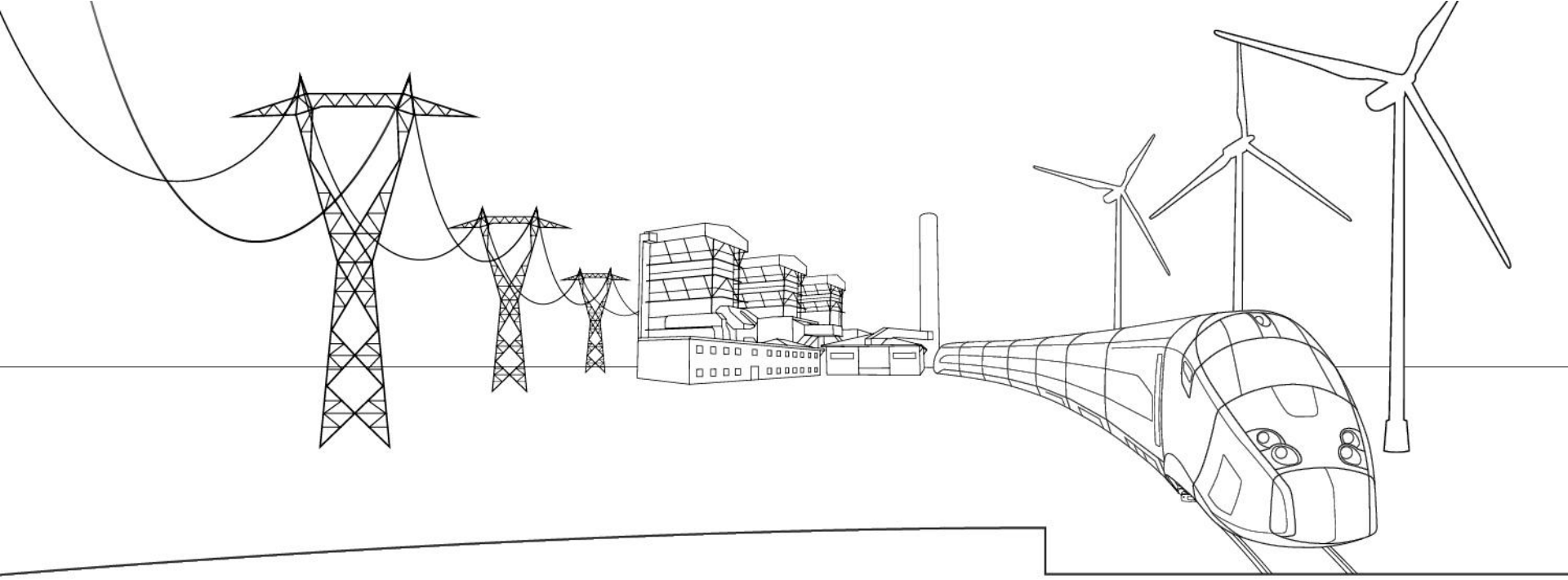

New Protection Relay for Variable Speed Double Fed Induction (DFI) Motor Generators

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CIGRE

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Shaping the future

BACKGROUND

- Power management and stabilisation of the grid are of growing importance.
- Increase in the use of renewable energy generation systems such as wind turbines and solar plants has led to more gas turbines being installed as spinning reserve because the required additional electrical energy can not be produced on demand.
- This is not a long-term solution to reduction of CO_2 emissions in the future.
- To overcome this problem, efficient and economic technologies to store large amounts of electrical energy are needed.
- Pumped storage power stations are still the most efficient technology to store large amounts of electrical energy.

SUMMARY

New innovative protection relay for protecting large variable speed Double Fed Induction (DFI) machines for pump storage plants :

- Extremely low frequency currents and voltages in the variable speed rotors
- To achieve low frequency measurements <5Hz requires Non-Conventional Instrument Transformers (NCITs) & Non-Conventional Voltage Transformers (NCVTs) to be connected to the relay using an IEC61850-9-2 LE interface.

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SUMMARY

IEC 61850 -9-2 Overview

- **Sampled Value Transmission**
  - Unidirectional link (MU to IED)
  - **Physical layer** : Optic fibre (copper optional)
  - **Data Link layer** : Ethernet 100 Mbit/s
- **Application Layer : IEC 61850-9-2 "Light Edition" guideline to aid implementation and interoperability**
  - Sampling rate : 80 or 256 samples per cycle (80 for protection)
  - Neutral current and/or voltage may be measured, or derived
  - Sampled values are multicast on the LAN
  - Defines Logical Device "MU"
  - Synchronising of sampling

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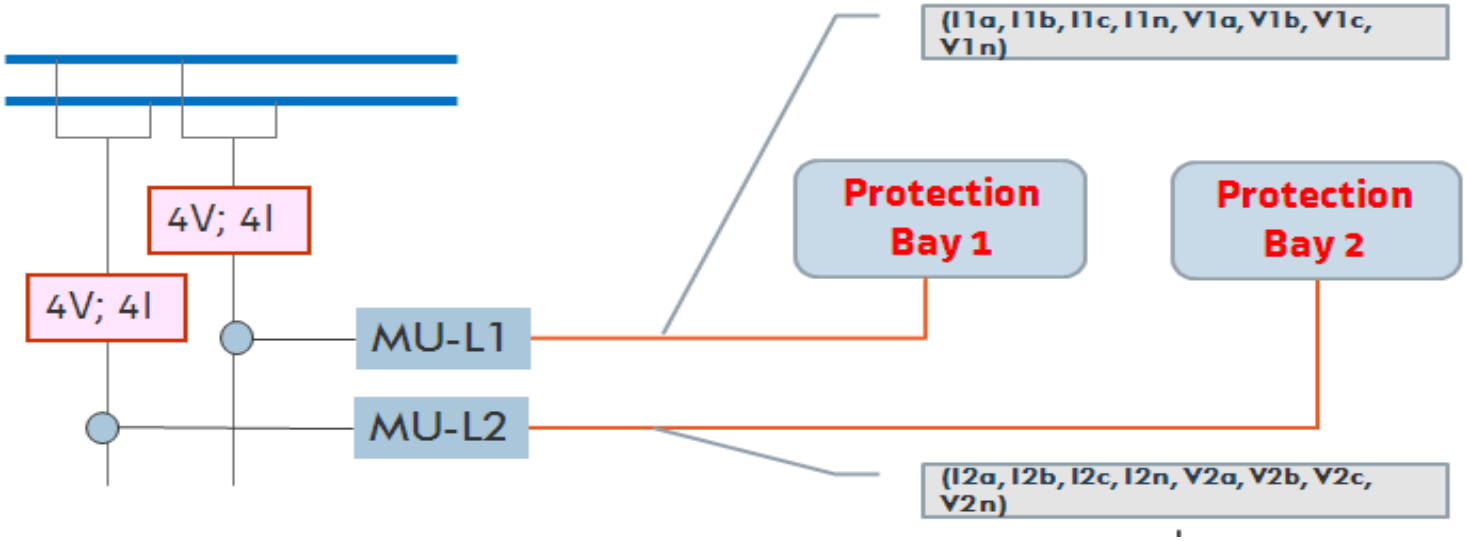
SUMMARY

IEC 61850 -9-2 Overview

- **IEC 61850-9-2LE Sampled Values**
  - Each SV message has 4 voltages, 4 currents
  - Primary values, quality info
  - Current : 1mA to 2.14 MA, Voltage : 10mV to 21.4 MV



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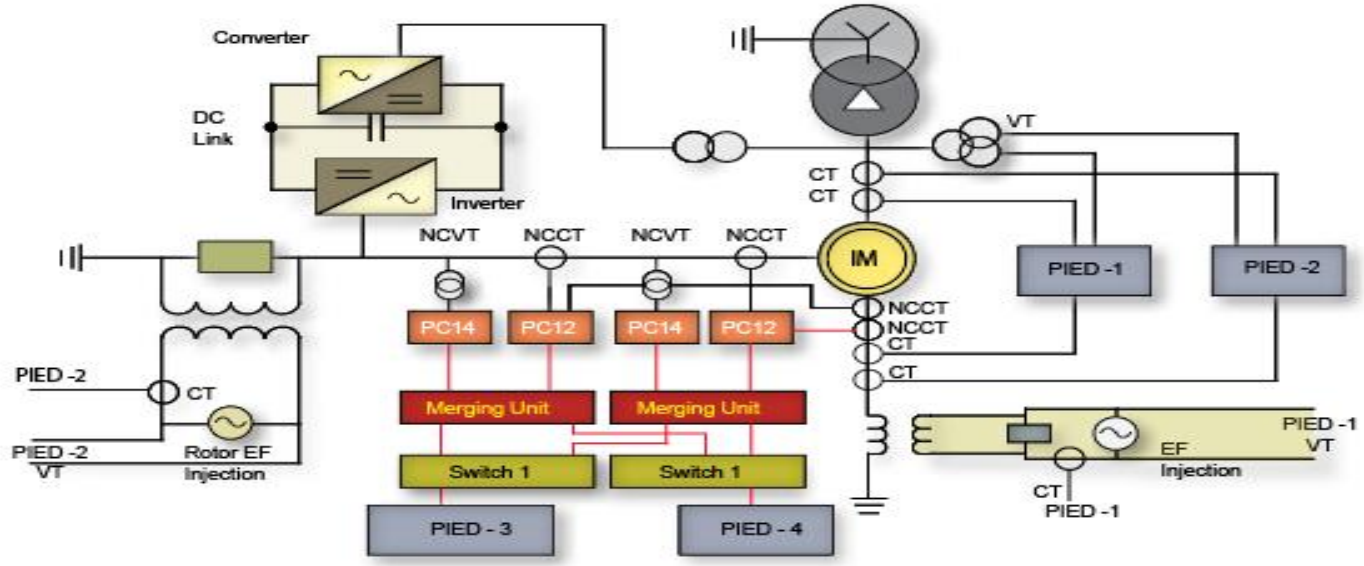
TYPICAL PROTECTION SCHEME



- PIED: Protection Intelligent Electronic Device (Digital Protection relay)
- NCVT: Non-Conventional Voltage Transformer (voltage sensor)
- NCCT: Non-Conventional Current Transformer (current sensor)
- PC 12 and 14: Analog to digital signal converter (ALSTOM PCBUS protocol)
- Merging unit: Digital signal (PC BUS or IEC61850-9-2) to IEC61850-9-2 digital signal converter including time synchronsing (1 Pulse Per Second or IEEE1588 protocol)
- EF: Rotor Earth Fault protection devices
- Hardwired connection:
- Digital connection:

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CURRENT AND VOLTAGE MEASUREMENT

Current and voltage sensors (NCCT and NCVT) are required for this application to be capable of measuring fault currents up to 170kA and voltages up to 12kV in the frequency range of 0.1Hz to 70Hz.

CURRENT AND VOLTAGE MEASUREMENT

Real NCIT Solutions

Application	AIS/GIS	AIS	GIS	GIS
Technology	Optical-Faraday	Capacitive EVT	Rogowski ECT	Capacitive EVT
				

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STATOR PROTECTION

A) Using conventional CTs and VTs :

- Low frequency injection 100% stator earth fault protection is required
- The frequency range 5-70Hz.

B) Using Non-Conventional Instrument Transformers (NCIT) & IEC61850-9-2 LE :

- Achieve low frequency measurements <5Hz
- The frequency range 0.1 to 70Hz
- Overcurrent and Negative Phase Sequence overcurrent protection

ROTOR PROTECTION

Power supply frequency is generally between 0.1Hz and 6 Hz during normal running and can reach up to the power system frequency (60 Hz) during machine run-up and run-down.:

- NCITs are required to achieve low frequency measurements <5Hz
- Overcurrent, Overvoltage, Neutral voltage and Overfrequency protection from 0.1 to 70Hz

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CONCLUSION

Development of a new innovative protection relay for protecting large variable speed DFI machines for pump storage plants. :

- Cutting edge “Digital Substation” technology solutions have been developed and implemented in a new relay to meet the challenging requirements of variable speed machine protection.
- Using a complete protection package covering the entire variable speed machine (both stator and rotor), implementation of the latest NCIT and IEC 618509-2 LE process bus technology offers significant user benefits.

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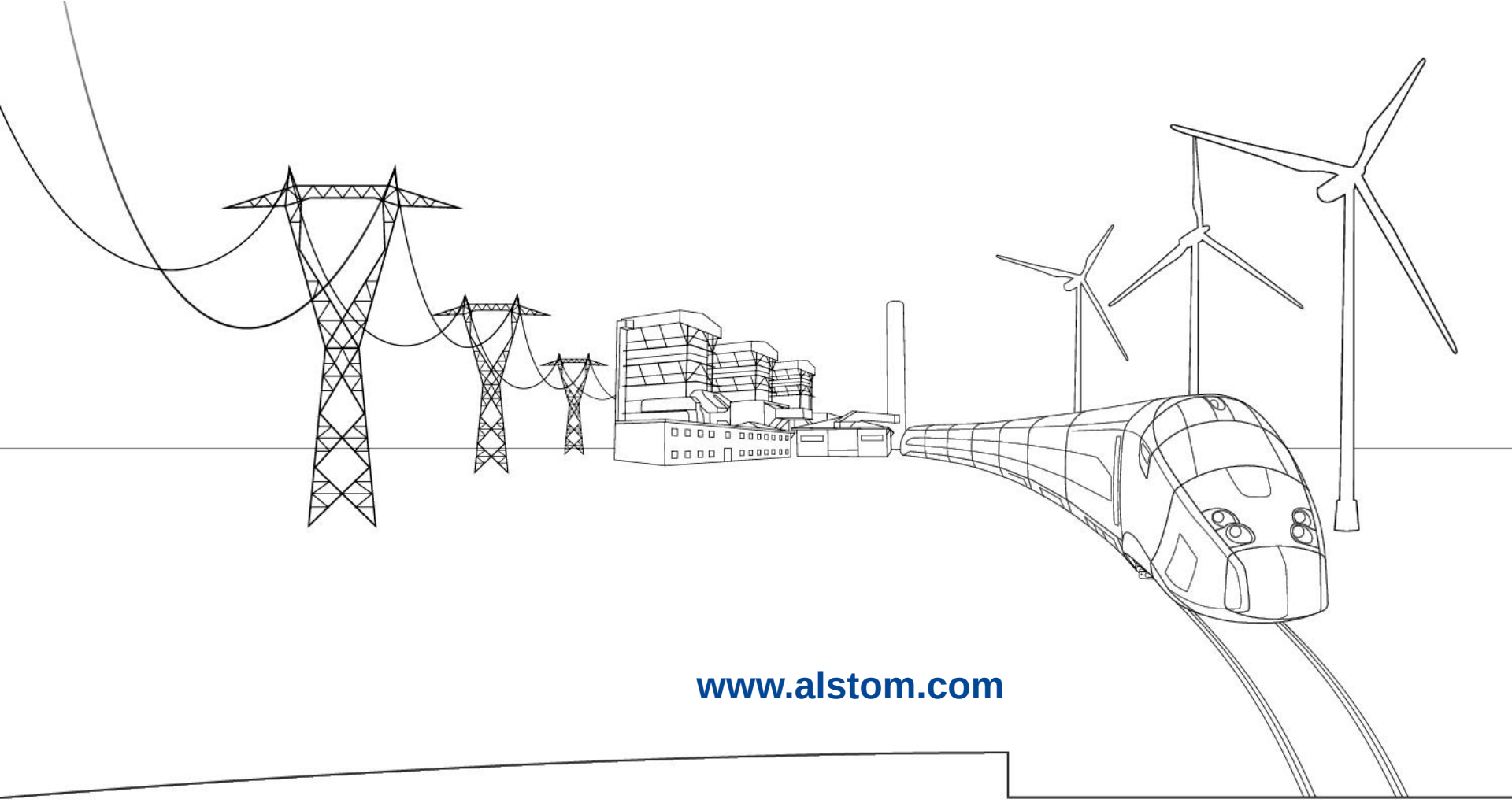

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