Research on Classification of Substation Background Information for Monitoring

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Abstract. The substations are important parts of modern electrical grids. The monitoring of background information in substations should be carefully managed to keep the smoothly operating of the electrical system. However, there are still some problems in present substations. As a result, some problems can not be handled efficiently and effectively. In order to improve the robustness of information monitoring of substations, this study first analyses the typical problems in the substations. Afterwards, several ways are proposed to handle these problems. As all the information in the substations are standardized, classified and automatically diagnosed, the occurred problems can be smoothly solved with high efficiency and effectiveness.

1 Introduction

Modern electric grids paly an important role in our daily life so their safely operating should be carefully considered [1-3]. In the previous works, there were many works about the safety of the substation, e.g., fault analysis, backup protection, logic visualization, etc. [4-12] As a complex system, there is a large amount of information in the substations, which records the states and conditions of the electric system. However, at present stage, it is still a hard task to effectively deal with the information and the whole efficiency is at a low level [13-16]. So, it is necessary to untangle different kinds of information in the substation background and divide them into several categories. Afterwards, the corresponding measures can be employed to evaluate different kinds of information in order to help the man-made decisions.

In this paper, we research on the classification of substation background information thus helping the overall monitoring of the whole electrical system. At first, the existing defaults in present substations are analysed including the low efficiency, inconsistent standards, and low automation level. As a result, there are many hidden dangers in the substations, which threat the whole electrical system. As a remedy, we proposed several ways to handle these defaults directionally. First, all the background information is classified into several categories with different priorities. Therefore, the workers could deal with the most important issues at first to avoid the failure of the whole system. And sequentially, other problems can be solved afterwards. Second, unified standards should be formulated to manage different substations. In this way, the information and operations from different substations can be employed and handled efficiently. Third, some artificial intelligence technologies should be incorporated into the software in the substations. These modules could help the works make reasonable decisions and enhance the tolerance rate. Finally, we discuss the whole paper with some conclusions.

2 Defaults in Present Substation Systems

2.1 Low efficiency

With the fast development of electric grids, there are more and more substations in the whole system. As a result, much more background information in the substations needs to be monitored. However, the traditional monitoring systems only have a few windows with responds to “general alarms”. The defections occurred in the software, hardware or other places are all included in the same windows with no classification. As a result, the workers even with high skills can hardly deal with the unlabelled alarms in a short time. It should be noted that some problems may affect not only individual substations but also the whole electric systems. The time delay in handling some key problems may cause big troubles in the system. Therefore, the whole efficiency of monitoring the background information in substations should be considered carefully.

2.2 Inconsistent standards

Although some substations operate in the same system, they do not have consistent standards. Such differences may be caused by different construction styles or ideas. Also, some newly built substations may not be

compatible with the old ones. As a result, the definitions of the background information in different substations may be different. For example, the alarm in one substation indicating the software error may be mistaken to be hardware error in another substation. Such problem may cause severe confusions when some substations are managed by the same group. And the truly occurred problems can hardly be dealt with in time. Therefore, it is necessary to establish unified standards for the management and projection of the substations.

2.3 Low automation level

Although many automation technologies have been already applied to the construction of substations, there still need many human interventions at present. As there are a large amount of information in the substations, it is difficult to correctly process them with limited human labours. When there are some time delays in handling key problems, the smooth operation of the substations and whole electrical system may be severely affected. Therefore, it is still a long way to go in order to enhance the automation level in the substations.

3 Potential Ways

3.1 Classification of the background information

In order to improve the efficiency of monitoring the background information in the substations, all the information should be classified at first. For example, the information can be divided hardware category, software category, system category, and network category, etc. So, the workers can immediately find the relevant problems. Furthermore, for the problems occurred in a certain category, they can be classified as “anomalies”, “ordinary alarms”, “medium alarms”, and “severe alarms”, etc. Then, the workers can deal with some problems with priorities or reported to the superior administrations. In this way, the problems occurred in the substations can be handled efficiently with high effectiveness.

3.2 Formulation of consistent standards

For the information interchange of different substations, consistent standards are formulated to standardize the definitions of different kinds of information, operations, etc. All the instructions from different substations should have the same formats and meanings. The workers in one substation can monitor the states of other substations from the received information. Meanwhile, they can send messages to the substations with some problems in order to help them deal with them. Those substations needing helps can correctly interpretate the information from other systems to deal with their problems. In this way, the substations at different locations can operate as a whole and help each other for the smooth working.

3.3 Enhancement of automation level

To enhance the automation level of the substations, the present artificial intelligence technologies can be employed. These tools can help classify the background information in the substations and automatically detect the anomalies. Based on the massive historical data, some training can be conducted to locate the problems and recognize their types. The workers can further evaluate the decisions from the system and quickly take measures to handle the occurred problems. Therefore, with the help of high-level automation tools, the problems can be located, handled more efficiently.

Fig. 1 shows the relationship between the existing problems in the substations and the proposed ways. The consistent standards are formulated to unify the data formats so all the information can be understood easily. The classification of information further makes all the information more concise and the human can understand them by categories including general information or anomaly information. The automation tools help the classification of different kinds of information and locate the true problems occurred in the substations. As shown in Fig. 1, the enhancement of automation level plays a very important role in the three potential solutions. It can help the classification of all the information in the substations. Meanwhile, it works to find the problems and recognition their types. So, it is necessary to develop or employ the artificial intelligence in the substation systems. Using these potential solutions, the problems occurred in the substations can be handled quicker with high effectiveness.

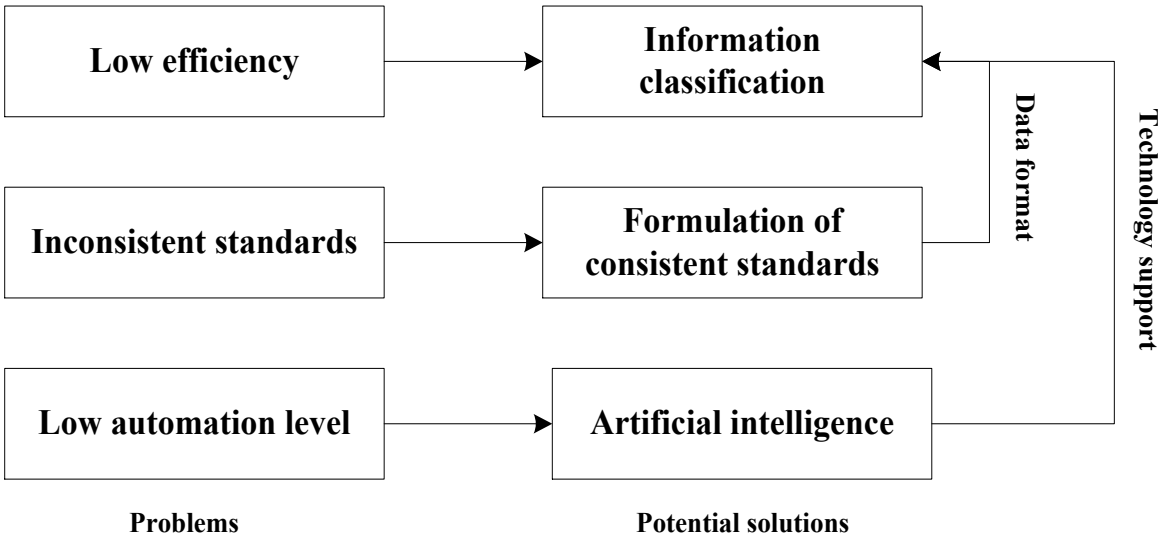

Fig. 1 The relationship between the problems in the substations and the proposed ways.

4 Conclusion

In this paper, we discuss some problems in the existing substations including low efficiency, inconsistent standards, and low automation levels. These problems make the monitoring of background information in the substations more difficult, which may cause big troubles in the smooth operating of the substations even the whole electrical system. Therefore, we correspondingly proposed three potential ways to deal with the three problems. With consistent standards, all the background information in the substations are classified into several categories. With the aid of new automation tools, the occurred problems in the substations can be quickly located and recognized. So, these problems can be handled with high efficiency and effectiveness.

Acknowledgement

Funding: This work was supported by Technology Funding Project of State Grid Corporation of China (Grant No. 52153218000G).

References

1. Borlea I, Buta A and Dusa et al. 2005 DIASE-Expert system fault diagnosis for Timisoara 200kV Substation in Proc. EUROCON pp 221-224.
2. Wang Y and Pan Z 2011 Study on test technology of smart substation secondary system in Proc. International Conference on Consumer Electronics, Communications and Networks pp 1-4.
3. Kezunovic M 2009 Substation fault analysis requirement in Proc. IEEE Power & Energy Society General Meeting pp 1-2.784-787
4. Lian J, Li H and Song K 2011 The analysis and corrective measures of common problems of 10kV capacitor bank in substation in Proc International Conference on Advanced Power System Automation and Protection pp 1750-1752
5. Gogan P L and Wyckoff G D 2012 Design and construction of sustainable substations in Proc. PES T&D pp 1-4.
6. Li Q, Zhou Z and Du D, et al. 2013 A novel substation area backup protection for smart substation in Proc. IEEE PES Asia-Pacific Power and Energy Engineering Conference pp 1-4.
7. Wang Z, Jin N and Zhang J, et al. 2014 Fault information and diagnosis modelling of on-line communication monitoring system for digital substation in Proc. IEEE PES General Meeting | Conference & Exposition pp 1-5.
8. Liu Y, Gao H and Gao W, et al. 2017 Development of a substation-area backup protective relay for smart substation IEEE Transactions on Smart Grid vol 8 no 6 pp 2544-2553.
9. Zhang H, Dou R and Zhi M, et al. 2016 The technology of interlocking logic visualization for smart substation in Proc. China International Conference on Electricity Distribution pp 1-4.
10. Dehbonei H 2016 Earthing-Substation fire and station transformer customers supply transfer voltage issue in Proc. Down to Earth Conference pp 1-7.
11. Vardhan H and Ramlachan R 2018 Deploying digital substations: Experience with a digital substation pilot in north America in Proc. Annual Conference for Protective Relay Engineers pp 1-9.
12. Li Z and Ma Q 2018 Discussion on optimization measures of relay protection technology in intelligent substation in Proc. IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference pp 1593-1596.
13. Topolsky D V, ToPolskaya I G and Topolsky N D 2018 Development of an intelligent measuring system for digital substations in Proc. pp

International Multi-Conference on Industrial Engineering and Modern Technologies 1-4.

14. Nassu B T, Lourival L and Bruno M et al. 2018 Image-based state recognition for disconnect switches in electric power distribution substations in Proc. SIBGRAPI Conference on Graphics, Patterns and Images pp 432-439.
15. Wang H, Li J and Zhou Y, et al. 2019 Research on the technology of indoor and outdoor integration robot inspection in substation in Proc. IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference pp 2366-2369.
16. Nichani A M and Swarup S 2018 Modelling and simulation of digital substation automation for inter-substation line protection in Proc. National Power Systems Conference pp 1-6.