We wrote an article called “Digital substation for EDF: Engineering approach and E-Monitoring development” and we are going to answer the question “What are your expected benefits of using digital substation concepts and how to measure if the benefits can be realized?”.

Actually, as an engineering center working on HV/MV substations, we expect 2 major benefits from IEC 61850 PACS development.

The first one is about configuration. Yesterday, with former numerical PACS, TSO/DSO such as EDF were not used to interfere into the system configuration: it was done by the PACS manufacturer, because the numerical language was proprietary, or because we didn’t know the data model. Thus, during the substation lifecycle, we were fully dependent on it.

Now, with 61850, it’s pretty different. EDF decided to create his own System Configuration Tool (eCS), in order to control the substation PACS configuration. For our current 61850 projects, the aim is to create the Specification File, and then, once the PACS manufacturer is chosen, to create the Substation Configuration File: so that we can now control all the data which will circulate on the substation numerical networks (Process Bus and Station Bus).

Thus, we will be able, later during the PACS lifecycle, to make change in it without the help of the initial manufacturer, saving costs, and time. We plan to be able to modify or to add data, to change or to add IEDs, to add e-Monitoring sensors, for example.

The second benefit concerns collected data, and e-Monitoring. With 61850 solutions, and a full control of the PACS data model as explained later, it will be easier and cheaper to add new data to the PACS, whereas it used to be expensive and complicated with former automation systems. And e-Monitoring (or HV devices supervision) development will be the natural consequence of that data flood. E-Monitoring will enable to avoid HV material damages, a better knowledge of the state of health of our HV/MV substation materials, and to let maintenance happen only when it’s necessary.

Let’s take the example of a power transformer: every operator knows it is a critical device and it’s economically and financially sensible to avoid a long-term damage on that kind of device. Nowadays, grid operators or electric power plant owners are almost blind regarding power transformers: they know very little about transformers health status throughout their lifetime. The increase of data collection will bring a radical change.

What kind of monitoring can be developed with power transformer windings temperatures? First, one or two simple threshold alerts can obviously be defined: once the windings temperature raises over the first or the second threshold, the operator receive an alarm. It can be an instantaneous or delayed alarm, depending on the threshold level for instance. These thresholds are usually defined empirically thanks to an historical data set collected over a period during when the monitored device is known to be healthy (the first year of operation for example).

Yet, we can go further in device monitoring. Assuming that the windings’ temperature depends on the current power running through the transformer, the simple threshold alarm will never be reached if the power transformer is running at a low power during a long period. This drawback can be solved thanks to early failure detection algorithms: the correlation between windings temperature and current running power can be learned by this kind of algorithms. We have healthy clusters, and as soon as a current running point is outside these clusters, it can show a problem whereas the simple threshold has never been reached.