NETWORK PARAMETER QUALITY TRACKING - BC HYDRO PRACTICES

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NETWORK PARAMETER QUALITY TRACKING

OVERVIEW

• Advanced EMS applications

• Network model characteristics

• Parameter tracking
  – Model requirements
  – Calculation method

• Examples

• Next steps
• State estimator
• Transient stability analysis
• Contingency analysis
• Voltage stability analysis
• Voltage var dispatch
• Voltage levels from 500kv down to 25kv feeders

• Large portion of 60kv network is modeled in detail

• Presence of lines with high r/x ratio

• Zip load model

• HVDC model
BC HYDRO MODEL CHARACTERISTICS

- Redundant telemetry in 500kv and portions of 230kv network
- Unobservable areas in parts of 230kv, 138kv and 60kv networks
- Large unobservable areas in external networks
- Large number of current measurements
- Significant number of summed measurements
PARAMETER QUALITY TRACKING

SCOPE

• Line resistance
• Line reactance
• Line charging admittance
• Parameter tracking performed on a network pocket

• The concept of network pocket— a contiguous portion of the network that meets the following requirements:
  • Measurement redundancy level > 2.5
  • State estimator solution quality meets performance criteria
  • Measurements in the pocket meet stringent quality requirements
• Based on the concept of bus mismatch

• KCL constraint in state estimator is met with margin of error (sum of injections/flows at a bus is not zero)

• For pockets with high measurement redundancy and measurement accuracy the parameter error contributes to bus mismatch

• Parameter errors can be calculated from power flow equations as function of measured real and reactive power injections, power flows, bus voltage magnitudes and bus mismatches
PARAMETER QUALITY TRACKING
TWO BUS EXAMPLE

\[ G + jB \]

\[ \Delta P_1, \Delta Q_1 \]

\[ P_{12}, Q_{12} \]

\[ P_{21}, Q_{21} \]

\[ V_1 \]

\[ V_2 \]

\[ \Delta P_2, \Delta Q_2 \]

\[ P_I, Q_I \]
\[ \Delta G = g_1(V_1, V_2, G, \Delta P_1, \Delta P_2, P_{12}, P_{21}) \]
\[ \Delta B = g_2(V_1, V_2, B, \Delta Q_1, \Delta Q_2, P_{12}, P_{21}) \]
\[ \Delta BCH_1 = g_3(V_1, V_2, \Delta Q_1, \Delta Q_2, \Delta G, \Delta B, Q_{12}, Q_{21}) \]
\[ \Delta BCH_2 = g_4(V_1, V_2, \Delta Q_1, \Delta Q_2, \Delta G, \Delta B, Q_{12}, Q_{21}) \]
\[ \Delta P_1, \Delta P_2, \Delta Q_1, \Delta Q_2 \text{ are bus mismatches} \]
\[ V_1, V_2, P_{12}, P_{21}, Q_{12}, Q_{21} \text{ are telemetered values} \]
STATE ESTIMATOR SOLUTION QUALITY PERFORMANCE CRITERIA

- State estimator cost < 15000
- Data availability > 70%
- Maximum MW mismatch < 20 MW
- Load allocation error < 350 MW
- Total unit mw error < 50
- Total tie line error < 20
- Normalized residual < 7.5

- Long term average standard deviation consistent with static standard deviation (within 95%)

- Long term average bias < 2% of the rating
PARAMETER QUALITY TRACKING

5L45 EXAMPLE

LINE ENDS
5L45
DISPLAY STATUS R 2

MDN
5CB3
L 5
5CVT2

5D22
187 A
531.4 KV
96 MW
96 MX

CK5
5CB3
R
5D24
122 A
536.1 KV
95 MW
1 MX

MDN -- LEAD: NO SUPERVISION
CKY -- FOLLOW: SUPERVISED BY RESTORATION OF POTENTIAL

CHARGING MVARs = 80 MVARs
CIRCUIT LENGTH = 66.75 KM (41.5 MILES)

5L45 LINE RATINGS (AMPS) PER SDG 6T-10

<table>
<thead>
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<th>SUMMER NORMAL 30 C</th>
<th>WINTER NORMAL 10 C</th>
<th>WINTER NORMAL 0 C</th>
<th>PROTECTION A</th>
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<tbody>
<tr>
<td>CKY 500</td>
<td>2160</td>
<td>3130</td>
<td>3416</td>
<td>3000 - CT</td>
</tr>
<tr>
<td>MDN 500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AMP / MW CONVERSION CHART
LINE 5L45 EXAMPLE - MEASUREMENT QUALITY

Plot 0

2010-07-12 8:01:51 AM
8.00 hours
2010-07-12 4:01:51 PM

- ANALOG: CK6.LMC.5L45_MW -11.42 MW
- ANALOG: CK5-SCC.5L45_MW.SE -22.42 MW
- ANALOG: MDN-SCC.5L45_MW 12.00 MW
- ANALOG: MDN-SCC.5L45_MW.SE 22.48 MW

150 140 50 60
5
20
-40 -60 -160 MW

Ready
LINE 5L45 EXAMPLE – REACTANCE TRACKING
LINE 5L45 EXAMPLE - RESISTANCE
LINE 5L45 EXAMPLE – REACTANCE AFTER CORRECTION
LINE 5L45 EXAMPLE – RESISTANCE AFTER CORRECTION

PI ProcessBook - [Trend Display*]

[Graph showing trend display with various lines representing different measurements or data points.]

BCHydro
• Implement detailed model for parameter error calculation for larger portions of the network

• Track quality of transformer parameters

• Develop global parameter quality index as part of global state estimator solution quality analysis
QUESTIONS?