Cloud based cable monitoring system for underground power cables

Shinnosuke **NAKANO**, Takefumi **SHIMOGUCHI**, Shoji **MASHIO**, Kozo **SUZUKI;** Sumitomo Electric Industries, Ltd., (Japan), nakano-shinnosuke@sei.co.jp, shimoguchi-takefumi@sei.co.jp, mashio@sei.co.jp, suzuki-kozo@sei.co.jp
Masaki **KURIHARA**, Kimihiro **IWASAKI;** TEPCO Power Grid, Inc., (Japan), kurihara.masaki@tepco.co.jp, iwasaki.kimihiro@tepco.co.jp,

ABSTRACT

To ensure the world's growing number of cable systems and accessories are utilized in a safe and reliable manner during the full expected cable lifetime, the advanced maintenance of cable assets is required. A full transition to Condition Based Maintenance (CBM) from traditional Time Based Maintenance (TBM) is expected. In particular, there is demand for low-cost and high-reliability maintenance, even with issues of ageing assets and a decrease in maintenance personnel and their inability to go to new increasing offshore wind power plants. In order to realize a transition to CBM, it is important to build a sensor network, and an operation and maintenance (O&M) platform that can accumulate sensor information and apply bigdata analysis to it with AI processing. The target of our recent proof of concept (PoC) efforts is to use a cloud server as the base of a platform to monitor and diagnose cable facilities, detect and predict abnormalities using AI, share facility status information with maintenance managers, and provide information necessary for appropriate CBM. This paper reports the details of a cloud-based cable monitoring system developed with TEPCO and the results of various PoCs carried out using this monitoring system.

KEYWORDS

Cloud based cable monitoring; Power Line Communication; CBM; Machine learning; Partial discharge detection; Real Time Thermal Rating (RTTR)

INTRODUCTION

The number of maintenance personnel is expected to decrease in Japan, in spite of issues such as an increase in maintenance work due to ageing of cable assets, and poor access to increasing offshore wind plants. Therefore, there is a growing awareness that maintenance should shift towards more advanced CBM systems that can maintain asset reliability and reduce maintenance costs. Conventional TBM based methods for cable assets consist mainly of visual inspections of cable assets based on experiential knowledge and various measurements. However, CIGRE TB 825 asks for a transition from TBM to a more advanced CBM that can reduce O&M costs and accomplish expected life of equipment by realizing early detection of abnormalities and predictive maintenance. The following are some of the issues that need to be dealt with in order to realize CBM using various sensors, IoT, and AI.

Issues to realize CBM:

- Need for detection sensors: Various sensors will be needed to accurately grasp the status of the cable assets, and to acquire data useful for maintenance, such as an early detection of anomalies and prediction of failures.
- Construction of a sensor network for underground cables: It is necessary to build a sensor network that utilizes IoT to collect information acquired by various sensors from cable facilities installed in underground tunnels and conduits. In addition to conventionally used optical lines, radio, and mobile communication, it is necessary to develop a communication method that can be used in manholes and temporary installations or when retrofitted sensor installations where there are no suitable communication method.
- Building an O&M platform: The aim is to build an information platform that integrates the collection, management and analysis of a huge amount of sensor information, and to significantly reduce O&M costs., In the future, the goal is to comply with IEC 61850, an international standard that defines communication protocols for SCADA and substation communication equipment. In addition, the platform is required to have a high level of information security in compliance with IEC 62351, which is for handling the security of the TC 57 series of protocols including the IEC 61850.
- Big data analysis for advanced maintenance: By accumulating sensor data and utilizing AI analysis of big data including information from other equipment, the platform detects anomalies at an early stage, predicts failures, and optimizes equipment operation. Maintenance managers use the visualization of sensor information and the analyzed information to carry out appropriate maintenance and equipment repairs.

Among these issues, we constructed a sensor network that utilizes IoT from various sensors (optical fiber sensors, analog sensors, PD sensors, images, etc.) using various communication methods (optical, wireless communication, power line communication (PLC), etc.). We developed a cloud-based O&M platform that can aggregate and accumulate various sensor data, and visualize and analyze the accumulated data in real time. Using this platform, we carried out multiple PoCs. In particular, we developed a communication method using PLC for existing manholes of cables installed in conduits, for which there was no appropriate communication method. We also tried data analysis using AI on the platform.

CONSTRUCTION OF SENSOR NETWORK BY PLC

Until now, in the monitoring of underground cables, optical lines have been used for underground tunnels, and mobile lines have been used for above-ground sections. However, there was no suitable communication method to collect sensor data from existing manholes where these two methods were not usable. In addition, there are similar issues when setting up new communication lines when sensors are urgently needed to temporarily monitor underground facilities. Therefore, there is a need to