Overview

PDQ TRACKER
phasor data quality alarming & reporting

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Phasor Data Quality Needs Attention

• Data quality assurance is becoming increasingly important for successful integration of synchrophasor data into utility operations.
  – Device (PMU) availability
  – Time quality issues
  – Value quality issues

• Alarms are needed to alert real-time analytics and operators of bad or missing phasor data.

• Reports are needed to support businesses processes to improve data availability and data quality
Phasor Data Quality Tracker

• An open source project jointly funded by Dominion and PeakRC’s new synchrophasor project
• Alpha Version now available which includes core functionality and two data quality reports
• Beta Version with increased functionality planned for release Spring 2015
High Level Features

• Focus is on the two major dimensions of quality
  – Data Completeness (Availability)
  – Data Correctness (Accuracy)

• Stand alone product for use within any synchrophasor data architecture

• Outputs to support:
  – Business processes for correcting / improving data quality
  – Integration with applications to flag incorrect data
Other PDQ Tracker Features

• System integration with an internal GPS clock to identify time-based issues
• Auto configuration of standard alarms as new PMUs are added
• Includes detailed alarm history and alarm logging data systems
• Documented API for real-time alarms – with filtering
• Ability for “comparison alarms” to be easily created
• Auto generation of email for specific alarms
• Creation of multiple auto-generated, periodic reports
• Auto emailing of periodic reports
Data Quality Tests

Completeness

- Bad CRC
- Out-of-Order Frames
- Missing Frames

Correctness

- Time
  - Reasonableness
  - Latency
- Values
  - Reasonableness
  - Latched Value
  - Signal/Noise Ratio
  - Comparison Tolerance
  - Off-Normal
  - Bad Data Pattern

PDQ Tracker maintains statistics on data completeness
PDQ Tracker raises alarms to flag incorrect data
Comparison Made Easy

• Assumes comparison values from a state estimator or SCADA system are available via a file (e.g., every 10 seconds) where each value is identified with an EMS-based ID.

• Comparison adapter creates new calculated points within PDQ Tracker based on the difference between the PMU measurement and the comparison value.

• Alarms can be created based on these calculated comparison values.
What’s “Off Normal”?

- Values that are within valid ranges that can be indicators of potential data quality issues
- Off-Normal values can be caused by:
  - Failing measurement systems
  - Failing power system equipment
  - Valid, but rare system conditions
- Off-Normal limits and based on statistical analysis – e.g., values exceeding the annual 5 sigma for this measurement (normal occurrence < 30 minutes per year)
What’s a bad data pattern?

• Values that are within valid ranges but which when analyzed as a waveform (or as a series of values) indicates measurement system problems.

• Examples include:
  – Rapidly cycling values
  – Independent step change in value
Hierarchy of Alarms

- A group of alarms is created for a “measurement point” provided to PDQ Tracker
- A measurement point can be:
  - A measured phasor magnitude or angle
  - A calculated value, such as
    • the difference between a measured value and a value from the state estimator
    • The rate of change of a measured value
Correctness

The alarm group

• Can be any number of alarms that fall into a severity hierarchy.

• The presence of a higher severity alarm for a measurement suppresses lower severity ones.

  – Critical Error – 1000
  – Bad Time -- 990
  – Latched Value – 980
  – Bad Data Pattern – 970
  – Engineering Reasonableness - 900
  – Alert – 700
  – Warn – 500
  – Off-Normal – 100

  \[ \geq 900 \text{ Data Accuracy Alarms} \]

  \{ \text{May be Data Accuracy related} \}

  \{ \text{e.g., warning alarms based on comparison values} \}
Simple Alarming

Alarm Set Point and Delay
More Complex Alarming Example

Warning and Alert Alarms are raised at set points and are cleared only after falling below a specified hysteresis.
Automated Reporting

• Multiple reports will be included
  – Daily Reporting
    • Existing 5-day availability plus list of PMUs sorted by duration of outage
    • Infrastructure summary stats – alarms and data flow
    • PMUs added / not-reporting
    • Relative Stream Latency
    • Absolute Stream Latency
  – Monthly reporting
    • Worst performing devices (PMUs)
    • Infrastructure summary stats – alarms and data flows
    • Relative Stream Latency
    • Absolute Stream Latency
Daily PMU Data Completeness Report

PDQTracker Completeness Report
Grid Protection Alliance

Tuesday, October 21, 2014

5-day Device Data Completeness

<table>
<thead>
<tr>
<th></th>
<th>10/17</th>
<th>10/18</th>
<th>10/19</th>
<th>10/20</th>
<th>10/21</th>
</tr>
</thead>
<tbody>
<tr>
<td>L4: Good</td>
<td>21</td>
<td>24</td>
<td>22</td>
<td>21</td>
<td>24</td>
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<tr>
<td>L3: Fair</td>
<td>73</td>
<td>70</td>
<td>72</td>
<td>73</td>
<td>70</td>
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<tr>
<td>L2: Poor</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<tr>
<td>L1: Offline</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>L0: Failed</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
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</tbody>
</table>
Daily PMU Data Completeness Report

Percent of Devices with Acceptable Quality (30 days)
Daily Data Correctness Report

PDQTracker Correctness Report
Grid Protection Alliance

Tuesday, October 21, 2014

5-day Correctness Summary

<table>
<thead>
<tr>
<th></th>
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<th>10/18</th>
<th>10/19</th>
<th>10/20</th>
<th>10/21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>89.91%</td>
<td>89.88%</td>
<td>89.90%</td>
<td>89.89%</td>
<td>89.90%</td>
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<tr>
<td>Latched</td>
<td>1.84%</td>
<td>1.84%</td>
<td>1.84%</td>
<td>1.84%</td>
<td>1.83%</td>
</tr>
<tr>
<td>Unreasonable</td>
<td>1.57%</td>
<td>1.57%</td>
<td>1.57%</td>
<td>1.57%</td>
<td>1.57%</td>
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</tbody>
</table>
Daily Data Correctness Report

30-day Correctness Overview

- Bar chart showing daily data correctness from 09/22 to 10/21.
Typical Installation

PDQ Tracker is installed in parallel to existing infrastructure, can be used with any vendor’s PDC and by default is self-configuring.
Alpha Version Available

http://www.PDQTracker.com/