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Question 2.02 What are the expected benefits of using digital substation concepts and how to meet these benefits during industrial application?

Benefits of digital substations

The expected benefits of digital substations with IEC 61850 process bus have been discussed in many papers and articles and typically include:

- Reduced copper cabling
- Smaller protection and control panels due to less conventional equipment
- Shorter installation time thanks to verification of complete data exchange in factory
- Software-based testing using IEC 61850-defined test and simulation modes
- Sharing of real-time data within and across substations with interoperable IEC 61850 GOOSE and Sampled Values, enabling new functionalities
- Permanent supervision of all exchanged data
- Integration of monitoring equipment, enabling condition- and risk-based maintenance
- ...

When executing digital substation projects for utility or industry customers, the expected benefits are often not met to their full extent. The contribution summarizes some important aspects that help to really meet the expected benefits. Such aspects can be found in all project phases:

Specification phase

- Applying digitalization concepts consequently and avoiding sticking to conventional components allows to optimize and simplify the PACS (protection, automation and control system) design and enable for example digital, software based, testing approaches.

Design phase

- To optimize panel designs and reduce control room footprint, the traditional allocation of devices to protection and control panels needs to be challenged.
- Supervision features like LGOSE and LSVS GOOSE and Sampled Values supervision needs to be thoroughly applied.
- The PAC products need to be designed to automatically react on bad quality or missing process data or time synchronization and enter fail-safes states without manual configuration or user interaction.
- The products shall gracefully only block those functions that are affected by bad quality or missing data or time synchronization.

Factory testing

- Unlike conventional systems where cabling between panels or switchyard and relay room is only done on site, the process bus-based system undergoes fewer changes between test field and site. Therefore, verification of entire dataflow, with real or simulated equipment in the test field makes sense, as it does not undergo changes when installed on site. However, this only works, if the device configurations, like protection functions, are reasonably complete already during factory testing.

- Training and familiarization of the customer with the maybe first-of-its-kind system during or before factory testing, helps the customers to prepare for maintenance of the digital system in a safe environment.

Installation and commissioning

- Planning of site activities must consider the changed system layout and installation procedures to really profit from the changed and reduced installation activities.
- Adjust the project test plans to avoid repetition of tests, that have already been completed during factory testing. Focus site testing on interaction with primary equipment.