

The application of IEC61850 in intelligent substation of China

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(PONOVO POWER CO., LTD 2014/4/9)



The first digital substation has been built in China in 2006.

Until now, there are already more than 100 operational digital substations based on IEC61850 standard so that there are chances for us to get more and more experience in IEC61850 application, in which case, amount of enterprise and industrial standard has been founded to promote the standard popularization and application.

In the following, there is a brief summary of detailed application from 9 different aspects to be conveyed.



- **1. The problems existing in the standard application**
- 2. Application of electronic transformer
- 3. Application of Switch
- 4. Software performance
- 5. Consistency testing
- 6. SCD file
- 7. Data Transmitting mode
- 8. Synchronization
- 9. Optional Testing solutions



1.The problems existing in the standard application

At the beginning of IEC61850 standard popularization, some shortcomings exist in the mount of LN(logic node), network redundancy and safety, etc. Besides, there are conflicts between expandability, interoperability and adaptability. Therefore, the standard is under a long process of amendments and improvements.



1.The problems existing in the standard application

In the field of protection and control, some special and complete function classification and configuration demands are not included in the standard, which need additional improvement.

Engineers are lack of experience in application of IEC61850 protocol, such as testing and analyzing solutions based on the standard. In that case, very few of engineers know well about detailed IEC61850 solution during design, manufacture, construction, installation, testing and operation, etc.



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2.Application of electronic transformer

Via application of electronic transformers, current and voltage sampling data is possible to be shared in the whole substation. The cable connected could be saved so that the secondary design could be simplified, strong and weak current could be validly isolated. Not only data transferring steps are decreased, Ambiguity and data loss could also be highly reduced. All the benefits provide favorable foundation for information integration and its expanded application.

Due to the simple isolation method of electronic transformers, cost performance is much more favorable when the voltage class is higher and higher.



2.Application of electronic transformer

Currently, most electronic transformers, which are designed based on the electronic principle, have been using in the substations of 220kv voltage class and below. Due to the problems of anti-electromagnetic interference, it is still not suitable to be used in the devices in substations above 220kV. Considering the possible unstable and unreliable operation of electronic transformers, in recent 1 to 2 years, many digital substations use conventional transformers and merging units, in which case, merging unit will do data collection instead of electronic transformers.



2.Application of electronic transformer

Regarding the electronic transformers based on optical principle, it is still lack of much engineering application so that the stability and reliability need to be further inspected in future.



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3.Application of Switch

In the field of IEC61850 application, industrial Ethernet switch is of vital importance. The switch needs to support IGMP snooping and redundant network topology, excludes long-time delay, packet loss and unstable data communication. Besides that Ethernet switch could meet the requirements of network management technology of digital substation automatic system, the anti-electromagnetic interference and environmental adaptability of switch need to be mainly considered so as to guarantee substation reliable operation.



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4.Software performance

In the substation automatic system, communication is the key point so that communication software performance is very important since some bugs may cause many problems. It is not a long time when IEC61850 standard applied to substations. Software defect cannot be completely avoided due to the limits of the understandings, experiences, time and resources of the new protocol. So software performance influences a lot on the safe and stable operation of digital substations, especially at the very beginning of new protocol promotion.



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5.Consistency testing

The aim of constructing new international standard of communication protocol is for enhancing the compatibility and interoperability among various devices of different suppliers so that the project construction time and cost could be lowered, which is beneficial for both manufacturers and users.

The protocol defines 90% content and the rest 10% could be self-decided by manufacturers. Due to different implementation degree of manufacturers, Users may not be able to clearly raise a claim of relevant protocol in the function plan.



5.Consistency testing

Therefore, at the beginning of IEC61850 application, it is necessary to emphasis the research of consistency testing solution and to improve the design criterion and fix testing procedure. Also, it need to construct a simulation platform for consistency testing to develop relevant tools, such as, IED server simulator, IEC61850 user monitor software, system configuration tool, IED configuration tool and protocol analyzing tool, etc.



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In the new standard, Specialists have to read SCD files, instead of circuit diagram, to design, install, test, run and do maintenance of digital substations. The configuration file of IEC61850 is XML file. In the real operation, people may be not quite familiar with XML language so that they need a visual tool to convert the files into circuit diagram.

All the IED should be operated on relevant software version.SCD needs to be changed frequently during field testing due to the reason of designers and manufacturers. So the relevant ICD files and even the device function software version, have to be revised as well.



6.SCD file

SCD file is very important for field testing and it is also the key point to enhance the testing efficiency and quality. So if SCD files need to be revised repeatedly during testing, the project quality could be influenced and construction period may be extended as well.

How to do the efficient management and control and correct inspection of the SCD files is the main problem that need to be solved expectantly.

Currently many specialists are positively searching correct solutions to manage and control SCD files. Besides, the professional inspection tool has also been developing for checking the protocol and design discipline of SCD files.



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7.Data Transmitting mode

In digital substation, the station level normally use networking mode where GOOSE and SV could transmit Under the condition that the devices, networking structure and clock are not quite reliable, most digital substations use point-topoint SV and GOOSE transmission to guarantee the safety and stability. With the development of devices and technology, all-station networking mode will be adopted in the future.



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8.Synchronization

As one sub-µs level distributed network synchronization plan, IEC61588 provides favorable technical options to fulfill synchronization clock accuracy of T5 level. It simplifies the system structure and save plenty of synchronization optical cables, which is the trend of synchronization system of digital substations. Currently, most digital substations choose IRIG-B code synchronization. Though IEC61588 could bring a lot of benefits, there are still many problems need to be solved at this stage.



8.Synchronization

There are few application cases of IEC61588 in digital substations due to that the devices based on IEC61588 are still lack of experiences and not stable.

Due to the special operating principle of IEC61588, it need enough safety defense measures to decrease the possibility of hostile attack. But the risk has not been taken into account seriously by the designers so that relevant devices may have some defects which will cause potential safety hazard to system operation



8.Synchronization

Although there are some pilot intelligent substations, very few experienced specialists know well about this new technology so that some defects exist in system design.

There are few matured products which could support IEC61588. Therefore, the complete cost of substation secondary injection system is quite high to block the application of IEC61588 in digital substation.



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9.Optional Testing solutions

For intelligent substations, the organization, relocation and transmission of digital signals need MU, Switch, Ethernet and so on. The conventional testing method could not inspect the relocation, organization and transmission of the input and output signal of the tested devices. The conventional testing solution, which is based on devices, could not meet the requirements of doing entire testing digital secondary injection devices anymore. So the testing method has to be changed into new station-level testing solution and projects.



Through the key technology R&D and pilot project constructions, IEC61850 relevant technology and management level has been enhanced gradually and is becoming more and more matured, which has made a favorable foundation for further promotion. Though there are still many problems, with the further protocol improvement and mature of technology and products, the mainstream substation automatic communication will be accepted in the whole world. The device integration from different manufacturers will be easier and the construction cost could be lowered. The project commissioning period will be also highly reduced. IEC61850 standard will be worldwide used in more and more countries.



Thanks!

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