

# Protection and control in the substation of the future

In the last half century we have seen computer technology revolutionise the electricity industry, and are well along the path to a new smart grid revolution as we navigate to a low carbon energy system with power flowing to and from consumers. However, the humble substation remains more or less unchanged in 50 years. What should the substation of the future look like?

**John Moutafidis** UK Power Networks Innovation Engineer

There are three basic components in the protection and control (P&C) system of a typical electricity substation – measurement devices (CTs, VTs etc), protection & control units (ie, relays) and a communications system connecting everything together. Each one of the components has and is evolving. However there is a need to take a step back and have a holistic view of the P&C system and make a conscious decision about the path we should take. We believe that we should move to a modern centralised P&C system.

The evolution of the equipment and the large number of substations that are typically operated by a distribution network operator (DNO) mean we operate a variety of equipment from legacy to new installations. The measuring devices have not changed a lot, only in the recent years we have seen non-conventional current transformers (CTs) and voltage transformers (VTs) however their usage has been very limited. Relays on the other hand are some of the most varied components, with a mix of mechanical and digital types across our asset portfolio. Digital relays have come a long way, they are now smaller with widespread capabilities and multiple functions, however this capability is underutilised in most cases. The communications systems are a mix of copper hardwired (analog or digital) and fibre optic.

## So what would we want in an ideal situation?

The absolute functional requirement for any asset in our network is reliability, and this cannot be stressed enough – our job is to keep the lights on. The network has undergone considerable change in the recent years and even more exciting change is on the horizon. UK Power Network's smart grid experts are in a race to predict and prepare for the opportunities these changes bring. With the rapid decarbonisation of transport, networks require ability to monitor and control in the secondary substations. The growth of distributed generation causing bidirectional power flows requires better active network management of active and reactive power. As the network is becoming smarter, more decarbonised and decentralised, the future



Above: **John Moutafidis inside a substation**

substation must be intelligent and adaptable to keep pace. Moreover it should support remote operations and at the same time conform to modern cyber security protocols. Finally this change to a digital substation should be affordable to DNOs, which ultimately means it should not be labour intensive to install and maintain. At the moment there are no solutions that can cover all the requirements, however some manufacturers are developing new P&C systems that will step change from the current practices.

The idea behind these systems is that since we now have increased processing power, we should put all the functionality of a substation in a central device. The central device aims to hold all the algorithms, with the substation bays only having the measurement units. Additionally the communications and data models should be based on IEC61850, the first attempt to standardise and rationalise a common methodology for P&C.

So what are the advantages of a digital substation? First, less plant means easier to replace, less plant to test, commission and maintain, although maintenance of digital equipment is almost non-existent besides the dreaded dusting! Next is agility, a software based approach will make it easy to update and modify the functionality. The changes

between various locations will only be in the software; less variety in equipment from a manufacturer could benefit from economies of scale. Additionally the required amount of standard configuration files is reduced. Some engineers will note that having less variety exposes networks to series defects. However as they would be upgradable, series defects could only be hardware based and still it is easier to replace central units than multiple bay units per substation. It is important to mention that dual units for redundancy would be required. Having one unit from two manufacturers would solve the series defect weakness, however it could increase interface challenges unless an international standard like IEC61850 was adopted.

Naturally, the switch from the conventional design (P&C per bay) to a centralised system will not be an easy process as with all big innovative steps. So what would be required for the adoption of the centralised P&C approach? The obvious initial step is a variety of commercially ready solutions from suppliers, ideally with some early adopters and demonstrators who can provide usage examples to support wider adoption. Collaboration between utilities and suppliers is of paramount importance. Utilities need to clearly define their requirements and specifications and suppliers should support them in that process and provide user training. Moreover this new approach is vastly different to business as usual and as such the new risks need to be identified and considered. The ever pressing requirement for financial value needs to be fulfilled through positive business cases and will require approval from a technical viewpoint.

The network is changing and we will see more major changes in the coming years. Instead of making new technology fit within existing systems and process, we should be starting from scratch and design what the ideal version could be.

At UK Power Networks we are always looking for more efficient and effective solutions for our network as we ready ourselves for the low carbon transition and prepare our business for the future. If you have an idea contact us at [innovation@ukpowernetworks.co.uk](mailto:innovation@ukpowernetworks.co.uk) ■