Support for asset management in electricity networks

Insight into technical and economical network performance

At a glance

Network operators need to maintain economical efficiency and power quality at the same time. Siemens Power Technologies International (Siemens PTI) offers straight forward processes and methodologies to support asset management by enabling solid and objective decisions on asset management strategies. These include:

- effects of possible decisions on network cost and quality, as well as the respective correlations
- well-founded schemes for the objective assessment of condition and importance of assets
- increased efficiency in network operation, while maintaining adequate quality levels and considering long-term performance

The challenge

Decisions on preventive maintenance or replacement of components have a direct influence on both the cost and the quality of the power supply. The underlying correlations are highly complex – and typically financial impacts are realized in the short term, while technical impacts, e.g. from reduced maintenance efforts, show in the long term only.

Thus, asset management needs to consider the performance of the overall system in the long term. Decisions should be based on objective analyses and assessments, ensuring that all performance requirements will also be met by the system in the future.

Our solution

Due to the complex nature of the challenges and correlations, there is no simple, complete solution for asset management. Rather, a comprehensive methodology needs to be adapted to the concrete case under consideration. For this purpose, the detailed system knowledge of the customer is combined with the expert knowledge and experience of Siemens PTI consultants.

Based on a suitable assessment of component importance and component condition, an objective and quantitative prioritization of the network components is evaluated. Component importance considers the relevant reliability aspects. From the current system state, different scenarios are derived and analyzed (see Figure 1).

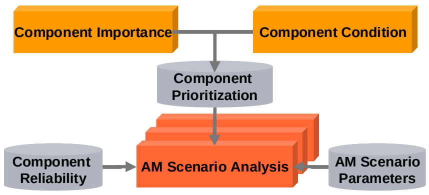

Figure 1: Overview of the key process modules.

Our solutions for asset management support make use of this basic scheme, adapting and extending it as necessary for special focus:

- Reliability Centered Asset Management (RCAM®)
- Asset Risk Mitigation Analysis (ARMA)

In addition, the process is adapted to the specific requirements of every individual project.

RCAM-Safeguarding long-term system reliability

The special focus of the RCAM process is to analyze and forecast system reliability performance with consideration of the strategies for preventive maintenance and replacement of assets. Different sets of strategies can be evaluated for high-level indices of economical and supply reliability performance over a future study period.

System supply reliability performance is evaluated by probabilistic reliability calculations (see Figure 2).

Contrary to contingency analyses, all relevant contingency states are modeled based on a stochastic description of component failures. For supply interruptions, the supply restoration process is also evaluated.

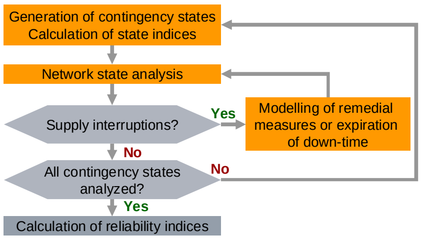

Figure 2: Overview of probabilistic reliability calculation methodology

Application example

Together with the customer, suitable assessment schemes for component condition and importance in a medium-voltage (MV) distribution system were defined and evaluated (see Figure 3). In this component prioritization diagram, different strategy areas are defined. In each area, different parameters for preventive maintenance and replacement of components are used. The strategy areas and these parameters characterize the different scenarios.

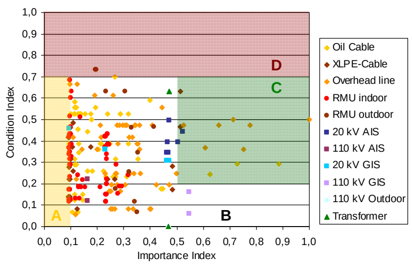

Figure 3: Component prioritization

In this example, for each scenario the supply reliability performance (e.g. ASIDI) and certain cost parameters (e.g. investments, operational expenditures OPEX) are calculated over a 40-year time horizon (see Figure 4).

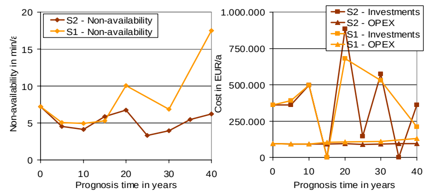

Figure 4: Performance indices over the study period

ARMA-Risk management for power system assets

The ARMA process focuses on detailed investigations into both the conditions of certain assets and their impact on overall network reliability performance. From these results, a risk profile is developed for each asset (Figure 5).

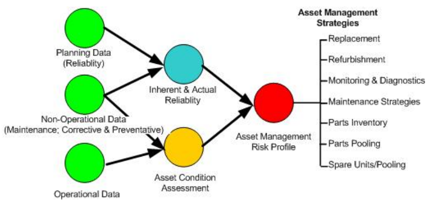

Figure 5: ARMA process overview

The risk analysis can also include economic aspects, such as equipment and reliability costs. From the risk profile, the recommended strategy for each asset is derived.

Application example

Power transformers offer an excellent example for applying the ARMA process because of their relatively high per unit cost, their importance on overall network operation and their advanced average service age in many systems.

The potential impacts of asset failures on network reliability are calculated using both typical failure statistics (providing "inherent reliability") and specific failure data that takes into account the asset conditions, e.g. age (reflecting "actual reliability").

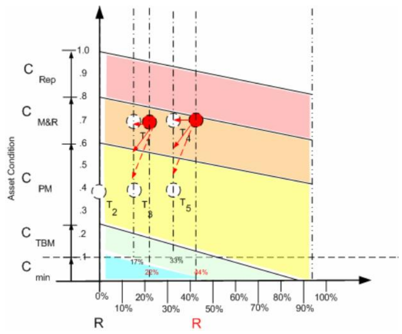

Figure 6: Condition and reliability values (white: inherent reliability; red: actual reliability)

Figure 6 illustrates the expected improvements in asset conditions and reliability impacts by applying different measures, e.g. replacement or monitoring, to T1 and T4. When the related OPEX and CAPEX charges are weighted against the potential reliability improvement, the most efficient strategy for each transformer can be identified.

Published by
Siemens AG 2016

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