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QUESTION N° : 3.1

Condition monitoring on installed switchgear, without additional sensors

At Elia, the Belgian TSO, we have switched from time based asset management towards condition based asset management since 2017. For the existing switchgear, this means that more than 2.000 circuit breakers and 6.000 disconnectors of different types (hydraulic, pneumatic, AIS, GIS,…) are currently maintained and replaced based on their condition. The condition of these assets is derived from a set of classic parameters like: construction type, construction year, #operations, #compressor hours, contact resistance and operating times measured during maintenance, and some more…

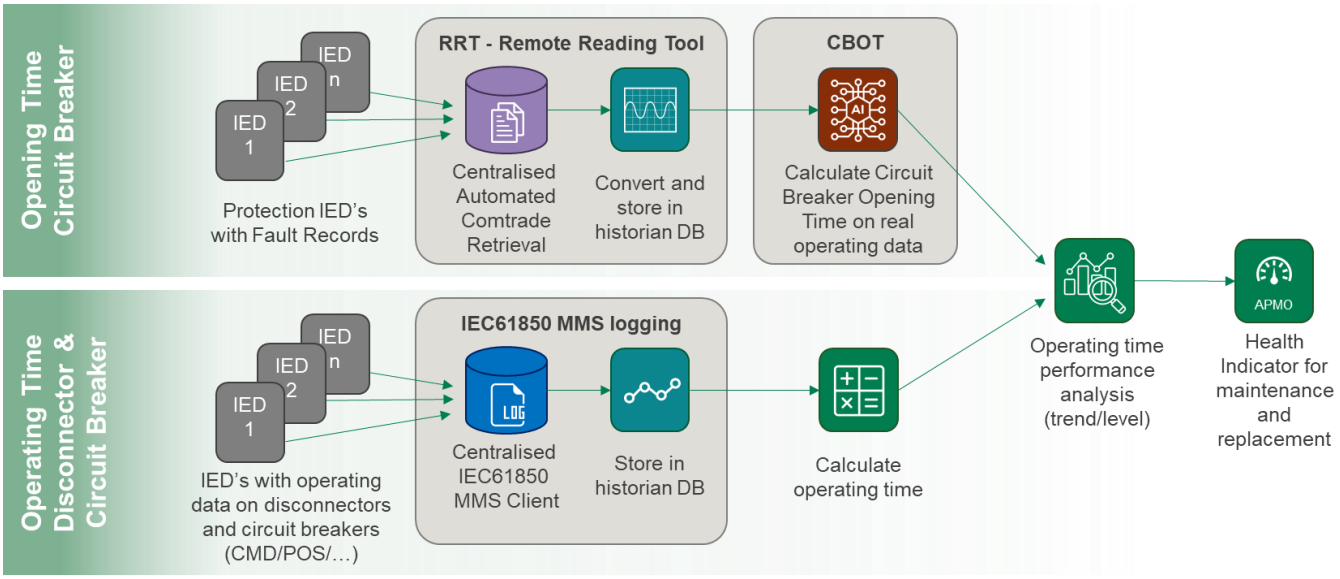
For Elia, this has resulted in a good and reliable basis to define the maintenance interval and perform general fleet management (ie replacement policies).

A next step would be to detect early failures and move to Predictive Asset Management. The data refresh rate is however slow, which makes it very difficult. This is due to some important parameters like contact resistance or operating times that are only captured during maintenance every +5 years. Therefore, they cannot be considered as a good data source to quickly detect early or recent wear and tear that can lead to a failure.

Adding sensors to existing switchgear is the market advised solution to collect more data. Unfortunately there are some draw backs:
- Devices and installation are expensive when a TSO needs to cover a big fleet (installation hours, the sensor, communication network,…)
- The installation of the sensors requires an outages to install the sensors in line with current safety regulations.
- Adding parts to a system will in general increase the complexity and the failure rate (even when it's minor failures).

As an alternative, Elia has built a concept to harvest in a smart way more information/data from its already digitalized existing installations, making use of IEC61850, Fault Recordings, Central Data Management and AI/ML techniques.

There are two main streams in the concept, which are clarified step-by-step on the next page:



A. Opening Time for Circuit Breakers based on fault recorder data

The automated steps are:

1. collect the fault recorder data from the protection devices using ‘Get File’ over IEC61850 (RRT)
2. convert, label, categorize and store the data as time series in to an historian database (RRT)
3. use a trained AI/ML algorithm to derive the electrical opening time of the circuit breaker (CBOT)
4. evaluate the opening times of the circuit breaker to detect slower operation (trend) or the exceeding of an absolute threshold.
5. use this information as a data input to calculate the condition of the circuit breaker and even give predictive input based on the trending.

B. Operating Time for Circuit Breakers or Disconnectors based on IEC61850 MMS data

The automated steps are:

1. collect command and position data on circuit breakers and disconnectors from the substation IEDs (protections, bay controllers) using a centralized IEC61850 MMS client.
2. label, categorize and store the data as time series in to an historian database
3. use a basic calculations to derive the mechaniclcal opening and closing time of the circuit breaker or disconnector
4. evaluate the operating times to detect slower operation (trend) or the exceeding of an absolute threshold.
5. use this information as a data input to calculate the condition of the asset and even give predictive input based on the trending.

Status from concept to production:

- The Remote Reading Tool (RRT) has passed the pilot phase and is in development
- The CBOT has passed prototype testing and is awaiting more data to refine the training of the model (ie waiting for RRT)
- The IEC61850 Logging is currently in test
- The evaluation system (trending and thresholds) is an existing platform that will need some parameterization.

Advantages of this concept:

- The concept uses existing digital data sources and doesn’t add parts to the circuit breaker or disconnector system
- With every switching operation we collect new data that will help us to assess the condition of the asset
- The condition monitoring is now based on real ‘in operation’ data, and not only on data obtained during maintenance in almost ideal circumstances
- With the fault recordings we even get the real electrical short circuit interruption time, which is very valuable to assess the condition