STUDY COMMITTEE B5

ACTIVITY REPORT

June 2012

Scope

The scope of Study Committee B5 “Protection and Automation of Substations” covers the basic principles, design, application and management of power system protection, substation control, automation, monitoring, recording and metering. Associated internal and external communications and interfacing for remote control and monitoring are also included.

The added value of SC B5 is the collection of best practices, the evaluation of the capability of existing protection to operate correctly and the promotion of new protection solutions. In this regard, the key aspects are the worldwide scope of the SC. This consideration is especially important regarding protection. Let’s remind ourselves that protection is the art of achieving the balance between security (guarantee of trip when requested) and reliability (avoid unwanted tripping). This optimal balance depends on the specific network and external constraints. The opportunity to share practical knowledge about how to achieve that balance in so many different countries, networks and protection philosophies is probably the strongest point of SC B5.

The activity of SC B5 supports the CIGRE Technical Committee strategic plan mainly in the strategic directions SD 1 and SD 2: Electric Power System of the future and Making the best use of existing systems.

Electric Power System of the future

The structure of the electric power grid is set to change dramatically over the coming years with the implementation of distributed generation and new technologies to improve efficiency and capacity. These will pose many challenges and opportunities both for the transmission and the distribution networks and the engineers associated with them.

In the future transmission networks, new long distance bulk transmission infrastructures based on HVDC technology or meshed HVDC networks to transmit energy from Renewable Energy Sources areas to load areas are under discussion. The protection system for this type of network requires new developments and approaches. TB 484 produced by JWG B5/B4.25 (2011) analyses the Impact of HVDC Stations on Protection of AC Systems and provides guidance on designing a proper HVAC protection system in the presence of adjacent HVDC systems.

The experience of recent large disturbances shows that in many of the large incidents with multiple contingency cases, Special Protection Schemes (SPS) were already in place to shed large amounts of load and generation in an effective

effort to stabilise the system. However, the present prediction type SPS is limited because of the complex contingencies present in real large disturbances. It seems that SPS should operate more accurately and prevent the spread of blackouts by using real time calculations just after contingent events. WG B5.14 (2013) studies the opportunities for the application of Synchrophasors to Wide Area Protection and control of modern interconnected power systems. It covers the available technologies, their current applications in schemes around the world and also their complete system requirements.

The key aspect that will shape the future distribution will be the large penetration of Distributed Generation and the massive introduction of intelligence in the network. This will change deeply the procedures and structure of electrical utilities. TB 421 (2010) analyses the impact of Distributed Generation on Substation Protection and Automation.

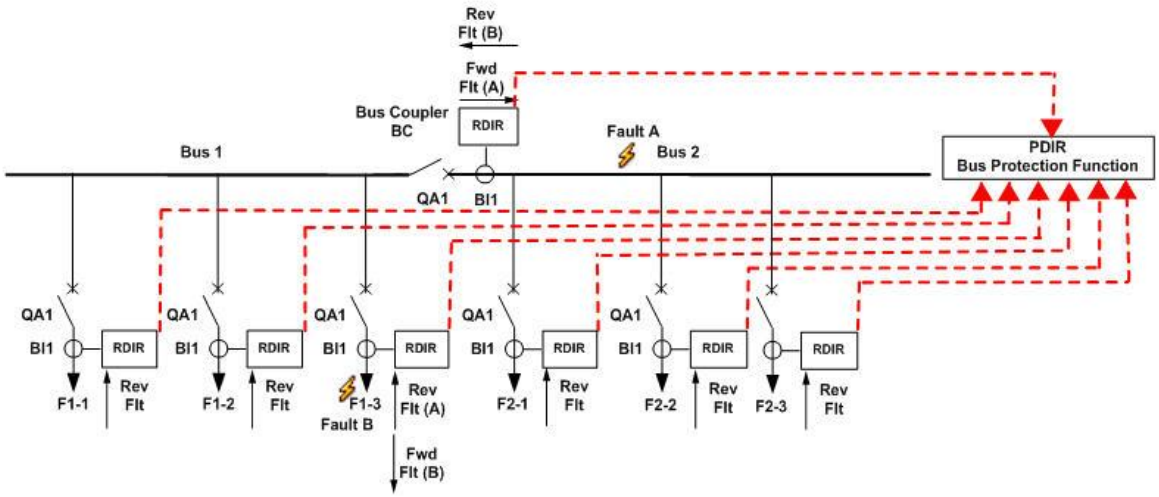
Perhaps one of the main aspects of the introduction of RES and HVDC links will be the impact on protection of reduced short circuit contribution from new generation technologies. WG B5.48 “Protection for developing network and different characteristics of generation” (2015) will evaluate the capability of existing protection to operate correctly and the needs for new protection solutions

All the aforementioned issues will result in new requirements and challenges for the protection and automation of the future systems. The enabler of all these new functions will be the communication technologies. Internet communication systems will offer new challenging opportunities for new wide area and local applications. That is one of the main conclusions of JWG D2/B5.30 “Line and system Protection using Digital Circuit and Packet Communications” (2012). This WG covers also the inter-substations communications and trys to cover the traditional gap between protection and communication people, even more difficult with the advent of packet networking in the inter-relay communication

Such a comprehensive communication system with components from many suppliers calls for a global standard with powerful communication services and a data model with standardized high-level semantics (interoperability) avoiding any risk for misinterpretation both by operators and IEDs.

IEC 61850 is the standard which provides a data model on high semantic level, and services with high performance and high reliability. It was successfully designed and accepted for substation automation. In addition, the standard has already been extended beyond the limits of substations e.g. for distributed energy resources (DER), hydro and wind power, where first applications are going into operation. Therefore, IEC 61850 is the key communication solution for the future grid.

IEC 61850 is now the most common application worldwide within substations. SC B5 has been effectively supporting and promoting the new standard. As a matter of fact SC B5 has engaged five WGs, three preferential subjects and two Electra papers dedicated to an aspect of IEC 61850 since year 2000. The challenge now is to launch the introduction and utilisation of the process bus concept. A Process bus addresses all connections between bay level devices and process equipment, including breakers, switches and instrument transformers. The concept implies the substitution of conventional wiring by optical fiber, with the consequential cost reduction. The communication covers the standardized transmission of samples for current and voltage between bay level and process level. This includes also the possibility to transmit trip signals, switchgear status data and commands. Reference (1) gives the SC B5 view. One of the main limitations at present is the interchangability of instrument transformers of different manufacturers. WG B5.24 (2013) addresses the requirements on transient response of a complete signal processing chain, including Merging Units and Non-conventional Instrument Transformers. Another important aspect is the capability for intra and inter substation intertripping using GOOSE messages. WG B5.36 (2012) proposes application for protection schemes based on IEC 61850.



Bus-bar directional comparison protection based on IEC 61850

However IEC 61850 is more than a communication protocol. It offers new opportunities to improve the procedures of engineering and maintenance of protection an control devices, resulting in life time cost reduction. In this regard the key aspects are engineering tools that should allow staff to take full advantage of the standard functional opportunities, in spite of the intrinsic complexity of the IT technology. TB 486 (2010) analyses the steps of the engineering process, the requirements and opportunities of IEC 61850 and make proposals about improvements in the standard and in the engineering process of electrical utilities. Documentation is the basic support of the engineering process WG B5.39 (2013)

evaluates the documentation requirements from design to operation to maintenance of IEC 61850 substation automation Systems. However, internet based technologies have an inherent possible limitation because of security access constraints. This has been especially relevant after the September 11 attack and reported hacking attempts on utility systems. JWG B5/D2.46 analyses the application and management of cyber security measures for protection and Control Systems.

Probably, the main driver for the application of new technologies will be the improvement of the cost/benefit ratios. A great opportunity for cost reduction in the engineering of new substation is standardisation. The analysis of the implications and opportunities of standardized protection schemes is dealt by WG B5.27 (2013).

An example of one utilities' standardised protection and control bay

Making the best use of existing systems

Protection should be considered a strategic asset that must guarantee the security of the power system operation. New demanding requirements are coming because of the aging of the networks and the need for large interconnections related to the massive introduction of renewable energy sources.

It seems obvious that the main requirement for protection is reliability. However, the second main requirement would be the optimization of the life time cost.

In this regard SC B5 is working mainly on two aspects:

Reliability and availability

The general objective of WG B5.47 “Network protection performance Audits“ (2014) is to show how protection availability can be improved. It will highlight the issues to be considered when undertaking a protection performance audit; the power system and protection analysis software required and also the methods for accessing protection performance on an interconnected wide area network.

WG B5.42 (2014) will collect the experience concerning availability and reliability of Substation Automation System with practical recommendations. In addition to reliability, the maintenance of present Digital Substation Automation Systems has to take into account several factors including total cost of ownership and the possibility of modification, extension and partial replacement of components. TB 464 (2011) proposes maintenance strategies for Digital Substation Automation Systems

Lack of settings coordination is the most common cause of incorrect protection operation. TB 432 (B5.19) “Protection System Coordination” (2010) describes solutions on protection relay coordination based on different theories and philosophies around the world. WG B5.31 (2012) addresses the processes and techniques required for the life-cycle management of the settings associated with protection relays.

Education and training

Through the world, the transmission and distribution industry is short of personnel resources. There are more demands on these engineers, whilst protection and control devices become more complex. WG B5.40 (2013) deals with the requirements for education, qualification and continuing professional development of engineers in Protection and control.

SC B5 is also producing a series of reports covering the application of digital technologies to the protection control and monitoring of electrical equipment. In 2011 two reports have been produced for synchronous generators (TB 479) and transformers (TB 465). This series will be completed with the reports regarding shunt reactors WG B5.37 (2013), shunt capacitors WG B5.49, (2015) and special transformers (WG B5.44) (2015).

SCB5 Colloquium and Sessions Preferential Subjects

Conclusion

In conclusion, SC B5 is working to facilitate the development and application of new technology in order to improve the efficiency of the engineering, operations and maintenance of electric power systems.

Priorities for future developments are given by the SC to:

- The impact of Integration of Renewable Energy Systems and Distributed Energy Resources on protection systems
- Development and implementation of advanced protection solutions, including solutions based on the new communications technologies.
- Supporting the development and implementation of new international standards in the domains of substation automation and protection.
- Tools, concepts and systems for Protection and Automation life time management.

References

(1) (How to complete a substation automation system with an IEC 61850 “Process Bus” – Electra 255)