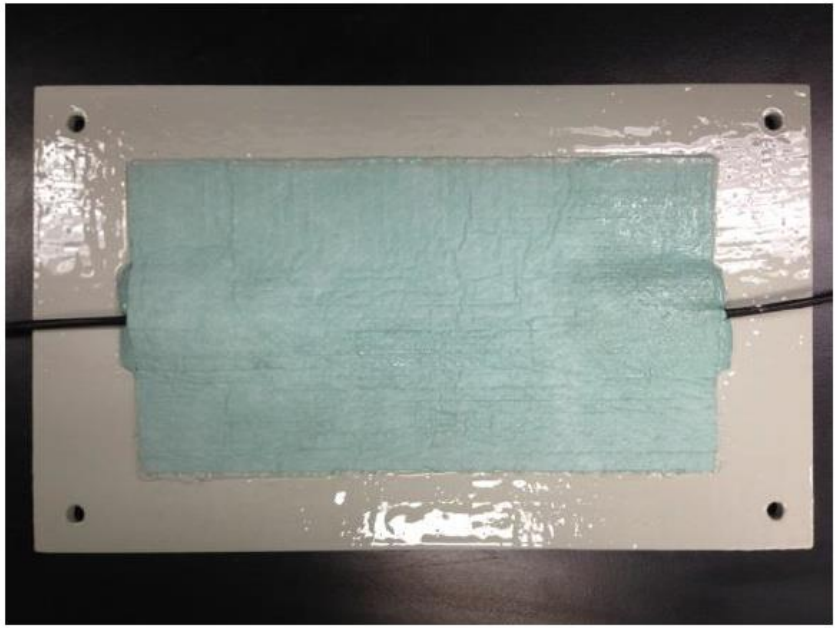
Surface Prep Area



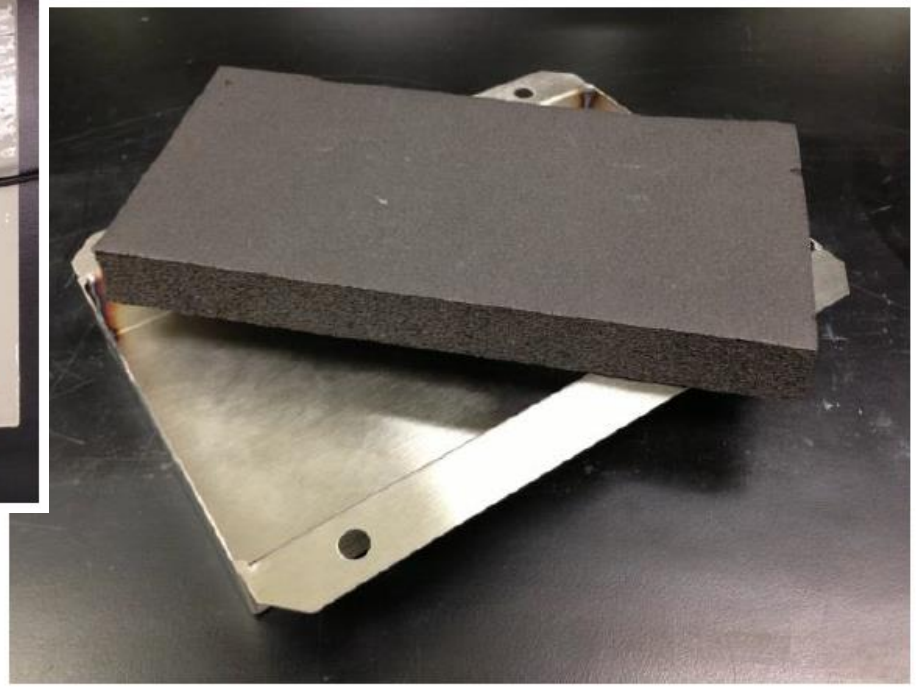
STOPAQ EZ Patch

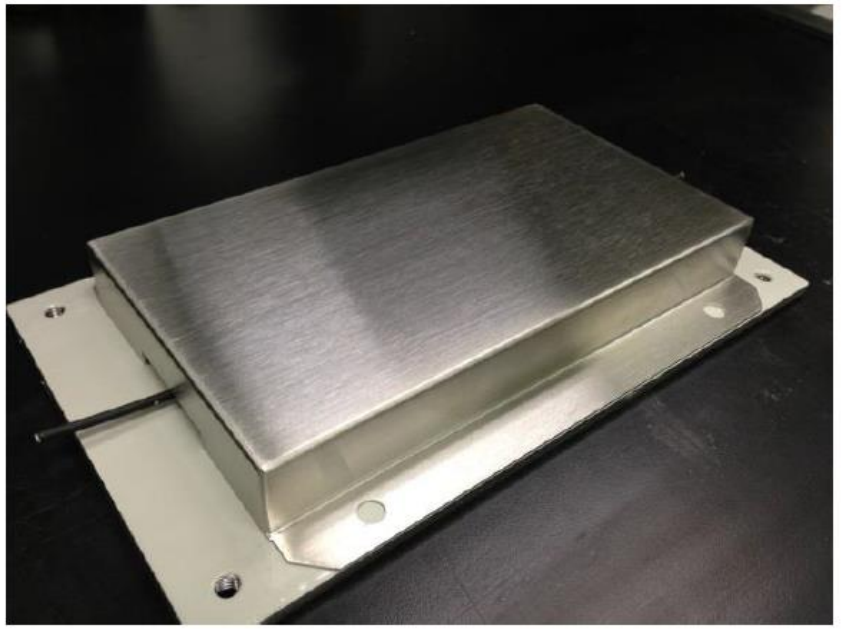


Seal around Cable



Primed and Painted





Covered Sensor

os315X Protective Cover & Insulation Kit

Rail Track Monitoring

Detect about depredation and Digging or rock fall

Summary of Customer

ACE would like to provide information for a Rail Track Monitoring project for Thailand. SRT would like to start the new solution for rail tracking preventive from Terrorist Attacks at the deep 3 provinces in the Southern Part of Thailand.

There are different gauge rail tracks and different configuration as shown below:

At this time there is no performance specification or additional details on what would constitute a threat to the rail line from terrorists, so our proposal is based on commonly used alarm events including:

- Gross attack on rail lines
- Manual or vehicle digging adjacent to rail track
- Theft or tampering with buried power or signal cables adjacent to the rail track
- Major objects on rail line that could cause derailments including from rock falls and landslides

ACE Technical Solution

Based on the information received to date. ACE suggests the following system architecture.

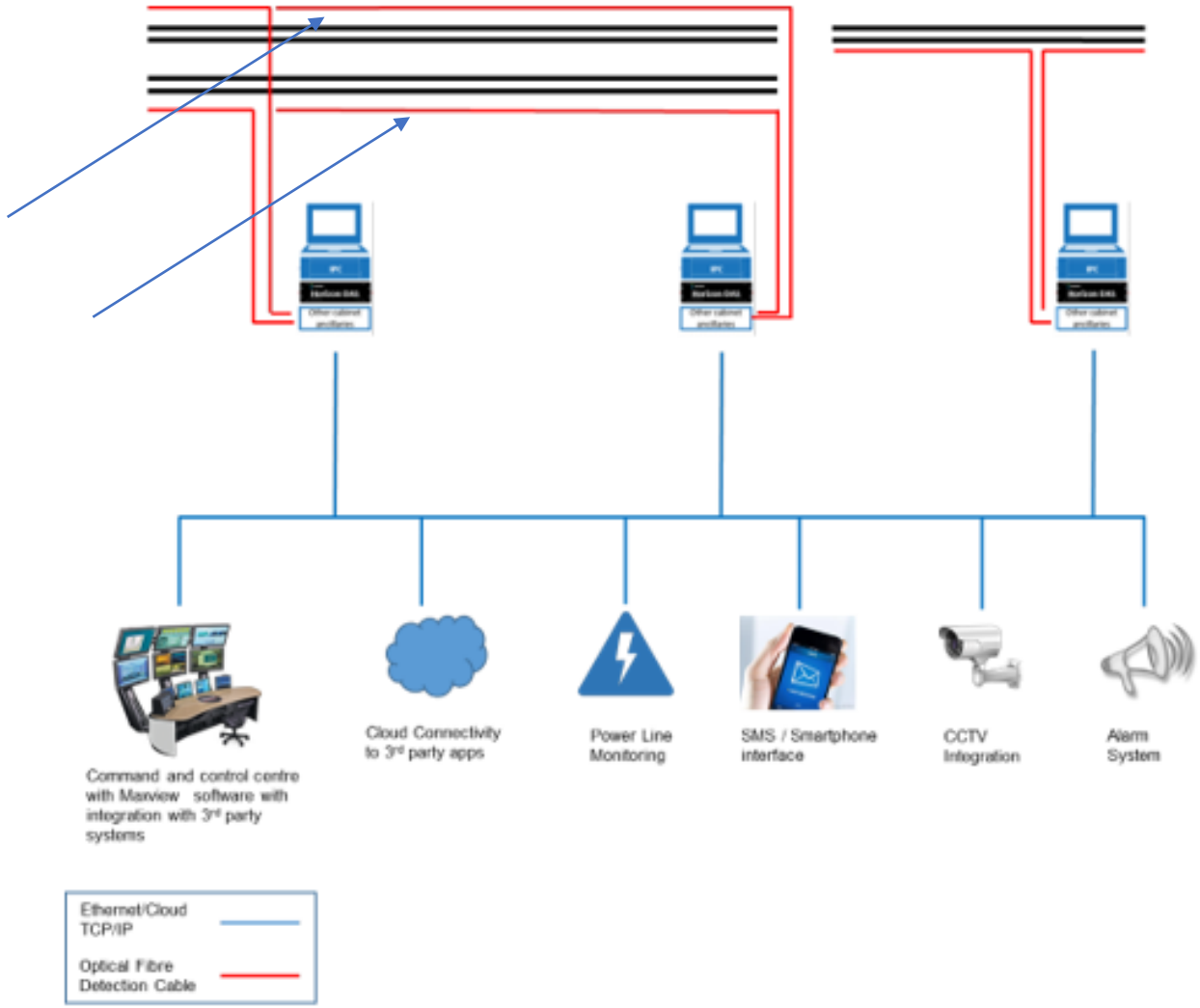


Figure 4-1 - System Architecture

The Horizon Detection Units (DU) will be used to detect third party interference along sections of the rail line. Multiple two channel Horizon DU's will be utilized to monitor identified sections of the rail line. **Each Horizon DU can monitor up to 50km of rail track per channel so 100km per DU**.

The cable layout will differ dependent on rail track configuration, where 1 single narrow-gauge rail line is **deployed a single optical fiber cable (OFC) can be used to monitor it**, however where multiple lines run in parallel than an OFC will be installed on either side of the rail line. See below diagrams.

For the purposes of these proposals it is assumed that there will be a dual run OFC on all rail lines, therefore it should be considered worst case scenario and the final firm proposal will be reduced.

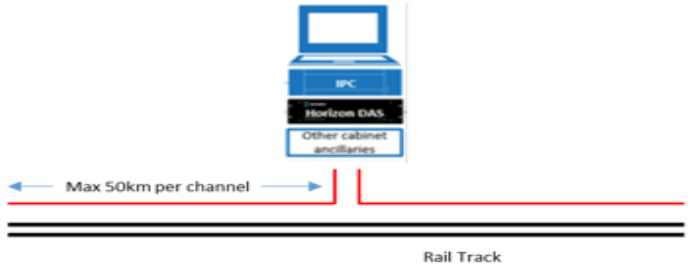


Figure 4-2-1 – Maximum channel length

Figure 4-3-2 – single track OFC configuration

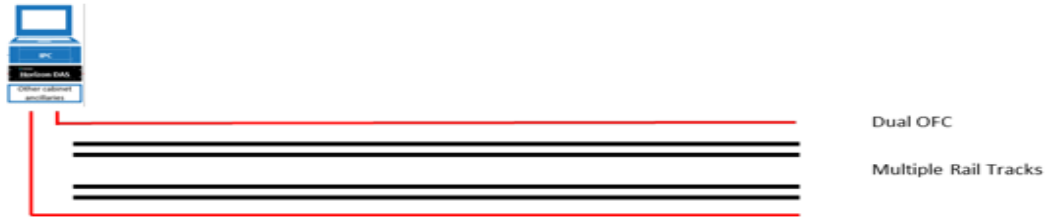


Figure 4-4-3 – multiple track OFC configuration

All Horizon DU's will be connected to a central control room via TCPfIP connection to ACE's MaxView software where it can interface with 3rd party software.

For the purposes of this budget proposal it is assumed that the Horizon DU systems will be located in 19" rack mounted cabinets in a suitable location to be agreed, the racks will be supplied by others.

Additional Horizon DU's may be required dependent on identifying suitable locations to ensure that maximum length of any one channel is 50km.

There is limited information about system integration at this point, however when utilizing the ACE Maxview software there is extensive ability to integrate to 3rd party software and systems, we have included our Maxview software in this proposal.

The total number of Horizon DU's contained within this proposal are

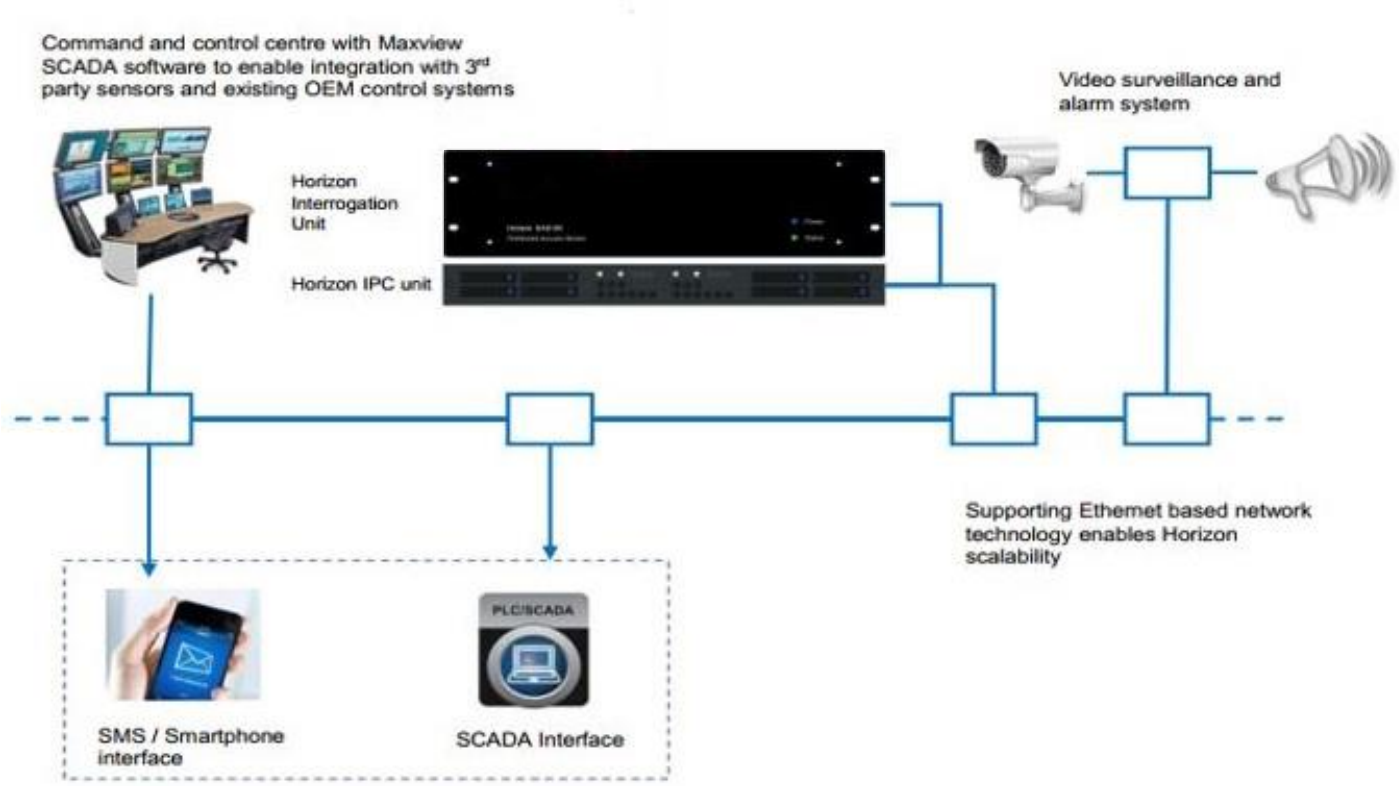
<u>Southern Route Preventive Project</u>

Songha –	100km of track	3 No. Horizon 50
Pattani -	29km of track	1 No. Horizon 50
Yala -	40km of track	1 No. Horizon 50
Narathiwat -	72km of track	2 No. Horizon 50

<u>High Speed Train/ Airport Link</u>

City Line -	60km of track	2 No. Horizon 50
Intercity Line -	160km of track	4 No. Horizon 50

System Architecture



Control Room Configuration

Third Party Intrusion Detection

One of the key benefits for the Horizon DU is in detection and classification of third-party interference events.

Event Classification

The Horizon DAS has inbuilt intelligent classification engine**s for accurate location of intrusion events (to within 5m) with minimal nuisance events and false alarms.**

Rail track Specific Algorithms

The specific issues that the end user is concerned with are:

- Unauthorized interference with the rail track, **this could be from terrorist activity which would include damaging the rail track to cause a derailment or planting of an improvised explosive device (IED)**
- Large object on the rail line including from **rockfalls or landslides that could cause derailment**
- **Theft or tampering with buried power or signal cables adjacent to the rail track**

Unauthorized interference

The system will be programmed to deploy an algorithm to detect a threshold level of activity against background environmental noise. This would include both manual or vehicular digging in the vicinity of the rail track − up to 20 meters away or major structural damage to the track by brute force attack again by personnel or machinery.

A person digging a hole has a unique acoustic profile which the algorithm will be programmed to detect, for example someone digging a hole for an IED in close proximity to the rail track.

Figure 4-5 Examples of buried IED

Object on rail line or Rockfalls

Assuming the category of an object likely to cause track, damage or derailment is 50-200kg +. This matches the definition of other operators which are in the range of 50kg (North America train operators – 0.028 m^3) to 300kg (Australian operators – 0.2m^3)

Figure 4-6 Example of 200kg rock fall - steep cliff

While it would be possible to categories different object sizes in a controlled environment, in the actual installation there are a number of factors which would make categorization very difficult. These include:

- Multiple rock falls: The reality is that rock falls may incorporate multiple rocks at one time. In this scenario if the rock falls are all within a 5-10m radius it is unlikely that the DAS technology will be able to distinguish between the multiple rocks if they fall simultaneously
- Trajectory of rock fall: The rock will likely roll down a slope to arrive on the tracks and so depending on the height or trajectory of the fall, the acoustic energy may be quite different (e.g. a 50kg direct impact from 10m may have similar impact energy to a 100kg rock impact from 5m that rolls down the hill)

It is therefore ACE's commendation that effort is not spent into trying to classify different object sizes but rather define a minimum object size (e.g. 100kg+) and classify all objects above this size as triggering an object on line alarm event

Buried cable interference

Similar to the detection algorithm for rail track interference detection, this algorithm will detect unauthorized personnel trying to interfere with buried signal or power cabling running parallel to the rail track.

Again, this algorithm will detect both manual and vehicular digging.

Mitigation and Minimizing Nuisance Alerts

It is anticipated that there will be substantial acoustic activity along the lines and so this will need to be clearly segmented and the zones and alerts tuned to meet the 95% detection criteria while minimizing nuisance alerts from other acoustic activity

It is anticipated that the main causes of background activity will be as follows:

- **Passing trains:** Whereas digging or rock falls or interference will be a singular event, train movement will be continuously moving and consequently will be fairly straightforward to categories and exclude from the detection algorithm

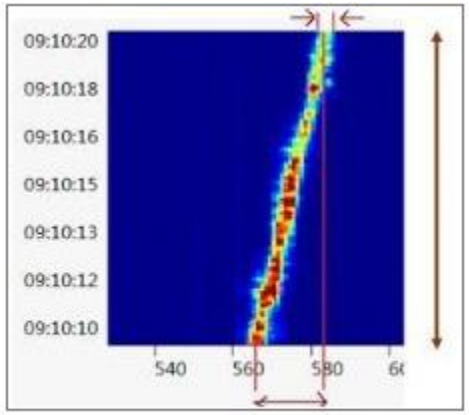


Figure 4-7 Example of moving train on the raw data waterfall

- **Wildlife:** Typically, wildlife will be of a smaller impact energy than a rock fall or human and so typically fall under the threshold of an alarm event. There typically will be multiple footsteps and again could be mitigated through a frequency/ count accumulation strategy
- **Crossings:** Depending on the crossing type. This may prove to be the most challenging as large vehicles crossing over the rails at defined points may have significant energy (similar to a gross impact). Crossing locations however can be identified and so it will be known that events will be associated with a crossing location and so can be prioritized accordingly.

Solution Element

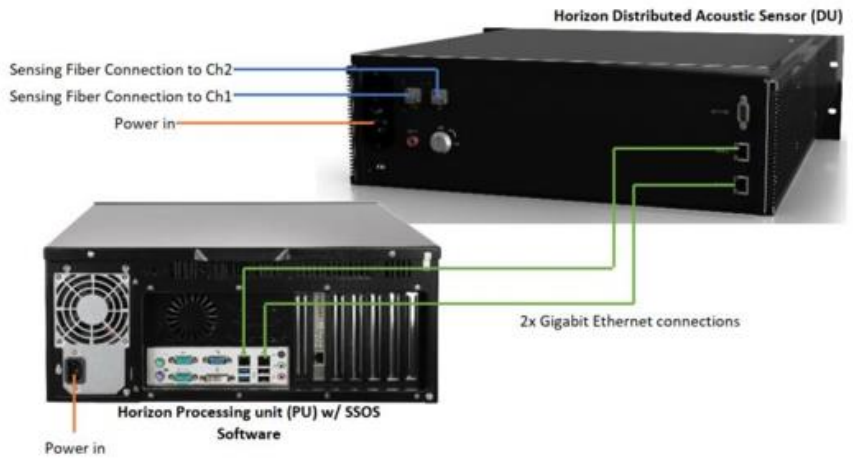
The key technology used for the intrusion monitoring detection is the Horizon Distributed Acoustic Sensing (DAS) which is developed and manufactured by ACE. This compact, low-power, user friendly sensing system is the ideal solution for medium to long range (5-100km) industrial monitoring applications where reliability, safety and seamless system integration are essential.

Horizon Processing Unit

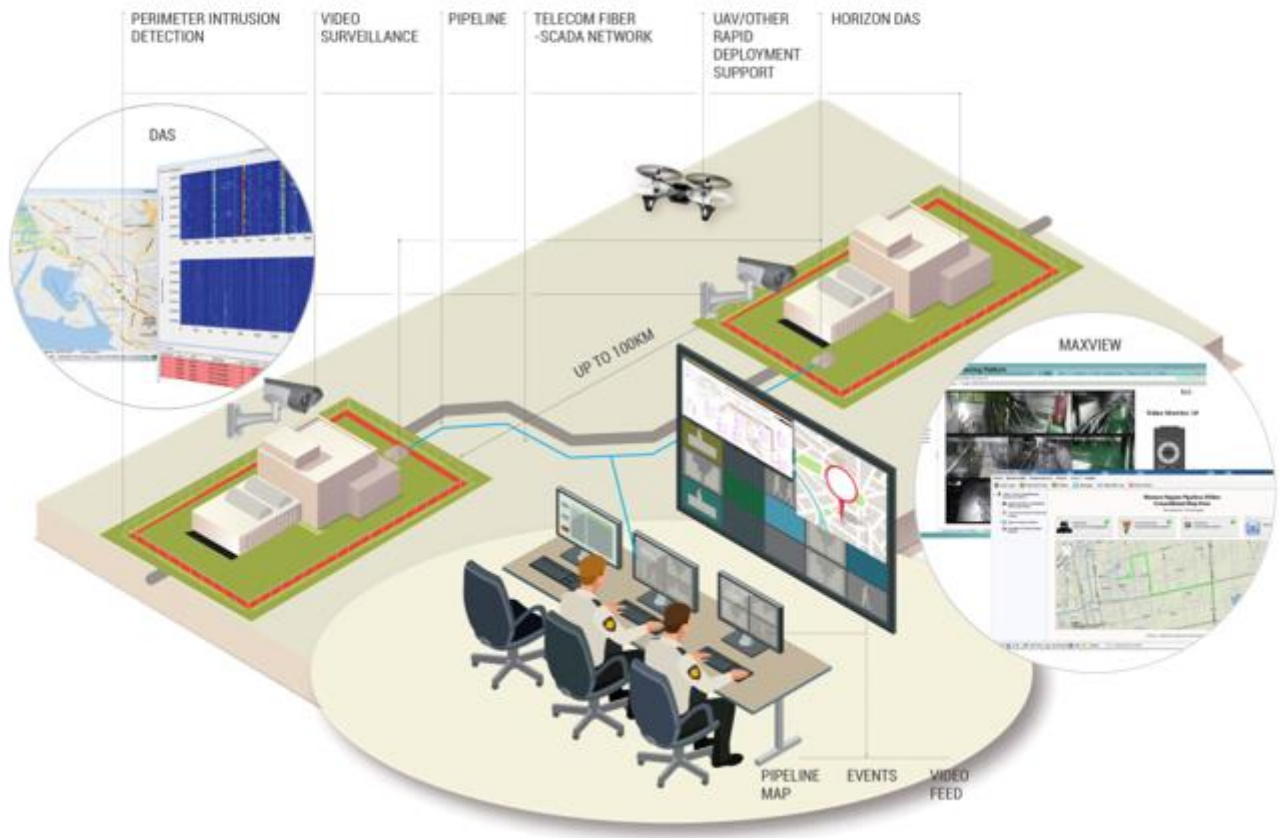
In addition to the Horizon DAS detector unit (DU) a Processing Unit is also required for the running the Horizon DAS SSOS system software. The main functionality of the software is:

- System configuration
- Visualization of data
- Ongoing management and monitoring of alarms
- Integration with external 3rd party camera feed
- Integration with MaxView system integration

The DU and the PU are connected by 2 Gigabit Ethernet cables to transmit information in the TCP/IP protocol, including vibration data, commands, results, and status.

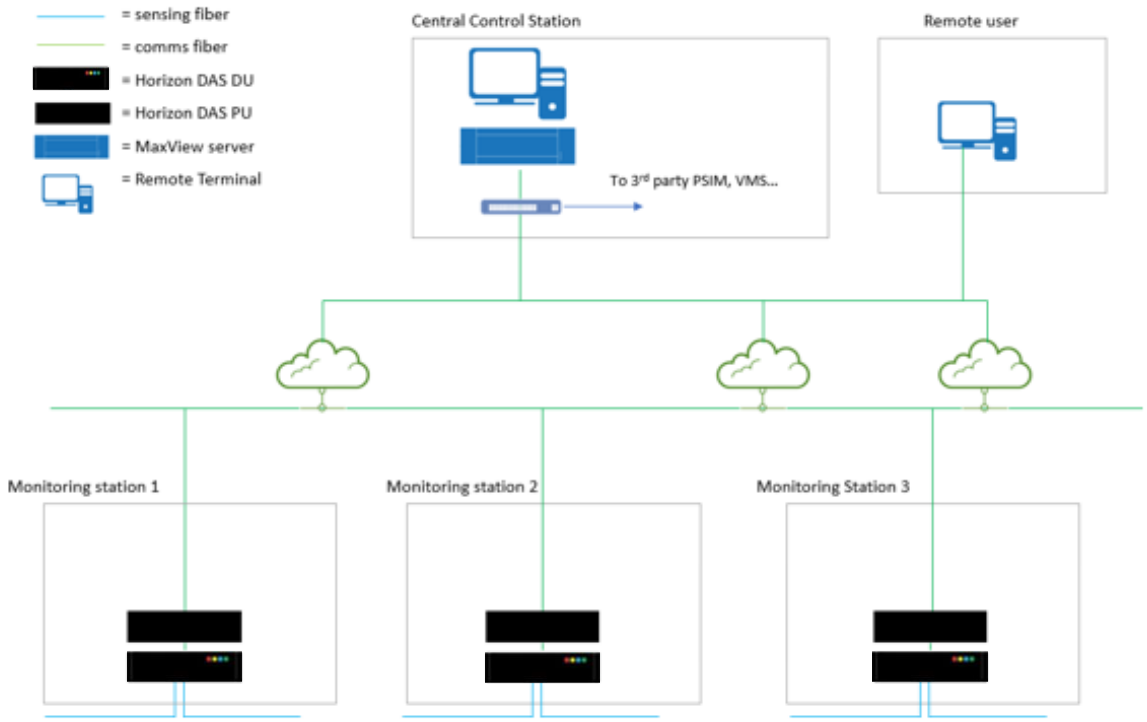


MAXVIEW INTEGRATED MONITORING PLATFORM



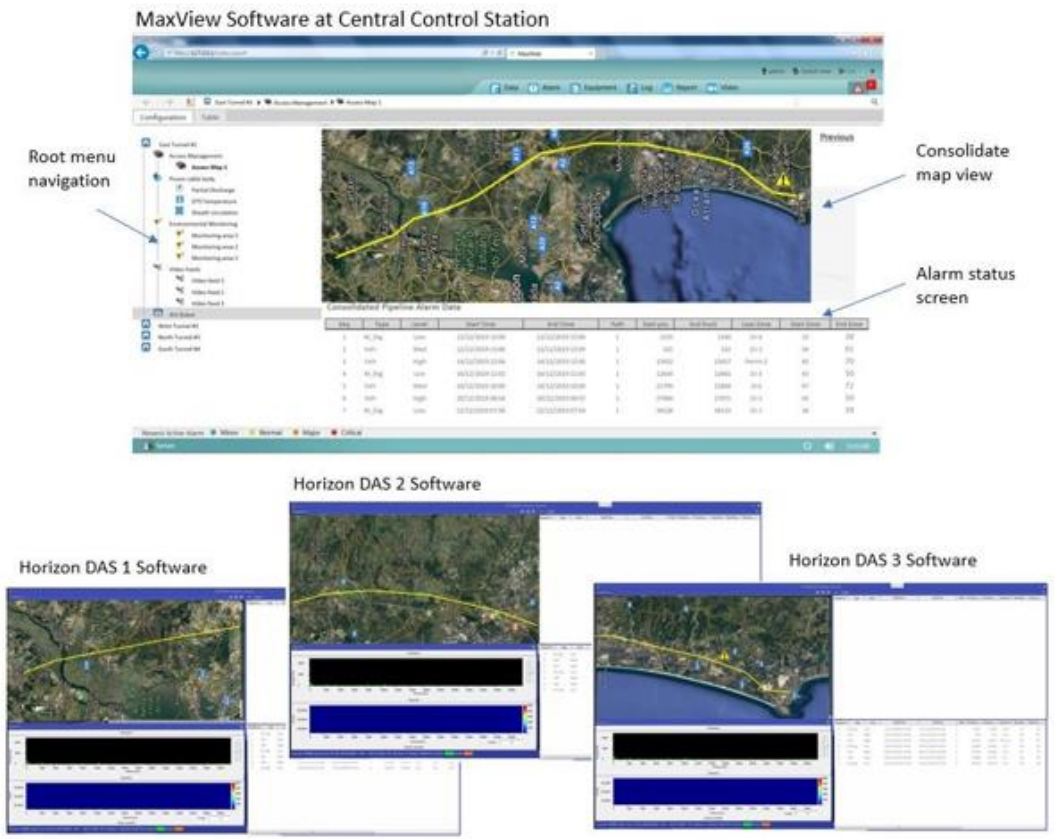
MaxView Central Visualization

one of the key functionalities of MaxView is centralization of the DAS visualization. In this scenario MaxView consolidates the visualization and data export of the Horizon DAS systems. In this scenario, MaxView is installed on a specialized server at a central location.



MaxView's key functionality includes:

- Central map view covering entire route of asset
- Central alarming functionality
- Consolidated data export to PSIM or other 3rd party system (SMS, SCADA, DCS…)



User Interface and SSOS Software

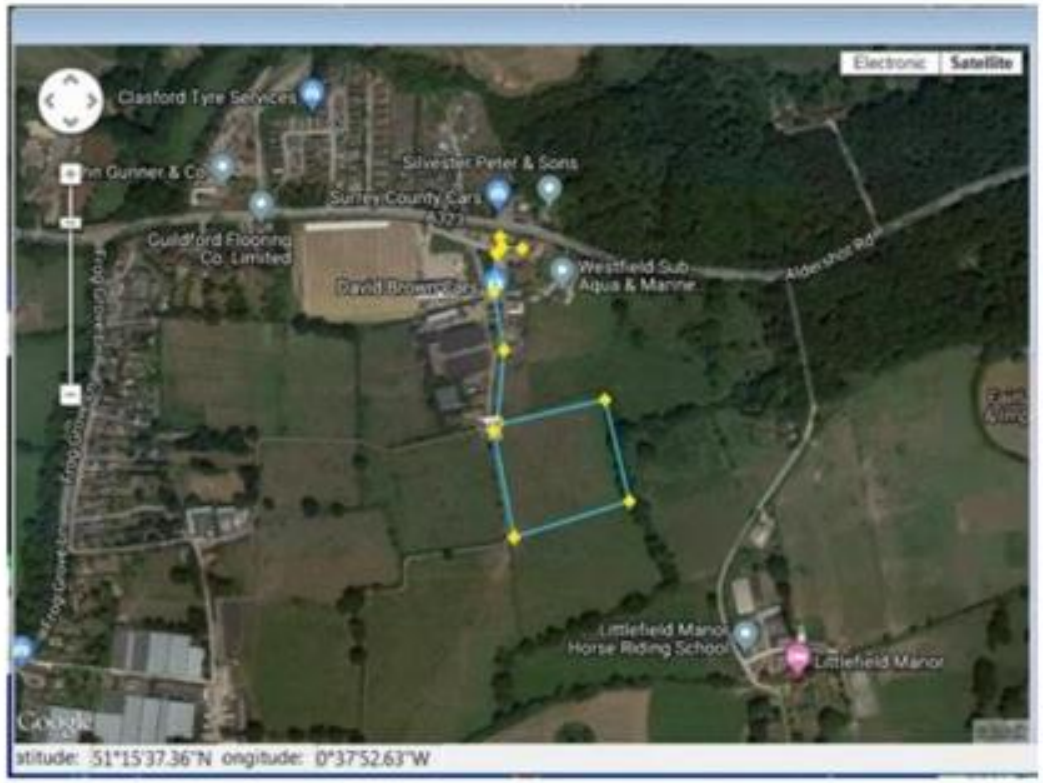
The Horizon PU utilizes in-built software with advanced data analytics and intelligent classification engine with Deep Neural Network (DNN) machine learning. The user interface as standard has the following functionality:

- Processing of algorithms (including DNN artificial intelligence)
- GIS mapping interface,
- Alarming functionality
- Waterfall data analytics
- Camera feed and integration

Below is a screenshot showing all of the functionality within one screen.

GIS Mapping Interface

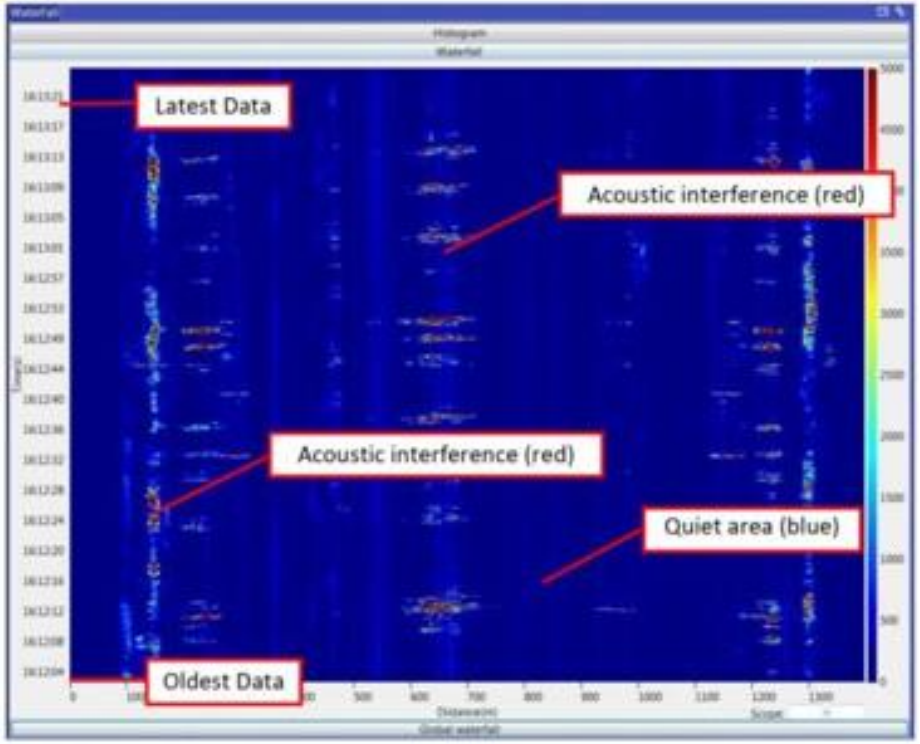
For the map view, the cable route is mapped at the calibration stage and a fully interactive map is then provided in which all alarm events will be graphically displayed on the GIS map



Waterfall Interface

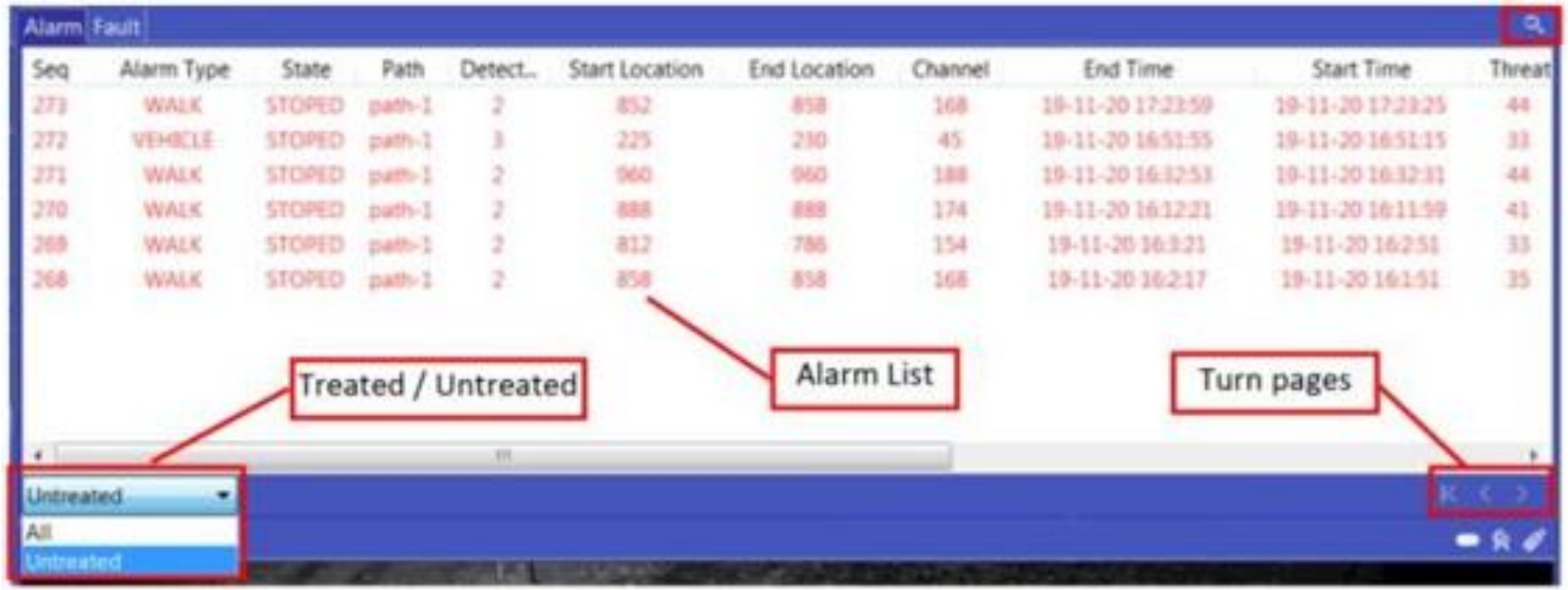
The waterfall screen is a real time rolling display which displays the acoustic data in an intuitive manner. This enables the user can carry out a real time analysis of the acoustic data in a quick and simple manner and allows more advanced interpretation of the data.

The color of the waterfall is proportionate to the acoustic energy and the user can zoom in on particular areas of interest along the length of the fiber route.



Alarm Screen

When an intrusion event is detected the software will present the alarm data within the detected alarm window with the associated information surrounding the event



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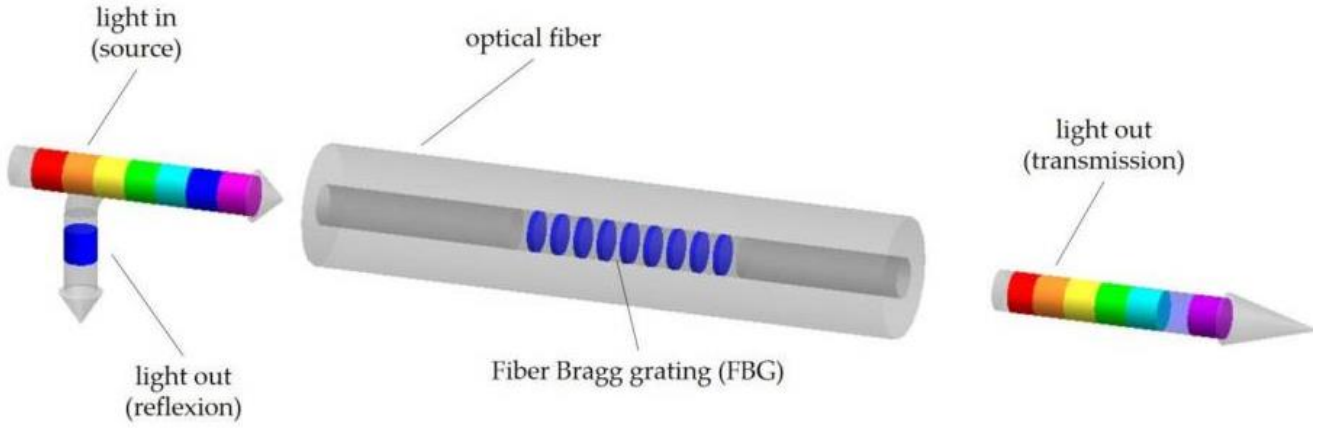
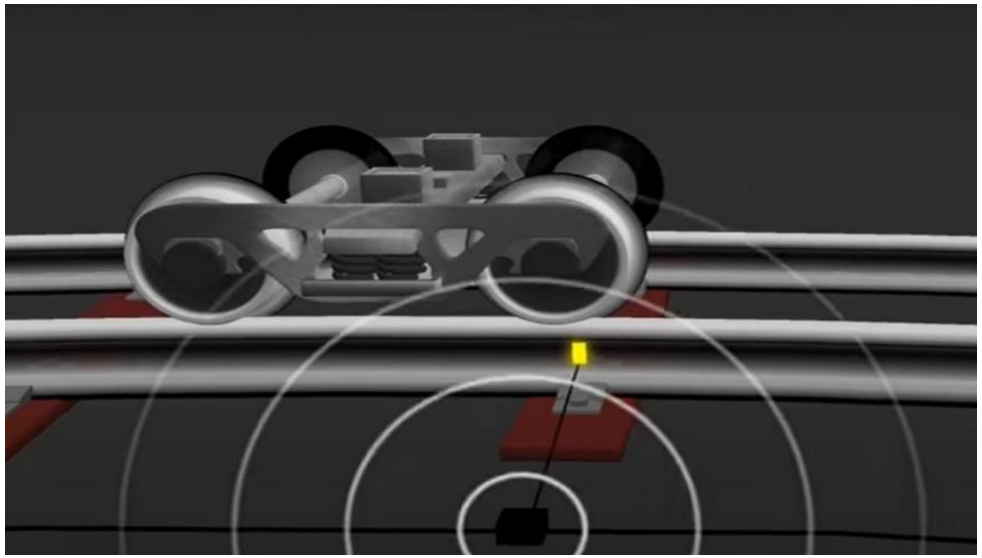


Strain Sensor

Position for installation

Protect for railway corrosion

Diagram for system



At railway

Central Computer connect with railway via LAN

Software monitoring real-time

Thank you