

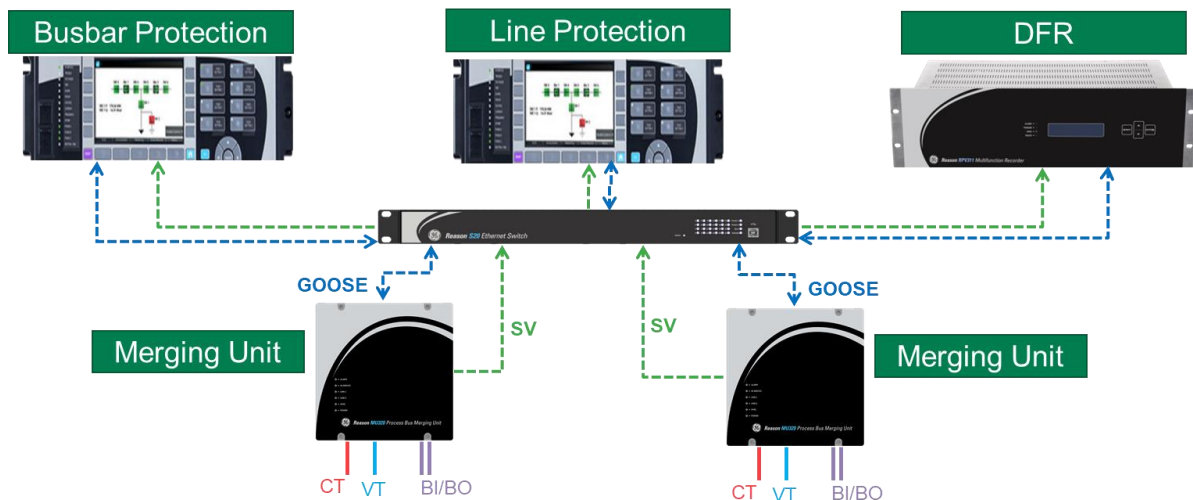
**Q3.05: What are your expected benefits of using digital substation concepts and how to measure if the benefits can be realized?**

Digital Substations are enablers for the digital transformation that shall bring more observability, reliability and reduce costs of the energy. The benefits and measures herein proposed are based on the experiences of the full Digital Substation Lorena 500kV & 230kV interconnected to the grid, and the project of expansion of Mata Norte 230kV that was done based in process bus technology.

**Benefit 1 - Share acquisition through process bus.**

With the usage of Merging Units it is possible to acquire data from process level (CTs, VTs and binaries) and share this data over process bus with multiple IEDs and functions without need extra hardware acquisition, which allow a more standardized measurement, cost reduction and set an enabler architecture for future virtualization.

In Figure 1 the diagram shows an architecture with redundant merging units simultaneously sharing data with Busbar protection, Line protection and DFR over process bus.



*Figure 1 - Architecture diagram with merging units sharing data over process bus with multiple IEDs*

**Benefit 2 – Modular architecture**

The modular architecture enabled by the Digital Substation and decoupling of acquisition from processing allows the simplification and standardization of the design, commissioning, and test processes, which consequently impacts in lower cost and time to the project.

**Benefit 3 – Reduction of Commissioning time & Infrastructure cost**

Based on the experience of the above mentioned projects it is expected that Digital Substations can reduce about 66% of the commissioning time with less terminations and 75% of costs with cables. On top of the cost reduction it is also important be highlighted the reduced footprint of the solution, including carbon emissions.

**Benefit 4 – Avoid electrical hazards in the control room**

Merging Units can be installed in kiosks in the yard sharing data with the control room over fiber optics, reducing the exposure of electrical risks for operators in the control room.

**Benefit 5 – Interoperability & Manufacturer independency**

Digital Substations are implemented with concepts and protocols standardized by the IEC 61850 and IEC 61869, which provides a comprehensive framework to implement solutions that are interoperable in between different IEDs and manufacturers, allowing more competitiveness for the solution.

#### **Benefit 6 – Enabler for advanced digital applications**

Digitalization is the key enabler for the development of new advanced solutions and achieve the real digital transformation as has already happened in other industries.

The digitalization of measurements and modelling of functions allows future applications like virtualization, centralized protection, digital twins, top-down engineering, and other innovative concepts that are not even in the literature.

To measure these benefits three main KPIs are proposed:

- **Cost and time for commissioning** – As mentioned in the benefits, commissioning time, and consequently cost, can be severely reduced with a digital substation project and it can easily be measured and compared against conventional substations.
- **Total Cost Ownership** – This KPI can be analyzed by knowing the CAPEX investment and estimating the OPEX related to a certain substation over a period.
- **Exposition to Electrical Hazards** – Considering that electrical hazards can be neglected in a control room without wiring from binary I/Os or CT/VTs it is possible to estimate the total time of exposure to electrical hazards per employee only analyzing when it is needed work in the yard.