By 2030 eThekwini will be Africa’s most caring and liveable city

Enhancement of Network System Performance Monitoring through Synchronised Measurement Technology

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**Vision:** eThekweni Electricity - a leader in electricity distribution providing energy for the future.

**Mission:** To provide electricity, public lighting and other energy services that satisfy our customers and community whilst maintaining sound business principles.

755,000 Customers
2,200 Square kilometres
5% of total energy generated by Eskom
Max Demand 1,729,268 kVA
Total revenue R 12.7 Billion
Operating Surplus R 1.4 Billion
Increase of 3.06% in energy sold 2016/2017
What Has Changed?

1) Increase of electric power demand.

2) Dynamic nature of modern distribution networks.

3) Changing customer.

4) Fourth Industrial revolution – IoT Technologies replacing legacy SCADA.
Power Quality

1) Reliability, indication of adequate and secure power supply.

2) QoS regulations: continuous improvement of visibility, protection, control and stability of electric grid.

3) NRS 048: Quality of the waveform, disturbances, incidents report and reliability.

4) IEC 61000-4-30: Address both quality of supply (voltage) and quality of use (current).
Power Quality

1) Wide Area Measurements Systems - Real time monitoring for stability and security.

2) Operational limits of a distribution grid are dependent on voltage, current and frequency.

3a) SMT – Synchrophasor Measurement Technology.
3b) PMU – Phasor Measurement Units.

4) Communication via Fibre Optic network.
Need for SMTs

1) The SMT collect data from different substations and control signals between substation devices throughout the grid.

2) They are a measurement and monitoring tool, which is synchronized by Global Positioning System (GPS) clock.

3) Samples measurements of current and voltage current phasors, frequency and power.

4) Perform self-configuration and self-healing tasks.
# Advantages Over Legacy

<table>
<thead>
<tr>
<th>Options</th>
<th>Option 1 (SMT)</th>
<th>Option 2 (Legacy PQ Instrument)</th>
<th>Derivable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Rate</td>
<td>1000 samples per cycle</td>
<td>128 samples per cycle</td>
<td>Synchronised instruments will improve resolution as it has a higher sampling rate. It captures more data compared to legacy instrument.</td>
</tr>
<tr>
<td>Availability of Data</td>
<td>SMTs will be connected directly to eTE electricity network.</td>
<td>It is deployed through a 3rd party network and there is latency associated with it.</td>
<td>SMT offers real time data streaming to network. This will help with real time wide area picture of network</td>
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<tr>
<td>Real Time Data</td>
<td>SMTs through use of PMUs allows real time data of current and voltage phasors</td>
<td>It provide non-real time voltage magnitude data.</td>
<td>SMTs allow you to have playbacks of events leading to fault. This can be used for root cause analysis.</td>
</tr>
<tr>
<td>Wide Area Visibility</td>
<td>SMTs will allow eTE network to have integrated real time readings from different substations and transmission lines.</td>
<td>It gives instance of fault at a certain location.</td>
<td>Synchronised instruments will allow us to have wide area monitoring of network which will help operator with system operation in real time.</td>
</tr>
<tr>
<td>Voltage and Current Magnitude and Phase</td>
<td>SMTs through use of PMUs provide real time data of current and voltage phasors</td>
<td>It provide non-real time voltage magnitude data.</td>
<td>Time data streaming will help with power factor (pf) and reactive power. This is used mainly by EMS.</td>
</tr>
<tr>
<td>Time Stamped Data</td>
<td>SMTs through use of PMUs provide real time, synchronized time stamped data.</td>
<td>It provides non-real time and it not synchronized.</td>
<td>Real time data streaming from Synchronised instruments will improve state estimation and assist in post-mortem. Furthermore, we do not need about latency that much as that will be time stamped.</td>
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</tbody>
</table>
Methodology
Methodology

Substation C
(11 kV)

Substation B
(132 kV)

Substation A
(275 kV)
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Results

<table>
<thead>
<tr>
<th>Channel</th>
<th>Vrms (% declared)</th>
<th>Vrms (V)</th>
<th>I rms (A)</th>
<th>Power Meter</th>
<th>Apparent Power (VA)</th>
<th>Active Power (W)</th>
<th>Reactive Power (VAR)</th>
<th>Phase Angle (°)</th>
<th>Total PF (p.u.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.456</td>
<td>110.511</td>
<td>749.040</td>
<td>P1 = V1 x I1</td>
<td>91.703k</td>
<td>70.429k</td>
<td>23.131k</td>
<td>-16.464</td>
<td>0.959</td>
</tr>
<tr>
<td>2</td>
<td>100.56</td>
<td>110.56</td>
<td>120.474</td>
<td>P2 = V2 x I2</td>
<td>75.275k</td>
<td>56.018k</td>
<td>-19.258k</td>
<td>-54.501</td>
<td>0.716</td>
</tr>
<tr>
<td>3</td>
<td>99.758</td>
<td>109.753</td>
<td>707.933</td>
<td>P3 = V3 x I3</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>51.608m</td>
<td>56.738m</td>
<td>641.058m</td>
<td>P4 = V4 x I4</td>
<td>36.745u</td>
<td>26.992u</td>
<td>-55.032u</td>
<td>-42.809</td>
<td>0.734</td>
</tr>
</tbody>
</table>

View 1 | View 2 | Harmonics

Voltage Phasors

Voltage Waveform

Current Phasors

Current Waveform
Conclusion

1) Electric Power Utilities need to consider deployment of SMTs for wide area monitoring and control.

2) Understanding, predicting and controlling power grid stability in real time.

3) As a cost saving mechanism, the use of a single SMT can be used for multiple applications to improve the overall distribution network business model.

4) Future Work:
   a) Optimise SMT Placement.
   b) Build AI Algorithms in SMT Server for automation and control.
   c) Investigate different algorithms for synchrophasor estimation.
• Future generations may well have occasion to ask themselves, What were our parents thinking? Why didn't they wake up when they had a chance? We have to hear that question from them, now.”

• Al Gore, An Inconvenient Truth 2006