

Distributed Temperature and Acoustic Sensing (DTS & DAS) for Multi-Utility Pipeline Monitoring

Pipelines are critical infrastructure not only for oil and gas, but also for transporting water, wastewater, ammonia, agricultural products, chemicals, district heating media, and other utility services. These networks often span large distances, pass through populated or environmentally sensitive areas, and are essential to public services, industrial operations, and resource management.

Operators face growing pressure to improve asset reliability, detect leaks early, reduce water loss, prevent environmental incidents, and protect buried infrastructure from accidental damage or intrusion.

Fiber optic sensing technologies provide a powerful, continuous monitoring solution for these challenges.



Distributed Temperature Sensing (DTS) enables thermal monitoring for leak detection, process monitoring, and asset integrity management.

Distributed Acoustic Sensing (DAS) provides real-time detection of third-party intrusion, pipeline disturbance, and operational anomalies.

Together, DTS and DAS support both operational integrity and infrastructure security across diverse pipeline networks.

Key Challenges

- Aging buried infrastructure
- Difficult-to-access or remote pipeline routes
- Leakage and operational losses
- Third-party excavation risks
- Environmental damage and compliance requirements
- Operational impacts
- Variable products and operating conditions
- Limited continuous monitoring along long pipeline corridors

Technology Overview

Distributed Temperature Sensing (DTS)

DTS uses optical fibers as continuous linear temperature sensors to provide real-time temperature profiles along the pipeline.

DTS enables:

- Leak detection through thermal anomalies
- Process and flow monitoring
- Hot spot detection
- Asset and process monitoring

Distributed Acoustic Sensing (DAS)

DAS transforms the fiber into a distributed acoustic/vibration sensor capable of detecting and classifying events along the pipeline route.

DAS enables:

- Excavation and third-party intrusion detection
- Leak-related acoustic event detection (application dependent)
- Operational anomaly detection
- Right-of-way monitoring

Key Benefits of Fiber Optics

- Provides real time temperature measurements along the pipeline with early indication of a potential leak (DTS)
- Provides early indication of third party activity before the pipeline is breached or damaged
- Immunity to electromagnetic interference (EMI/FRI)
- Passive sensing element (no power required in the field)
- Sensing cable with a design life of 25+ years
- Minimal maintenance requirements

System Architecture

A typical integrated DTS/DAS deployment includes:

Analytics and alarm management platform

Fiber optic sensing cable installed alongside or integrated with the pipeline

Deployment configurations:

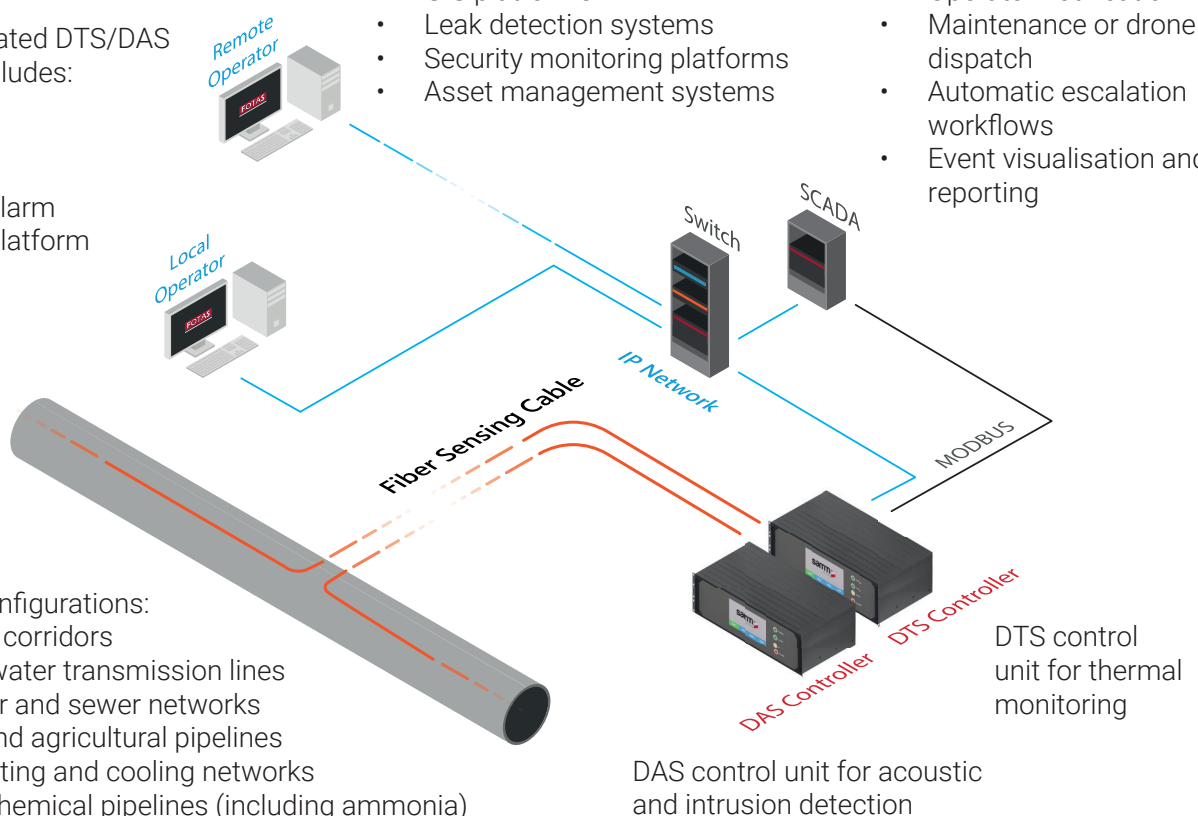
- Multi-utility corridors
- Municipal water transmission lines
- Wastewater and sewer networks
- Irrigation and agricultural pipelines
- District heating and cooling networks
- Industrial chemical pipelines (including ammonia)

Systems can interface with:

- SCADA / utility control systems
- GIS platforms
- Leak detection systems
- Security monitoring platforms
- Asset management systems

Possible responses include:

- Alarm generation
- Operator notification
- Maintenance or drone dispatch
- Automatic escalation workflows
- Event visualisation and reporting



Key Factors for Successful Deployment



Fiber Deployment

- Direct buried alongside pipelines
- Installed in ducts or utility corridors
- Configured for effective thermal and acoustic coupling



Cable Selection

- Ruggedised fiber suitable for buried utility environments
- Protection against moisture, mechanical damage, and soil
- Design compatible with both DTS and DAS performance requirements



System Design

- Alarm zoning and event classification strategy
- Integration with utility monitoring systems
- Redundant architectures where required

DTS FOR LEAK DETECTION AND ASSET MONITORING

Key DTS Applications

Water Transmission Pipelines

- Leak detection and localisation
- Detection of water loss in buried networks
- Monitoring of critical crossings and high-risk zones

Agricultural and Irrigation Pipelines

- Leak detection in long irrigation systems
- Monitoring of remote distribution lines
- Detection of abnormal thermal conditions impacting flow or system performance

Wastewater and Sewer Pipelines

- Leak monitoring
- Temperature anomaly detection associated with blockages or abnormal flow
- Monitoring of critical interceptors and pressure mains

Ammonia and Chemical Pipelines

- Leak detection
- Thermal anomaly monitoring
- Integrity monitoring of critical sections and facilities (particularly valuable where environmental or safety consequences are high.)

District Heating and Cooling Networks

- Heat loss monitoring
- Leak detection
- Insulation performance assessment
- Hot spot detection in buried district energy pipes

Leaks often generate detectable temperature anomalies due to product release or changes in surrounding thermal conditions.

DTS can identify:

- Localised temperature changes associated with leaks
- Flow-related anomalies
- Temperature disturbances indicating abnormal operating conditions



Key Benefits

- Continuous full-length monitoring
- Early leak detection and localisation
- Reduced losses and environmental impacts
- Improved asset integrity management
- Faster repair response
- Support for predictive maintenance
- Enhanced regulatory compliance
- Improved network resilience

DAS FOR THIRD-PARTY INTRUSION AND EVENT MONITORING

Excavation damage is a major risk across utility pipelines.

DAS detects:

- Mechanical excavation
- Trenching and drilling
- Vehicle activity near right-of-way
- Unauthorised access
- Ground disturbances near buried infrastructure

Event Classification

Advanced DAS analytics can distinguish between:

- Background environmental noise
- Benign activity
- Potential threats
- Critical intrusion events requiring immediate response

This reduces nuisance alarms while improving actionable detection.

Key DAS Applications

Excavation Damage Prevention

Early warning of:

- Backhoe activity
- Utility strikes risk
- Construction encroachment

Operational Event Monitoring

Depending on application, DAS supports detection of:

- Abnormal flow-related acoustic events
- Pressure-related disturbances
- Mechanical anomalies in some pipeline systems

Corridor Security and Monitoring

Continuous monitoring of utility corridors for:

- Intrusion
- Tampering
- Unauthorised activities



Key Benefits

- Real-time event detection
- Reduced excavation damage risk
- Continuous corridor-wide security monitoring
- Faster response to threats
- Reduced patrol requirements
- Improved situational awareness

INTEGRATED DTS + DAS SOLUTION

Using DTS and DAS together provides both integrity and security coverage.

Integrated monitoring can support:

- Leak detection
- Intrusion detection
- Asset condition monitoring
- Right-of-way protection
- Operational anomaly detection

Combined Benefits

- Single fiber supporting multiple sensing functions
- Comprehensive monitoring coverage
- Unified event management
- Reduced infrastructure complexity
- Improved risk mitigation