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The Role of Distributed Fiber Optic Sensing in Providing Intelligent Condition Monitoring Solutions for the Transmission and Distribution Network

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Introduction

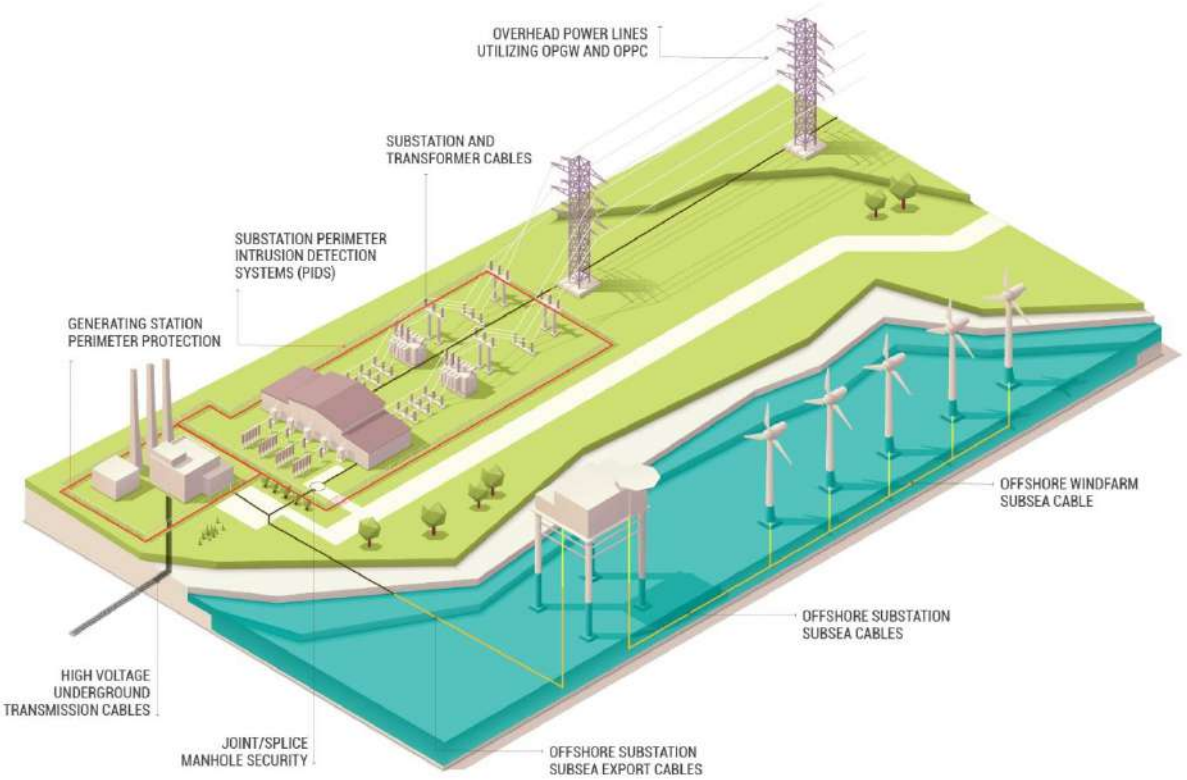
Fiber optic distributed sensing technology has become established as one of the key elements of condition monitoring systems with the transmission and distribution network. Although Distributed Temperature Sensing (DTS) technology was introduced back in the 1980s, improvements in system metrology, data management and storage, reliability and cost has meant that in the last decade this technology has cemented its place as a fundamental and essential tool for condition monitoring for transmission and distribution networks. Recently exciting new developments in Distributed Acoustic Sensing (DAS) technology have started to make progress within the power sector.

As the demand increases for renewable energy, offshore generation schemes are being planned and constructed at an increasing rate. Owing to the high cost of repairing subsea cables and the onerous installation and operating conditions, real-time monitoring of the cable provides an effective asset management tool. This can subsequently deliver large savings when preventative maintenance and condition based maintenance is incorporated into operations[1].

Distributed Temperature Sensing

The power industry supply chain has commented on the use of DTS technology within intelligent condition monitoring and its benefits. Applications range from the monitoring of power cables and subsea lines to transformers and switchgears to rotating machines, generation plants, overhead transmission cables and much more[2].

Research from the Korean Electric Power Corporation (2012)3 found that faults can be reduced and the operating ampacity of the underground distribution system can be increased when using DTS in real-time and on-line monitoring for underground distribution cables.



Clearly the key factors to consider when it comes to the longer range, more remote industrial monitoring applications, are reliability, safety and seamless integration. As a fairly mature sector there are a number of DTS systems developed specifically with these requirements in mind.

These systems are designed purposely for industrial monitoring applications and have the following design features and capabilities:

- Compact
- Low power consumption
- Fast response
- Built-in alarm and relay capabilities

In addition to the hardware, DTS providers have developed powerful integrated software platforms to allow for wider system integration, for example:

› Tunnel environmental monitoring
› Integration with video and emergency phone system
› Access control
› Advanced analytics including incorporation of RTTR

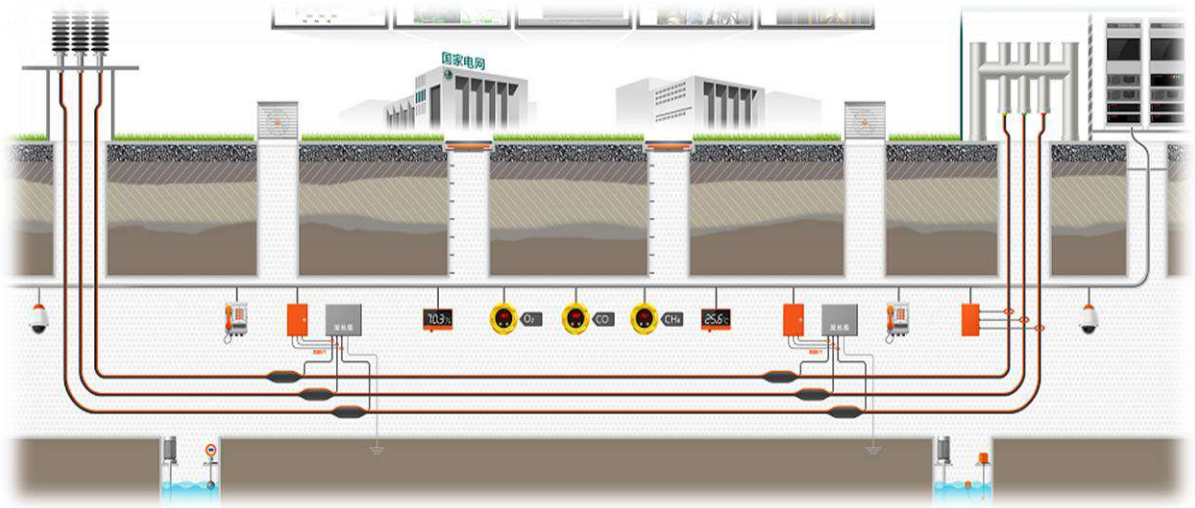


Figure – Example of integrated cable tunnel monitoring system including DTS, current sensors, water sensors, gas sensors……..

Real Time Thermal Rating

Another key component of a utility operator's intelligent condition monitoring solution is a Real Time Thermal Rating (RTTR) system. This system helps reduce risk, implement smart maintenance programs and increases the efficiency of the load management system.

Based on the thermal analysis defined by IEC-60287 and IEC-60853 and combined with DTS and DAS Sensors, RTTR systems can provide the following:

› A means to determine current and future loading and provide emergency rating calculations
› Fault location for the precise localisation of any issues in the circuit
› Analyze power cable hot-spots to determine if a circuit requires upgrading or providing required quantitative information for life extension cases
› Circuit diagnostics of a variety of circuit parameters including potential partial discharges

Distributed Acoustic Sensing

DAS systems have started to make an impact within the power sector. DAS measures the temperature along the fiber using a technique called Coherent Optical Time Domain Reflectometry (COTDR). The DAS rapidly sends laser pulses into the fiber optic and measures the reflected light from the optical fiber sensing cable.

What makes the DAS different from the DTS Sensor is the way in which the COTDR system returned scattered signal is mixed with a local oscillator and then filtered. By analyzing the returned light at the Rayleigh

frequencies, the DAS is able to create a distributed acoustic (or vibration) measurement along the entire length of the fiber, effectively turning the telecoms cable into a continuous series of microphones.
When used in conjunction with a proactive maintenance approach, DAS and DTS 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.

Below are some of the applications within the power and utility sector that utilize Kifta's range of distributed temperature and acoustic fiber optic sensors and intelligent software solutions.

- Cable rating for buried cable and cable tunnels
- Accidental third party interference from road construction
- Perimeter and access intrusion detection systems
- Overhead line galloping
- Metal theft from overhead towers
- Fault location in buried and subsea cables
- Subsea cable location
- Detection of anchor damage to subsea cables

Challenges and Opportunities

As the technology costs continue to fall and client interfaces become more user-friendly the number of applications will continue to grow. New applications in development include:

- Busbar monitoring
- Transformer temperature and condition monitoring
- Switchgear condition monitoring

There are still many issues for operators within the sector with recent evidence[5] showing that installation of subsea cables is still a major concern. Based on data from the UK sector 68% of the insurance losses recorded (>$300mn) were associated with cable faults which occurred during the construction phase[5].

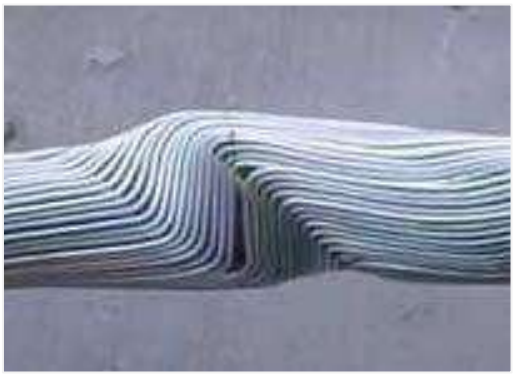
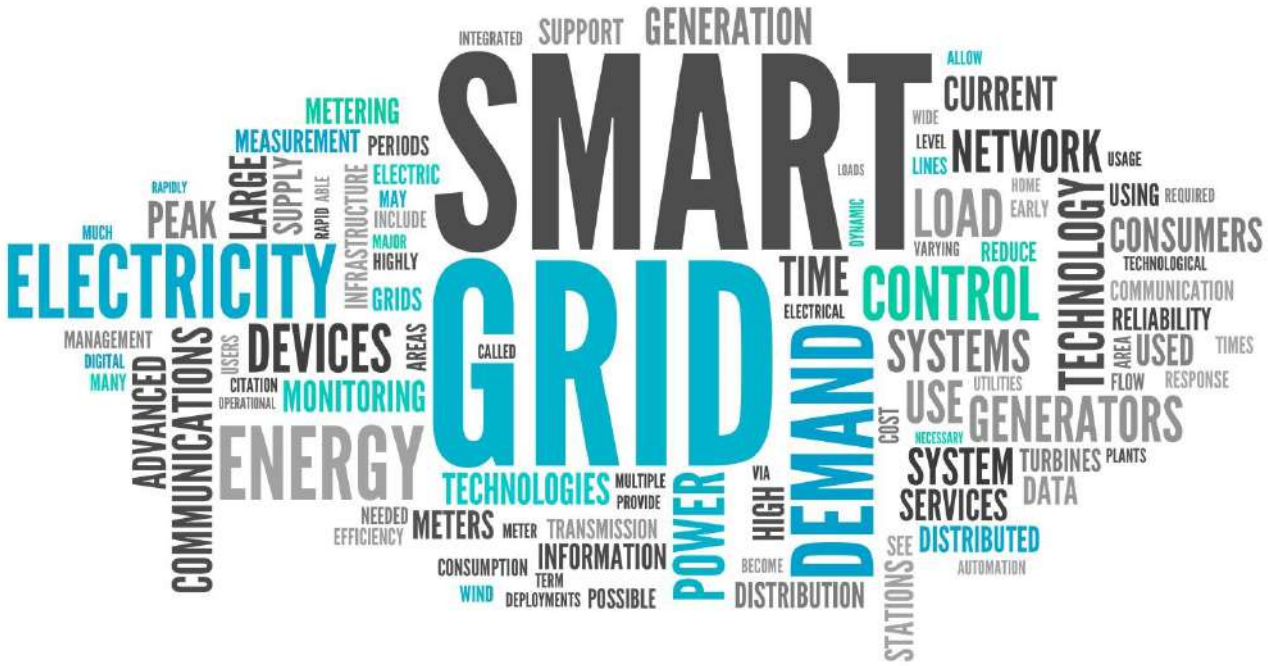


Figure 1 Example of cable damage

This is a key example where a lack of information is a problem and essentially operators are flying blind. DTS and DAS technologies may provide a means to garner information on the interface where the cable hits the seabed which in turn may prevent the damage.

We anticipate that the role of Distributed Fiber Optic Sensing will continue to grow and expand providing ever more intelligent condition monitoring solutions for the Transmission and Distribution Network – resulting in a truly smart grid.



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About Kifta Technologies

Kifta has been providing advanced fiber optic monitoring sensors and integrated technologies since 2015. 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, Kifta'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.