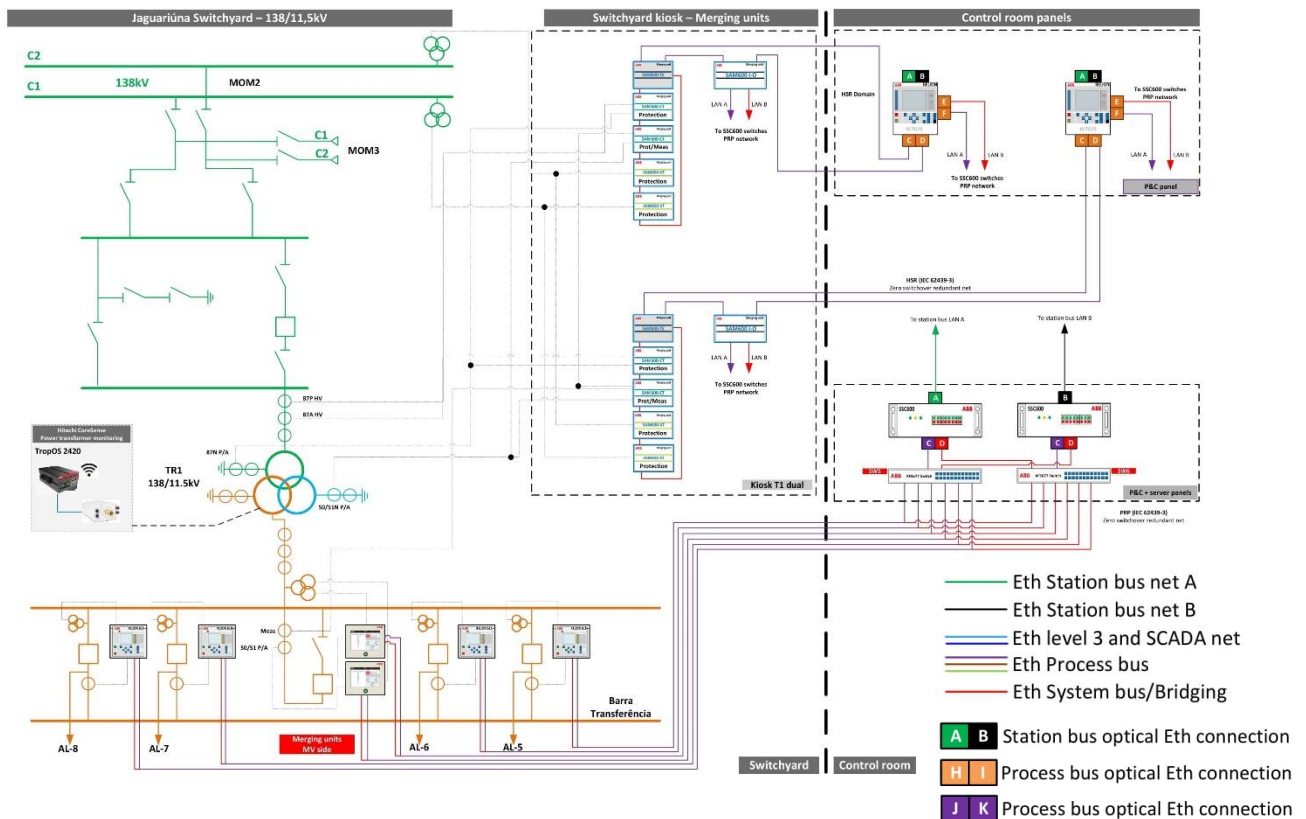


**Q 2.01 – What are the challenges in the development of digital substations and how to address the problems caused by the digitalization?**

This contribution is about the implementation of centralized PACS in the Jaguariúna 138 kV to 11,5 kV distribution substation, owned by ISA CTEEP, a large utility in the São Paulo state, southeast of Brazil.

The substation PACS is the first implementation of the fully digital substation (4.0 substation concept). It is being developed under a research grant from ANEEL, the Brazilian Electric Energy Agency. ISA CTEEP joined with São Paulo University (USP), LSI Tec and Hitachi to accomplish the task.

The new PACS, which is expected to be commissioned by the end of 2022, implements the centralized protection concept, where the merging units in the switchyard have some redundant basic protection functions implemented in the case the centralized control units fail. The figure below shows the station diagram, where the process bus for both higher and lower voltage sections connects the merging units in the switchyard to the IEDs in the control room.



The utility reported that there where deployment and commissioning cost reductions and it expects to use the new technology features to improve asset management and asset monitoring capabilities.

Among the many lessons learned, it can be detailed:

- The need to use proper tools to access the behaviour of network and IEDs.

- The importance of considering protection chain performance in the overall network architecture.
- The importance of adoption of an adequate maintenance procedure, including the availability of spare parts
- The increase in the relevance of factory tests that should include all measured quantities in the final implementation in order to better detect network congestion conditions.
- The monitoring of alarms for critical communication network failure conditions should be included in the local SCADA.
- Importance to qualify maintenance and operation teams to deal with malfunctions and to avoid unintentional introduction of errors that may lead to undesired unavailability.

Among the difficulties reported are the lack of qualified personnel to access all the design and implementation phases. Also, they found problems with compatibility among devices in the process bus and to difficulty in applying cybersecurity measures to the operational network.