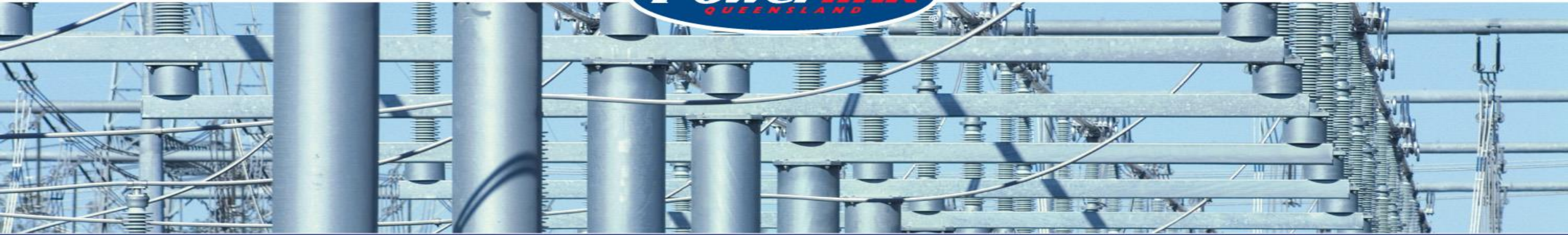
GIC Monitoring Equipment within the Queensland Transmission Network

Chuanli Zhang

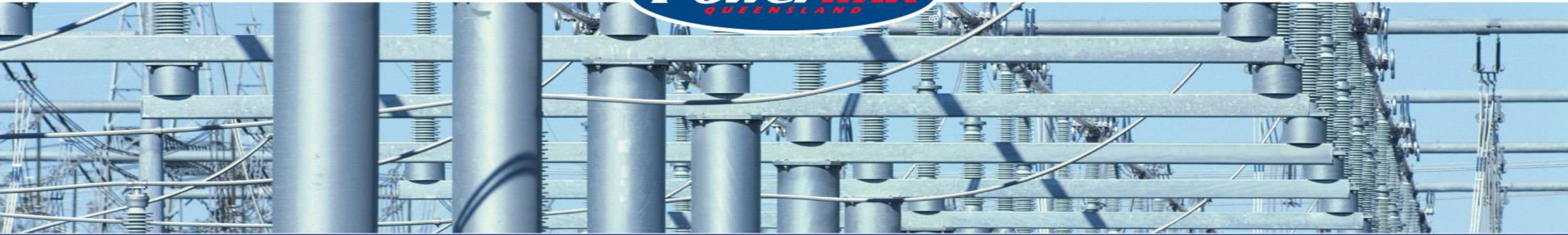
Senior Secondary System Strategies Engineer
Powerlink Queensland



Overview

Overview

- Key drivers of GIC measurement
- Powerlink approach
- Design and implementation of GIC measurement based on conventional transducers
- Design and implementation of GIC measurement based on Non Conventional Instrument Transformer (NCIT)
- Powerlink mitigation strategies



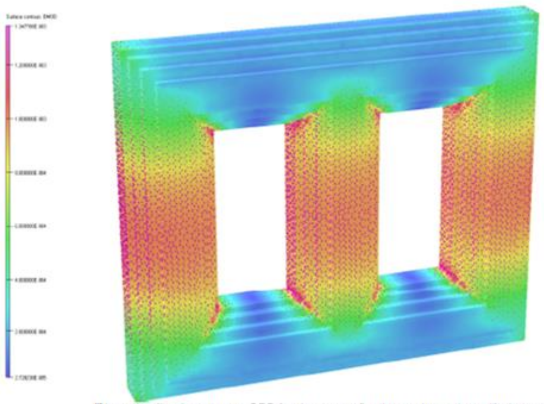
Key Drivers

Key Drivers for GIC Monitoring System

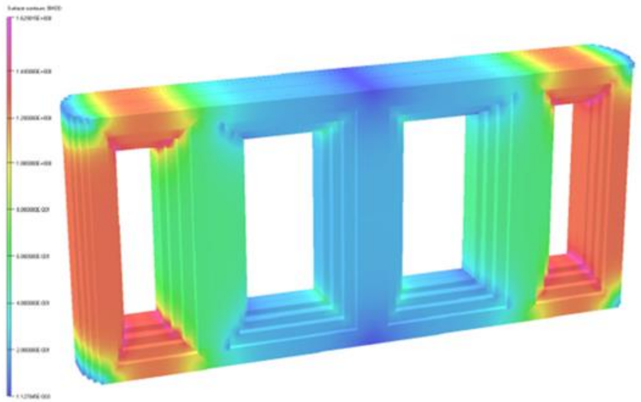
- Impact of solar storms on electricity networks based on recorded global events
- Need for network reliability
- Further understanding & manage potential risks to a network
- Time needed to repair / replace damaged transformers
- More severe solar storm activity predicted by scientists
- PSSWG

Key Drivers for GIC Monitoring System

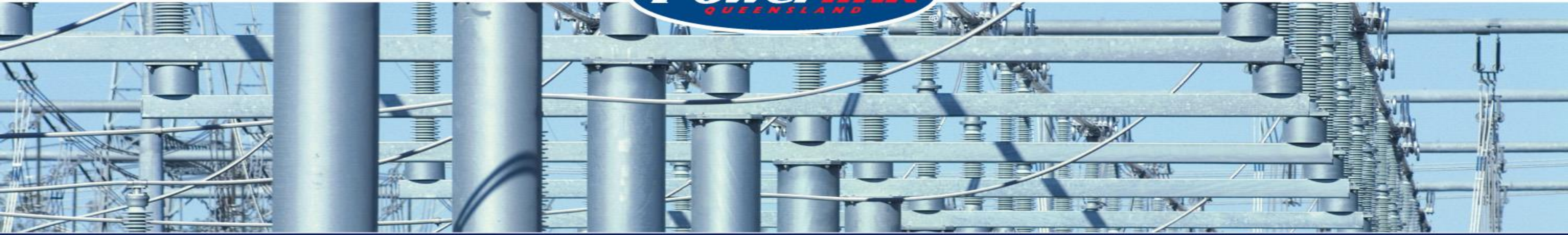
- Can cause abnormal heating within a transformer



Flux distribution due to GIC in the core of a three phase three limb power transformer.



Flux distribution due to GIC in the core of a three phase five limb power transformer.



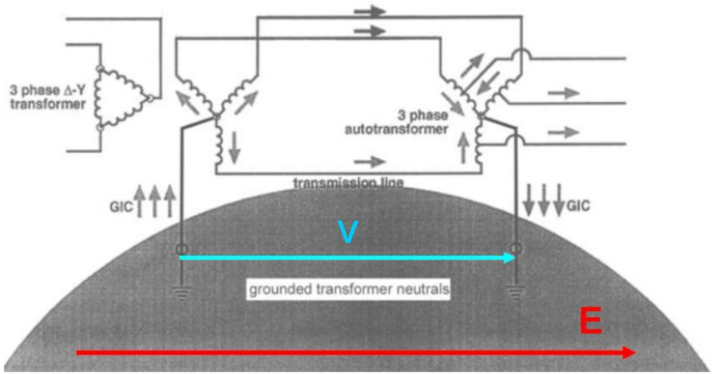
Powerlink Approach

Corporate Approach

- A need to expand our understanding of GICs & impacts
- Consider our network in light of these new learnings
- DC model of our state-wide transmission network
- GIC measurements needed for calibration of the model
- Optimize and implement more GIC monitoring locations
- Develop a complete GIC alert system across the network

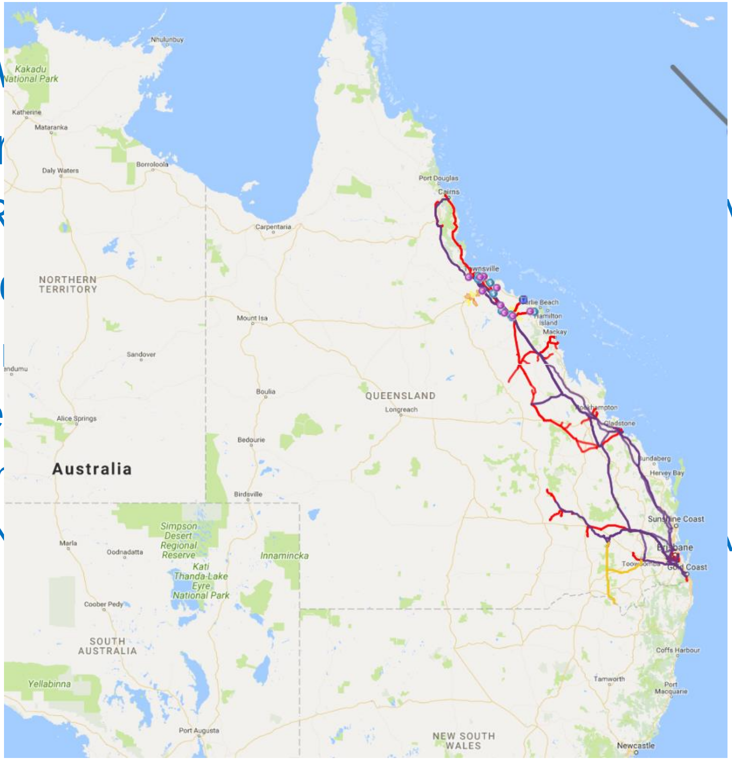
GIC Measurement Design based on Conventional Transducers

- Geomagnetically Induced Currents (GIC)
  - Typically GICs have a frequency between 0.001Hz - 0.10 Hz
  - Potentially significant impacts on power transformers
- Target: Transformer neutral current



Locations of GIC Measurement

- Large pow… oriented tr…
  - Middle R… MVA
- Influence …
  - Souther… Murarrie…
  - Northern… Bowen N… VA



Instrumentation Requirements

- DC component measurement of transformer neutral current
- Reasonable accuracy - +/- 0.5A
- Measurement if +/- DC GIC (AEMO convention is + for down into the earth)
- Scanned data at 4 seconds rate as per normal SCADA data
- Alarming functionality needed for high (pre-calculated) GIC levels
- A simplistic design suitable for sites of various control system topology
- Low cost solution

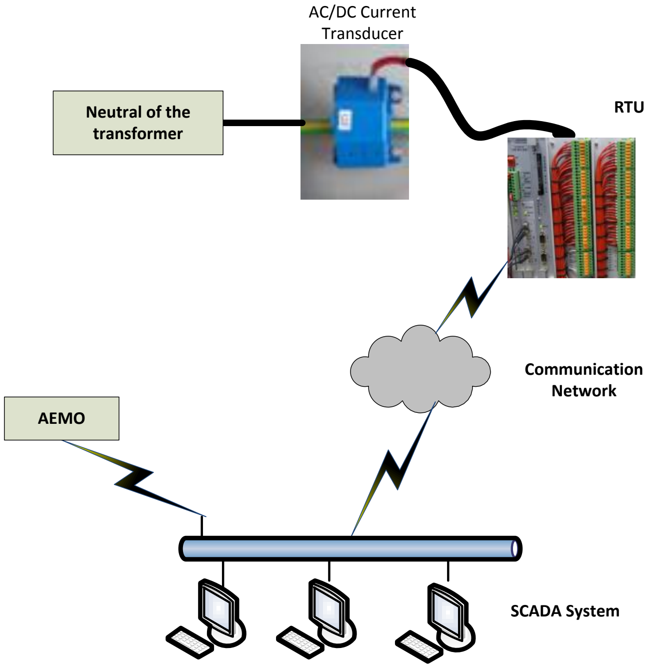
Design Considerations

- Design must reject high fault currents without electronic equipment damage
- Design must reject all AC components (i.e., imbalance in feeder currents)
- Typical transducers measure AC or AC+DC bias
- Unwanted signal noise associated with long cable runs

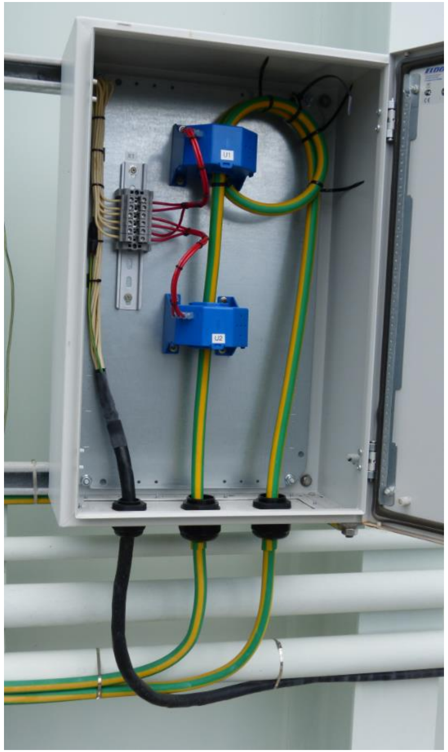
Implementation Details based on Transducers

- AC/DC Transducer
- Nominal 500/0.1Amp current loop output
- Different ranges: 100A and 50A GIC level
- Transducer power supply rail voltage limits the maximum current / voltage input excursions to the RTU during high primary current fault conditions.
- The AC component is filtered out by the RTU input low pass filter

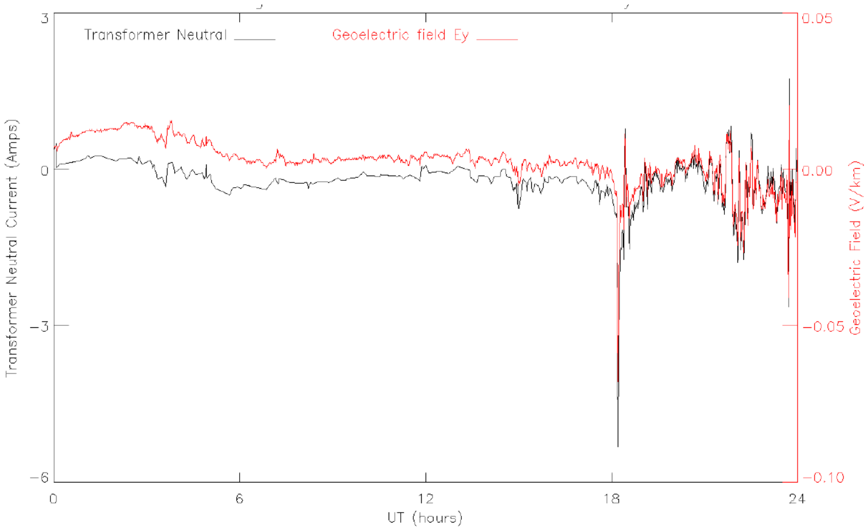
Measurement System Architecture

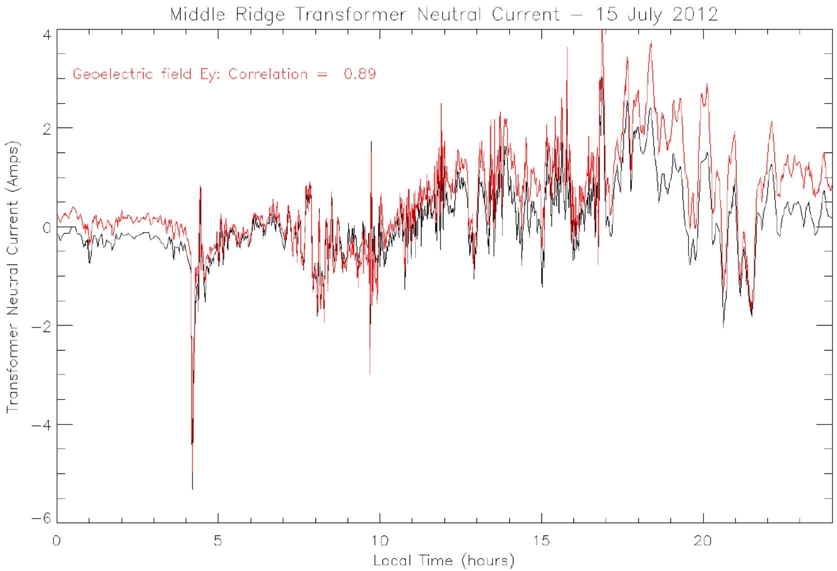


Field Implementation



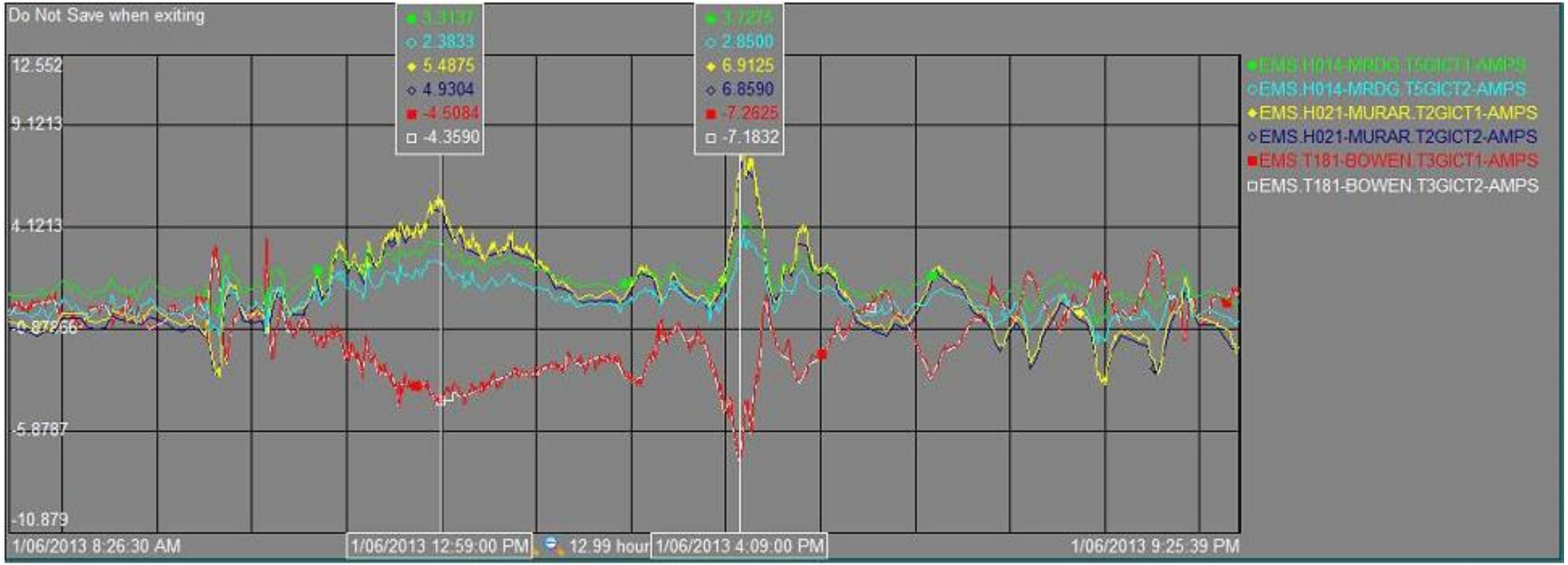
Measurement Comparison between Transformer Neutral and Geoelectric Field



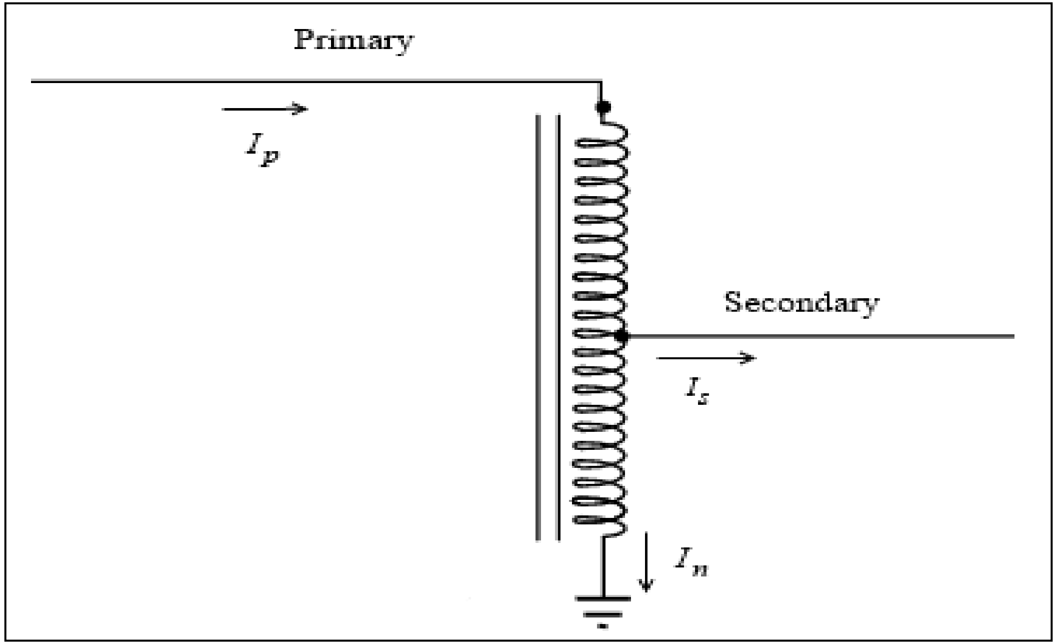


Results of GIC Measurements

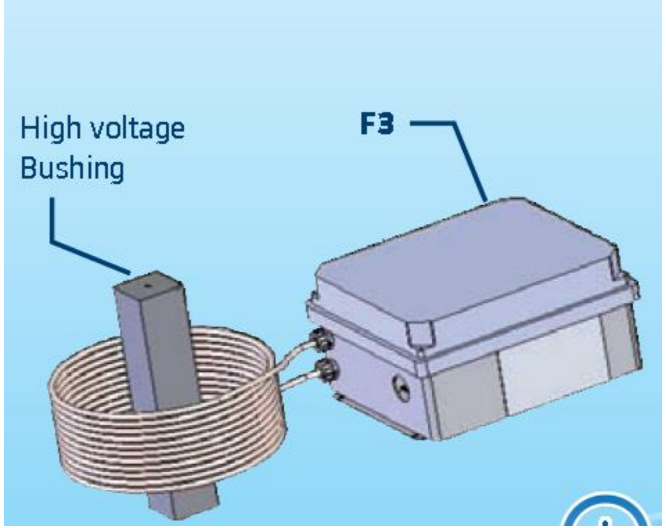
K6 events on 1/06/2013

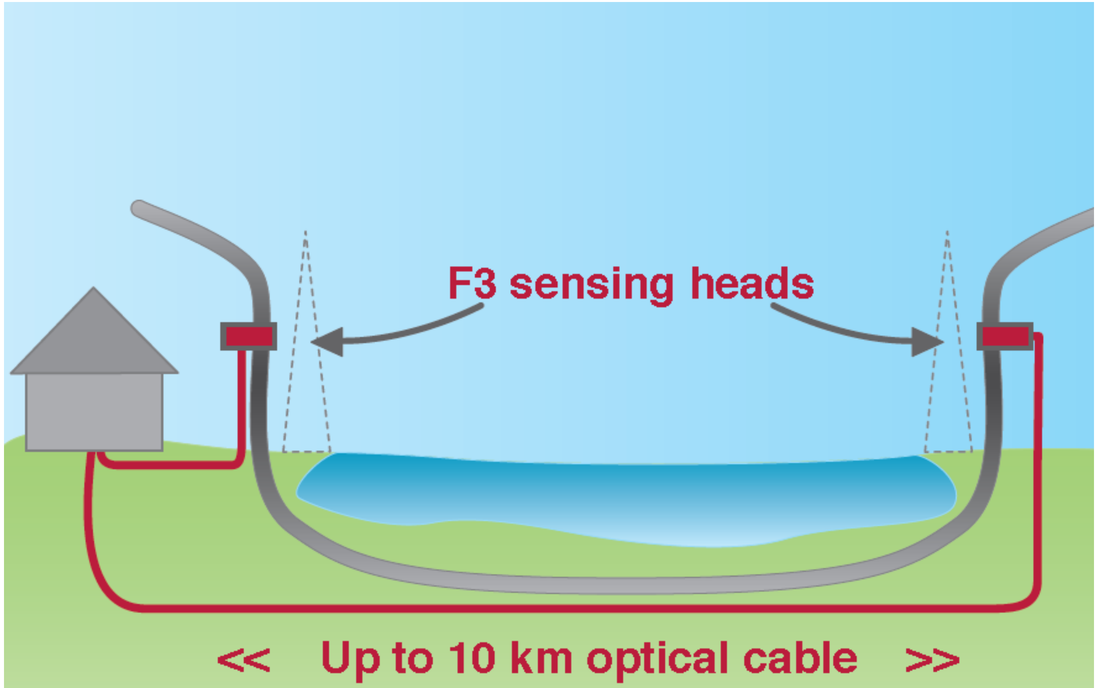


GIC Measurement on the HV Network (Autotransformer)



NCIT

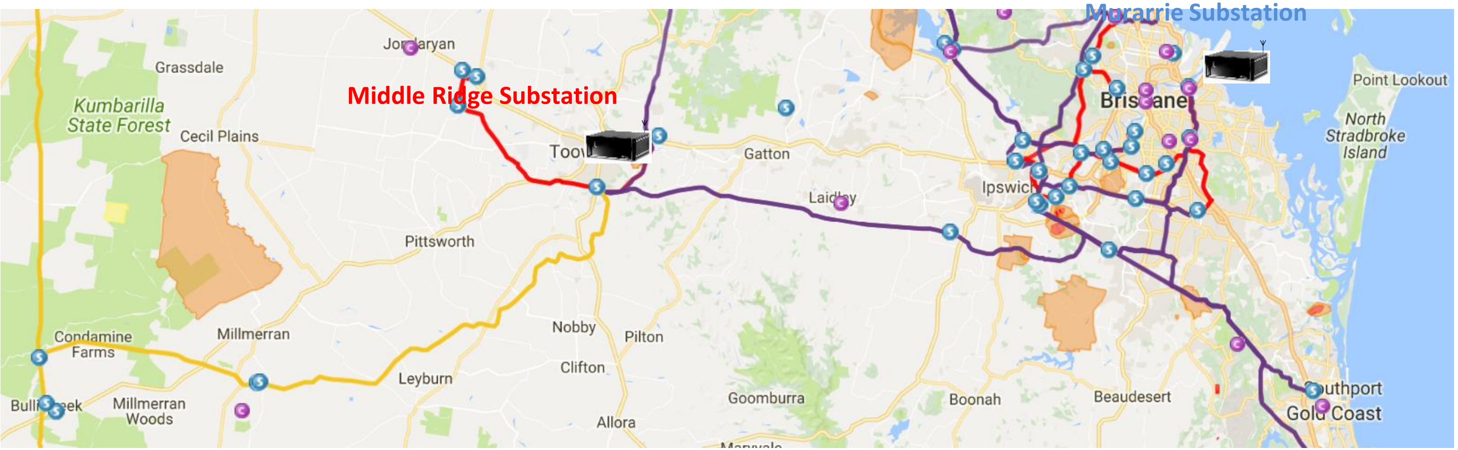

High voltage
Bushing
F3


F3 sensing heads
<< Up to 10 km optical cable >>

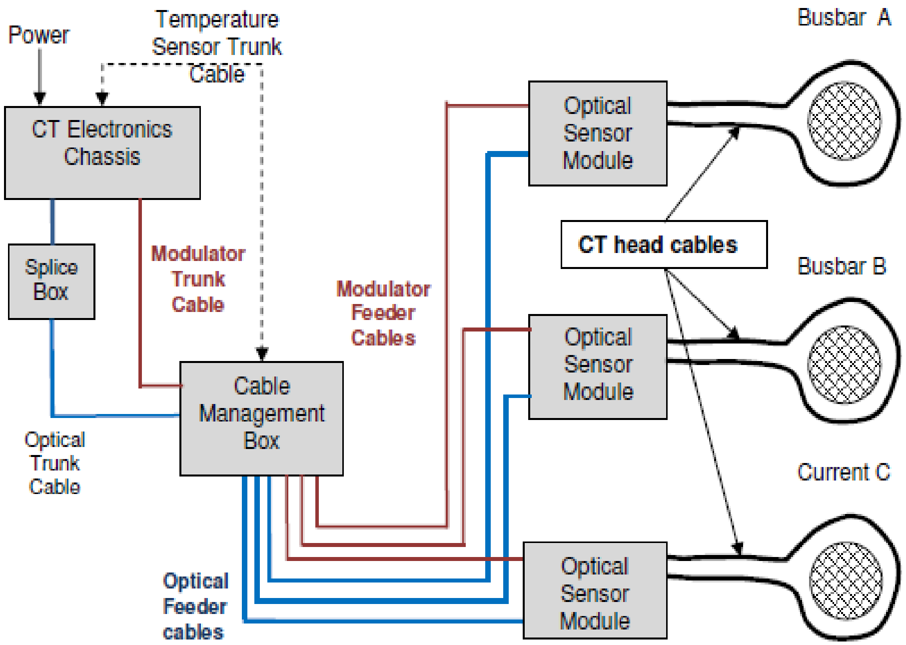
GIC Measurement of HV Network based on NCIT

- Middle Ridge substation: T5 – 330kV

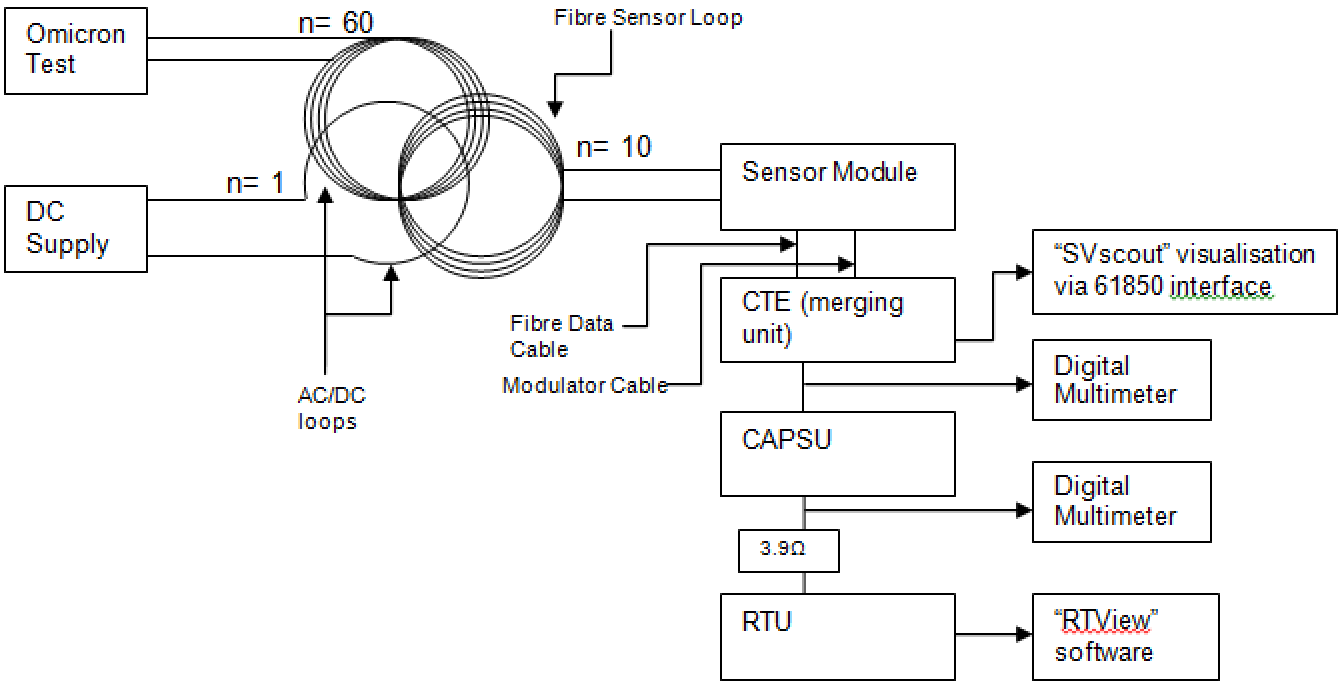
- Murarrie substation: T2 – 275kV



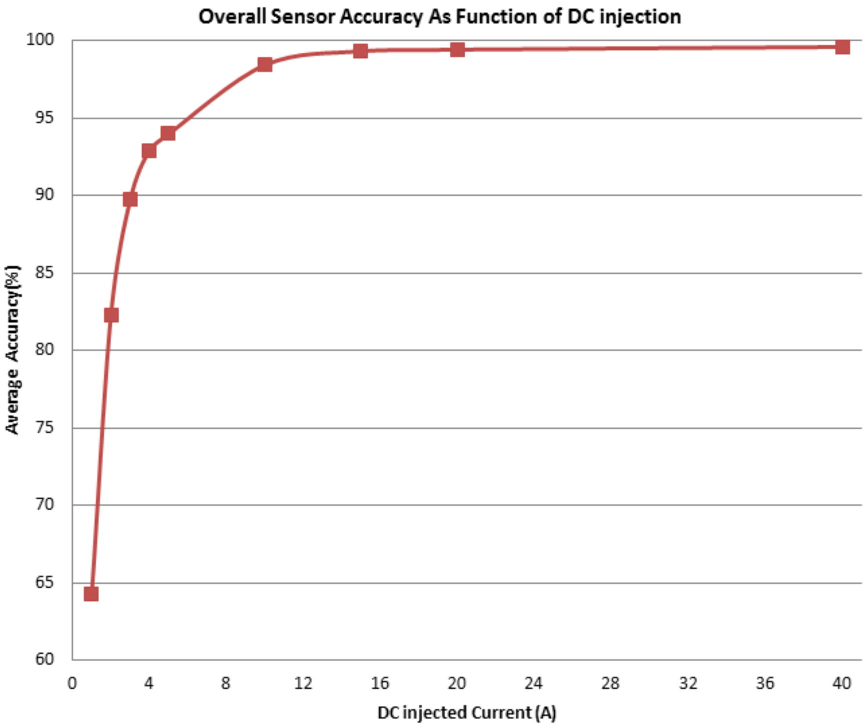
Non Conventional Instrument Transformer (NCIT)



Test Schematic

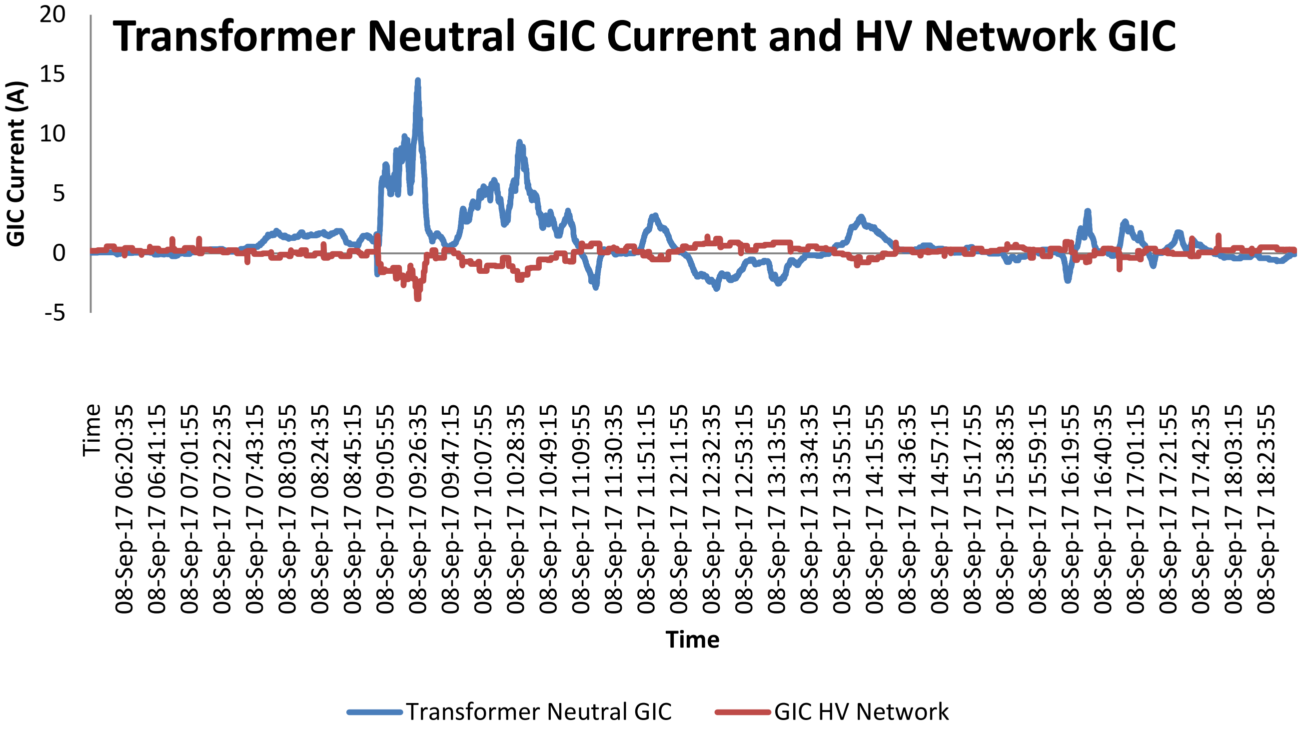


Overall Sensor Accuracy

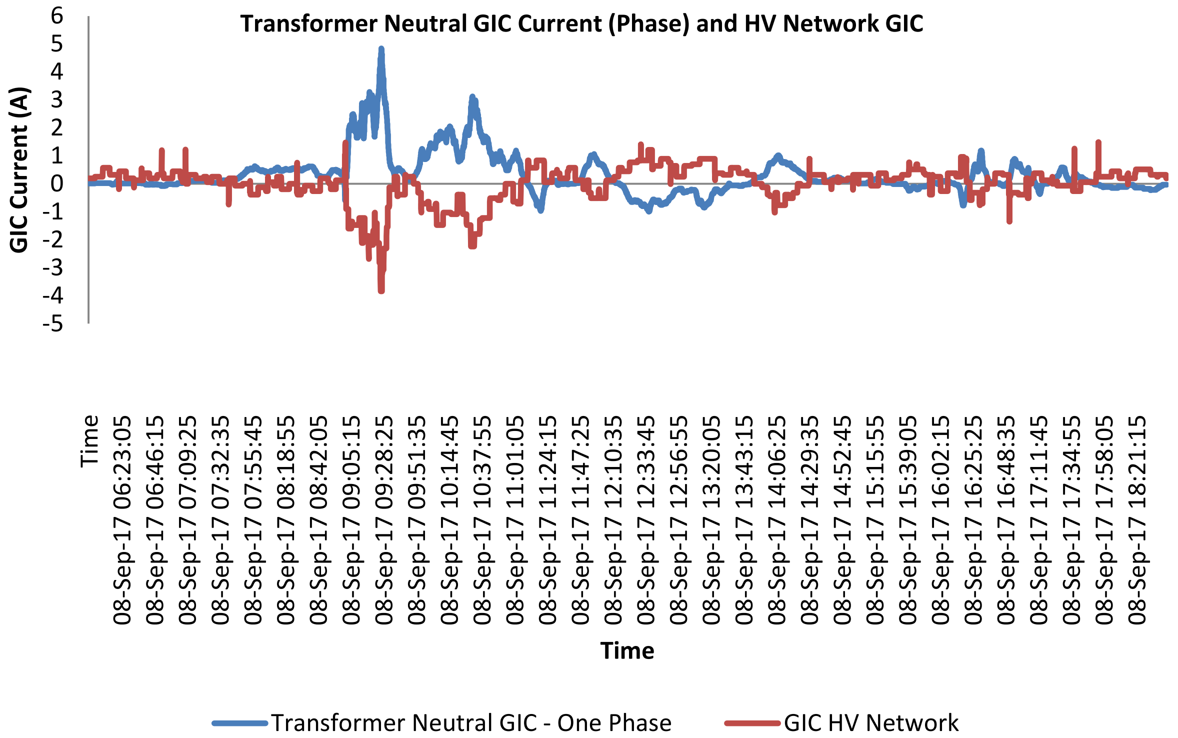


Field Implementation

Comparison of Transformer Neutral and HV Network GIC



Comparison of Transformer Neutral and HV Network GIC (K7 – G3)

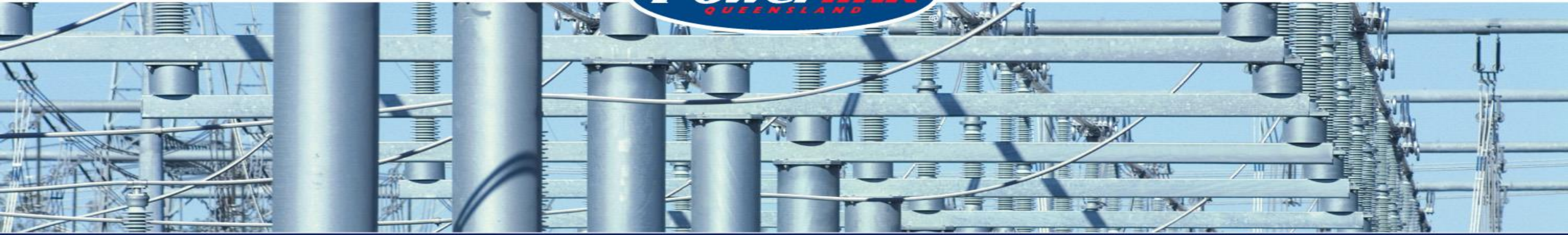


Impacts of Initial GIC Results

- Correlating results with predictions of the Powerlink GIC DC network model
- Calibrating the DC network model
- Need a better understanding of coastal affects
- Have a better understanding of GIC durations
- Will be doing further correlation between BOM and Powerlink GIC measurement data and network model

Potential GIC Mitigation Strategies

- Provide alert and trip the transformer by the on-line GIC monitoring system.
- Plan outages for critical primary plant to avoid possible damage caused by GIC / solar storm activity
- For high density networks, perhaps ensure as much of the network is in to distribute out the GIC?
- Installing NERs could cause non-solidly bonded network and may not solve the auto-transformer issue.



Conclusions

Conclusions

- Detailed GIC measurement based on conventional transducers and NCIT
- Calibration and refinement of the GIC model is needed
- Measurements are needed at more locations.
- Development of a mitigation strategy

Questions?