

FERC GMD Technical Conference

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Hydro One real-time GMD management system

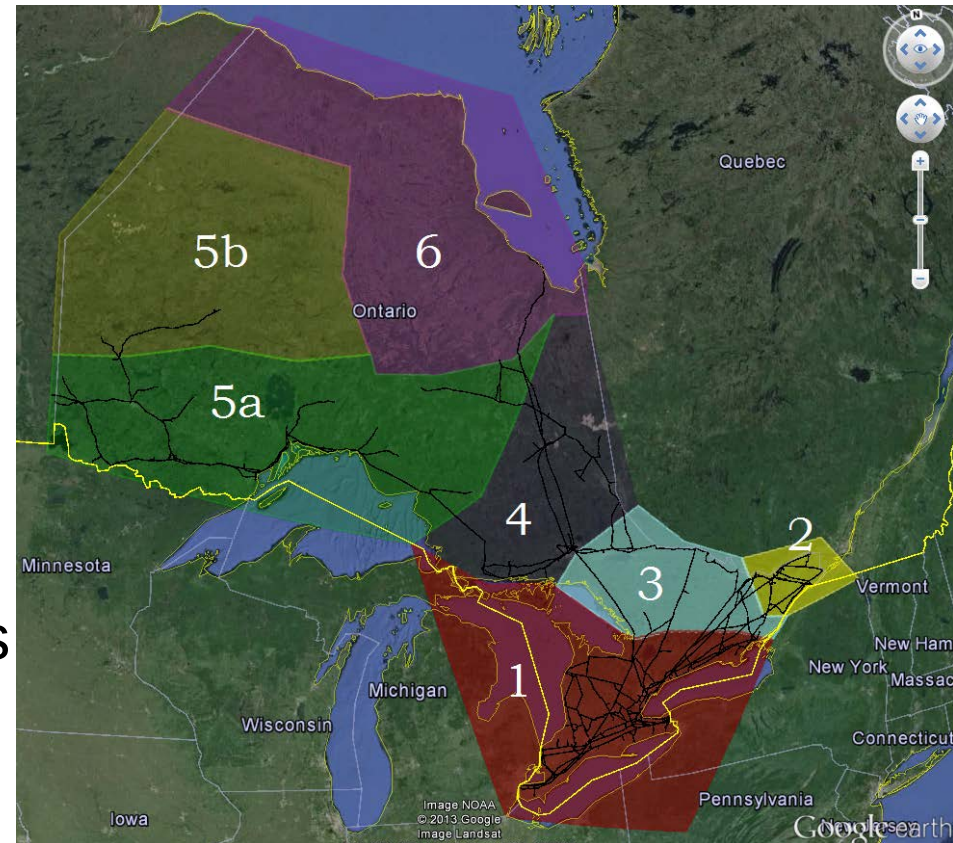
- Estimation of GIC flows in every part of the network from geomagnetic field measurements
- Dynamic network configuration: 530 HV transformers, 800 500 kV and 230 kV circuits, and 30 shunt capacitor banks
- Estimation of var absorption in every transformer.
- Estimation of hot spot temperatures in every transformer
- Estimation of harmonic currents in HV capacitor banks

Hydro One real-time GMD management system

- Data from the OTT magnetometer has a 1 second sampling rate.
- Calculation time around 250 ms carried out on every 1s geomagnetic field sample.
- A 10 second sampling/calculation cycle should be sufficient since it does not materially affect var absorption or thermal calculations.
- Real time control actions are pre-planned on the basis of system studies.

Hydro One real-time GMD management system

- Multiple physiographic regions (7 earth models)
- Direct harmonic measurements in key transformers
- Dissolved Gas Analysis in a few transformers
- Real-time transformer bulk oil operating temperature on the basis of loading.
- The application also retrieves power flow data from the state estimator



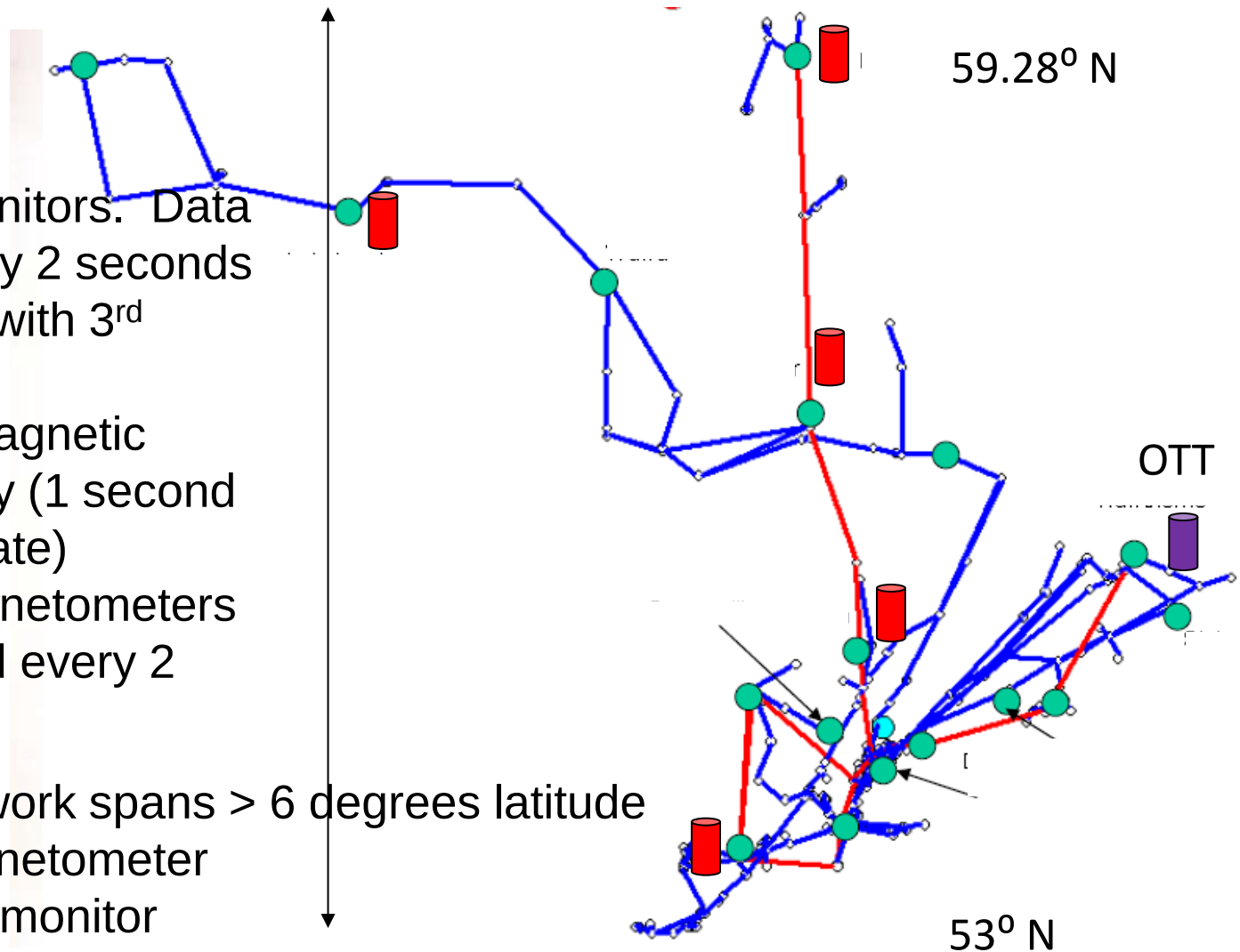
GIC monitor and magnetometer network

- 18 GIC monitors. Data polled every 2 seconds
- Replacing with 3rd generation
- OTT geomagnetic observatory (1 second sampling rate)
- 6 new magnetometers Data polled every 2 seconds

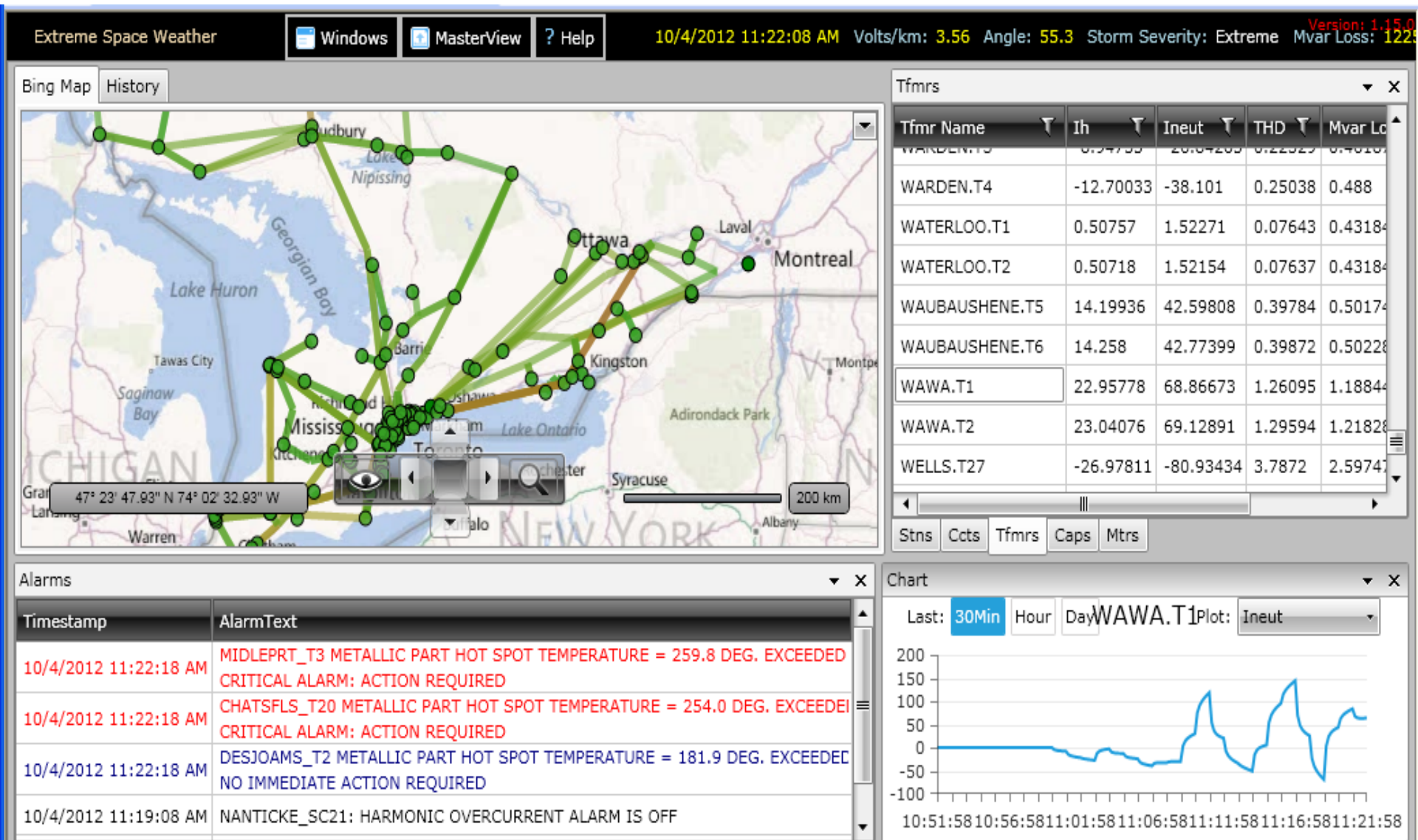
Network spans > 6 degrees latitude

 Magnetometer

 GIC monitor



Operator's Display Showing a Training Session



Purpose of the monitoring equipment

- To support the GMD management system
 - Cross-checking measurements and calculations in real time. GIC measurements have a limited value for situational awareness without system studies to provide context.
 - Canary stations
- Earth model validation/tuning
 - GIC monitors and magnetometers are physically close
 - Magnetometers 100 m away from a station or other sources of magnetic interference
 - Important to manage different data sources and sampling rates
 - Without the exact system configuration, attempts at earth model validation are not useful.
 - Validation and tuning must be done over the full frequency spectrum (0.1 mHz to 1 Hz).

GIC monitor placement criteria

- High GIC according to system studies
- Sensitive installations
- Key parts of the system (e.g., near series and shunt compensation)
- Away from transportation systems using dc (e.g., subways or light rail).

Magnetometer placement criteria

- Physically close to a GIC monitor
- Avoiding sources of magnetic interference such as roads, local distribution networks
- Latitude and longitude spread
- Allocated to diverse physiographic regions

Concluding remarks

- Hydro One has accumulated more than 25 years of experience in the monitoring and simulation of GIC. The main motivation is that the HV network is very close to the Auroral region.
- GIC and geomagnetic field measurements are used for
 - Situational awareness
 - Input to the real-time GMD management system
 - Model validation and tuning.
- For earth model validation/tuning, GIC and geomagnetic field data must be used with extreme care and attention to data sources, sampling rates and the nuances of signal processing over a broad frequency spectrum.
- For meaningful model tuning, GMD events of K7-K8 magnitude are needed
- Collaboration with the geophysicists at NRCan has been invaluable.