Communication and data collection solutions for condition monitoring purposes, and on how to utilize the collected data for developing elements of a digital twin is one of the important elements of the asset management system. More connected sensors and greater data volumes result in an increasingly complex ICT infrastructure. An adequate ICT architecture including intelligent systems for data collection and data storing that maintains a high level of information security is essential.

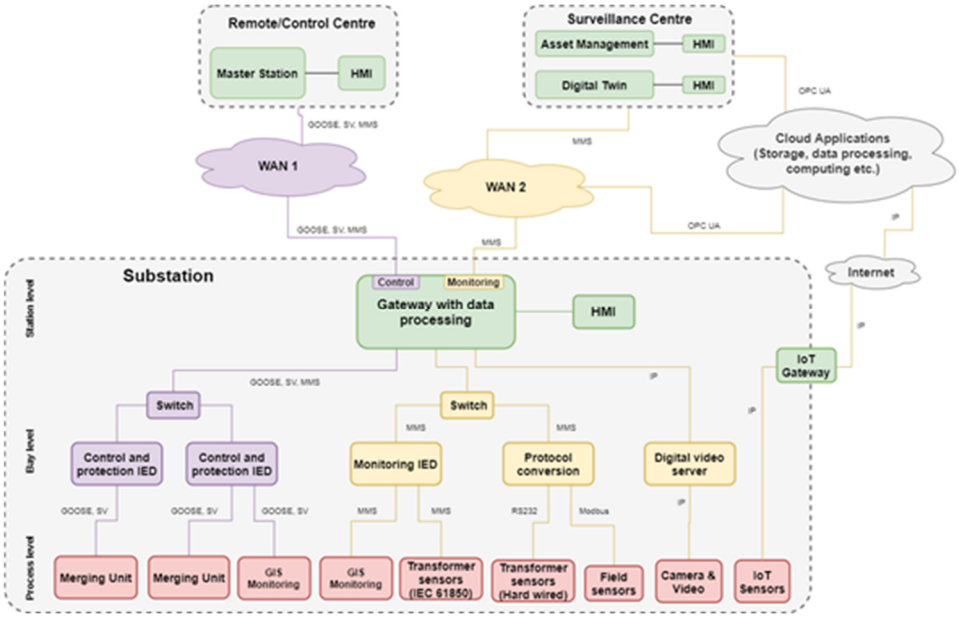
IEC 61850 provides several communication protocols. For real-time communication of critical operational data in a process bus-based control system, the protocols Generic Object-Oriented Substation Event (GOOSE) and Sampled Values (SV) are often suitable. For the communication of condition information, reports and logs suitable communication services are also provided by IEC 61850. Reports can be triggered e.g. by changes in sensor data, and sent immediately to the subscriber. Reports are therefore suitable for generating warnings/alarms based on sensor output. Logs, on the other hand, are archived for later retrieval and delivered upon request. Logs are suitable for feeding deferred data (non-critical data) to asset management systems.

Digital systems are always preferable when more advanced data analysis, e.g. on large amounts of data, is to be used. The added safety aspects of process bus technology (no secondary current and voltage circuits) is also a driver for digital systems. More and more areas of use are investigated and evaluated. One of them is the usage of process data for non-operational purposes. To be specific: while NCIT measurements are primarily used in a protection system for fault detection & tripping, these data could also be applied for additional uses such as to better monitor equipment usage or to early detect future equipment failure.

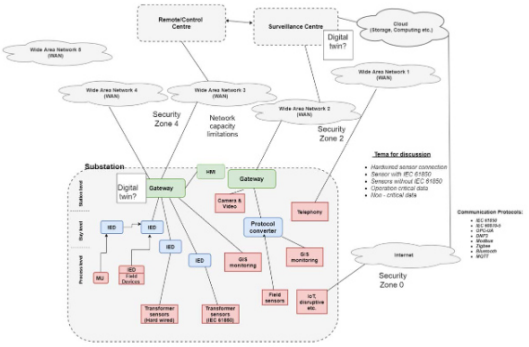
Hence, the idea is to use data which is available on the process bus anyway, and provide it to higher-level, non-operational data analysis systems that create additional business value e.g. for asset lifecycle management, data exchange via “REST” (Representational State Transfer) Webservices. Possible architecture:

- - Where to route what information
- - What routes to use.

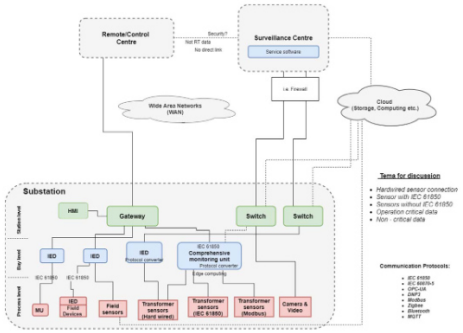
In of the R&D project in Statnett – ECoDiS(Engineering and Condition Monitoring in a Digital Substation) workshop was arranged between different utility partners in the project to come with the optimal networking solution for connecting different sensors to the DSAS. Three different network solutions shown in the figures below were discussed. Either of these three solutions are planned to be tested in some of the pilot projects in the ECoDiS project.



Alternative-1



Alternative-2



Alternative-3

The elements considered for network design are :

- Sensors with and without IEC 61850 interface
- Hardwired sensor connections
- Operation critical vs non-critical data
- Cyber security issues
- Remote access

In addition to the above elements and the possible network design, cost-benefit analysis of condition monitoring system was also discussed in the workshop. Lifetime cost and forward compatibility of the sensors required cyber security measures and maintenance of the sensors were taken in consideration. The most critical challenges are: i) how to exploit opportunities and recognise limitations of Digital Substation for system operators, ii) how to identify useful real-time monitoring functionalities and IEC 61850-compliant sensors and their benefits, and iii) how to find a good practice to implement these monitoring applications, with affordable cost, in a real-time environment where there are constraints on climate conditions, computing capability of real-time simulators, network security, etc.

Some transformer experts would like to have far more monitoring points on a transformer than is available today. On the other hand, there are no systems to handle the statistics and all the extra signals that one wants. The reason for this might be that it has been too expensive to hardwire all the signals to the control system or simply that there has been nowhere to send them for monitoring. When the substations become more digital this can easily change.

As to the first issue, it seems natural for the dispatch centre to handle signal necessary for a reliable and safe operation of the grid. But data that are more related to maintenance – e.g. monitoring status on primary equipment and communications network – is perhaps more appropriately handled by other departments within utility. It is not straightforward to make critical operational data available for condition monitoring purposes, as such data is subject to strict security requirements. Critical data traffic for control purposes needs to be isolated from the non-critical data traffic for condition monitoring purposes.

To ensure usability of the condition monitoring throughout the organization, a flexible and comprehensive ICT architecture is necessary, making all relevant data available to all stakeholders on a single platform.