PDQ TRACKER

phasor data quality alarming & reporting

NASPI Technical Workshop

Synchrophasor Data Quality Management and Improvement

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March 18, 2016

Phasor Data Quality Tracker
A Practical Tool

- An open source project jointly funded by Dominion and PeakRC
- Version 1.0 has been released and is now available which includes core functionality and two data quality reports

http://github.com/GridProtectionAlliance/pdqtracker

PDQ TRACKER
phasor data quality alarming & reporting

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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

Data Quality Tests

Completeness

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

Correctness

- **Time**
  - **Reasonableness**
  - **Latency**
- **Values**
  - **Reasonableness**
  - **Latched Value**
  - **Comparison Tolerance**
  - **Bad Data Pattern**

PDQ Tracker maintains statistics on data completeness

PDQ Tracker raises alarms to flag incorrect data

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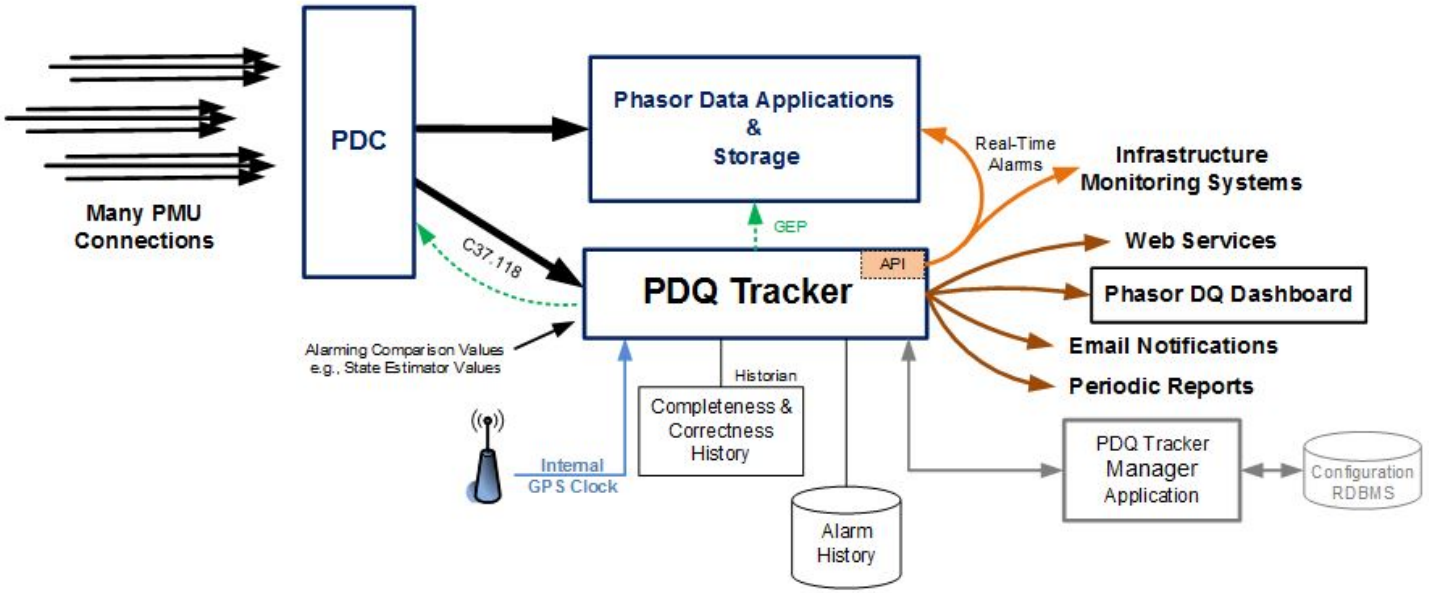
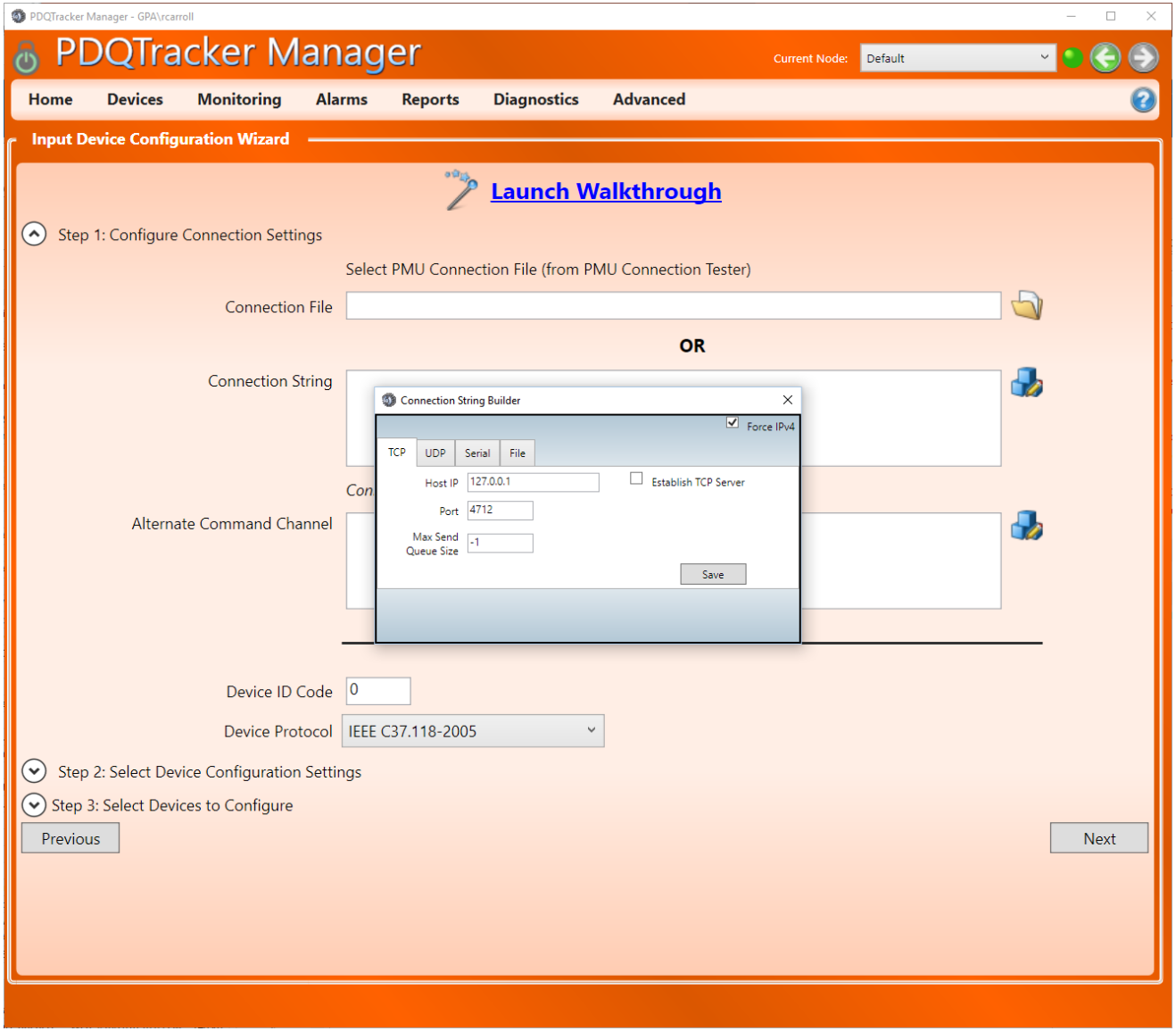
Typical Installation



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

Add Device Streams



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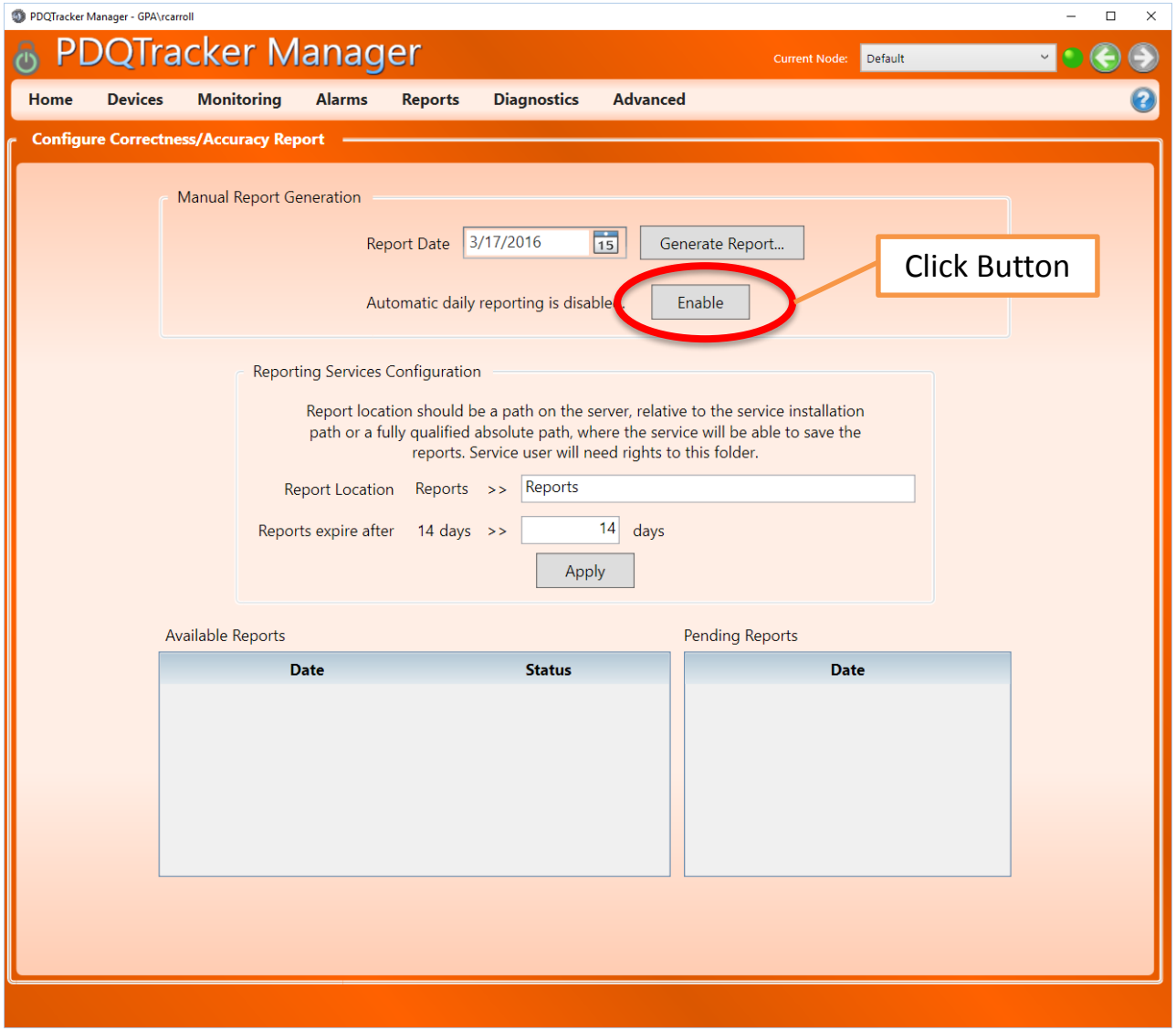
Enabling Reporting



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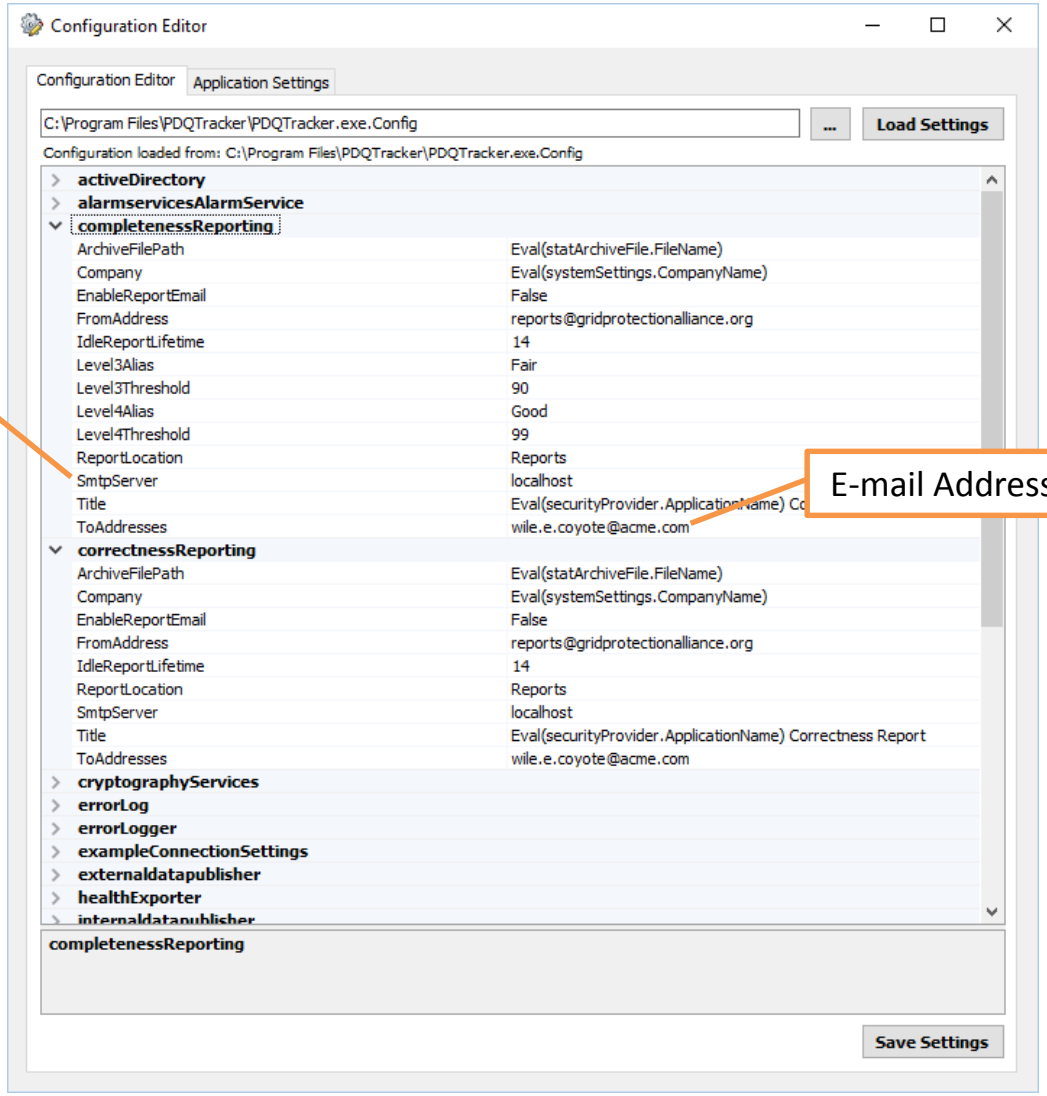
Configure Automated Report E-mails



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Completeness Report

PDQTracker Completeness Report

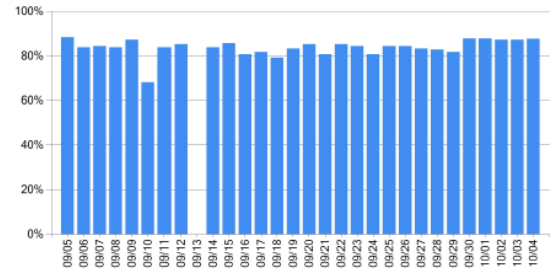
Grid Protection Alliance

Sunday, October 04, 2015

5-day Device Data Completeness

	09/30	10/01	10/02	10/03	10/04
L4: Good	156	141	160	163	163
L3: Fair	18	33	13	10	10
L2: Poor	17	12	12	10	9
L1: Offline	3	8	8	10	10
L0: Failed	4	4	5	5	5
Total	198	198	198	198	197

Percent of Devices with Acceptable Quality (30 days)



Definitions

Level 4: Good - Devices which are reporting as expected, with a completeness of at least 99% on the report date.

Level 3: Fair - Devices with a completeness of at least 90% on the report date.

Level 2: Poor - Devices which reported on the report date, but had an completeness below 90%.

Level 1: Offline - Devices which did not report on the report date, but have reported at some time during the 30 days prior to the report date.

Level 0: Failed - Devices which have not reported during the 30 days prior to the report date.

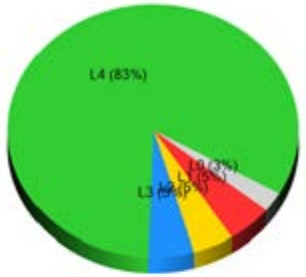
Completeness: Percentage of measurements received over total measurements expected, per device.

Acceptable Quality: Devices which are in Level 4 or Level 3.

Sunday, October 04, 2015

Data Completeness Breakdown

Level 4	163
Level 3	10
Level 2	9
Level 1	10
Level 0	5



Level 0

Name	Completeness	Data Errors	Time Errors
[redacted]N__01	0%	0	0
[redacted]___02	0%	0	0
[redacted]___01	0%	2,591,678	2,591,678
[redacted]PE__01	0%	2,591,678	2,591,678
[redacted]IC__01	0%	2,591,678	2,591,678

Level 1

Name	Completeness	Data Errors	Time Errors
[redacted]R__01	0%	2,591,672	2,591,672
[redacted]HN__01	0%	2,591,672	2,591,672
[redacted]___01	0%	2,591,672	2,591,672
[redacted]PI__01	0%	2,591,749	2,591,749
[redacted]P__01	0%	2,591,678	2,591,678
[redacted]___02	0%	0	0
[redacted]___01	0%	0	0
[redacted]___01	0%	0	0
[redacted]___01	0%	0	0
[redacted]___01	0%	0	0

Level 2

Name	Completeness	Data Errors	Time Errors
[redacted]___01	4.85%	2,465,957	2,465,957
[redacted]M__04	84.24%	0	0
[redacted]M__05	84.24%	0	0

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Report Areas

- 5-Day Summary
- 30-Day Trend
- Quality Level Graph
- Breakdown Details

5-Day Summary

- Summary data by PMU
- Each cell shows count of the number of PMUs that met the definition for each of the last 5 days
- Definitions are editable and managed on the PDQ server

5-day Device Data Completeness

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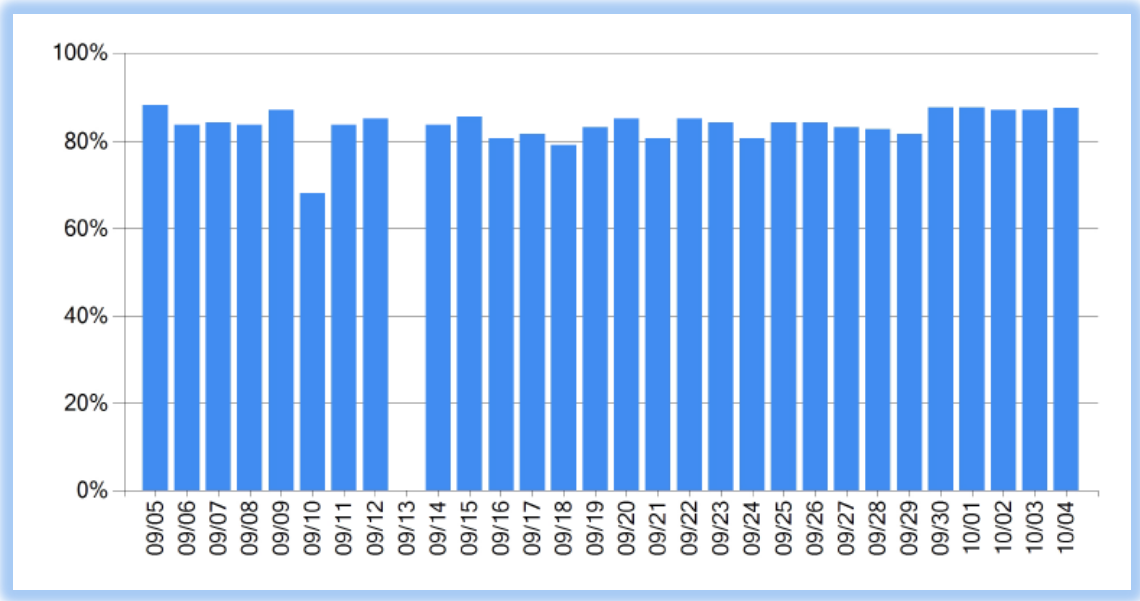
Completeness: Percentage of measurements received over total measurements expected, per device.

Acceptable Quality: Devices which are in Level 4 or Level 3.

30-Day Trend

- Count of devices (PMUs) which are in Level 4 or Level 3
- One bar for each of the last 30 days



Quality Level Graph

- Simple graph summarizing the number of devices (PMU) that were at each level for the reporting day

Level 4	163
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Level 1	10
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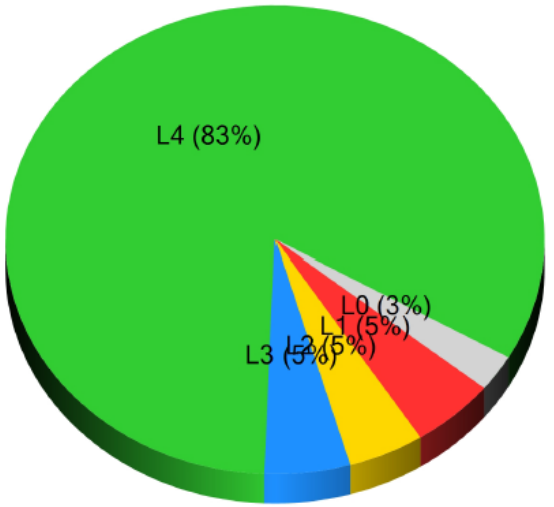


Breakdown Details

- One line per device (PMU) grouped by Level designation (0-worst to 4-best)

- **Completeness:** Percentage of measurements received over total measurements expected, per device. Uses calculated statistic of *Number of measurements received* divided by *Expected number of measurements* over reporting period (defaults to 10 seconds)
- **Data Errors**: Total number of data errors (IEEE C37.118 Bit-15) reported by the device. Uses device statistic for Number of data quality errors reported by device during last reporting interval
- **Time Errors**: Total number of time errors (IEEE C37.118 Bit-13) reported by the device. Uses device statistic for Number of time quality errors reported by device during last reporting interval

Level 3

Name	Completeness	Data Errors	Time Errors
UNIT_2	98.24%	0	954,034
UNIT_3	98.24%	0	954,034
ER	93.85%	0	0
R1	92.81%	0	0
R2	92.98%	0	0

Correctness Report

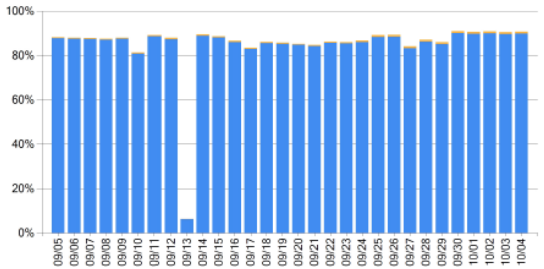
PDQTracker Correctness Report
Grid Protection Alliance

Sunday, October 04, 2015

5-day Correctness Summary

	09/30	10/01	10/02	10/03	10/04
Good	90.10%	89.82%	90.03%	89.72%	89.93%
Latched	0.52%	0.53%	0.52%	0.60%	0.61%
Unreasonable	0.39%	0.39%	0.34%	0.22%	0.22%

30-day Correctness Overview



Definitions

Good: Measurements received which are neither latched nor unreasonable.
Latched: Measurements received which have maintained the same value for an extended period of time.
Unreasonable: Measurements received whose values have fallen outside of the range defined by reasonability constraints.
Correctness: Percentage of good measurements over total measurements expected, per device.

Sunday, October 04, 2015

Data Correctness Breakdown

Name	Correctness
[redacted]E__09	78.71%

Name	Latched	Unreasonable	Total
[redacted]E__09-FQ	2,194,781	0	2,194,781

Name	Correctness
[redacted]N____02	68.09%

Name	Latched	Unreasonable	Total
[redacted]N____02-PM2	0	2,591,872	2,591,872
[redacted]N____02-FQ	8	0	8

Name	Correctness
[redacted]OX____03	68.44%

Name	Latched	Unreasonable	Total
[redacted]OX____03-PM2	0	2,591,872	2,591,872

Name	Correctness
[redacted]N____03	68.09%

Name	Latched	Unreasonable	Total
[redacted]TN____03-PM2	0	2,591,872	2,591,872

Name	Correctness
[redacted]N____03	68.43%

Name	Latched	Unreasonable	Total
[redacted]N____03-PM2	0	2,591,872	2,591,872

Name	Correctness
[redacted]OX____04	68.44%

Name	Latched	Unreasonable	Total
[redacted]OX____04-PM2	0	2,591,871	2,591,871

Name	Correctness
[redacted]IT__03	83.34%

Name	Latched	Unreasonable	Total
[redacted]NT__03-PA1	2,589,574	0	2,589,574

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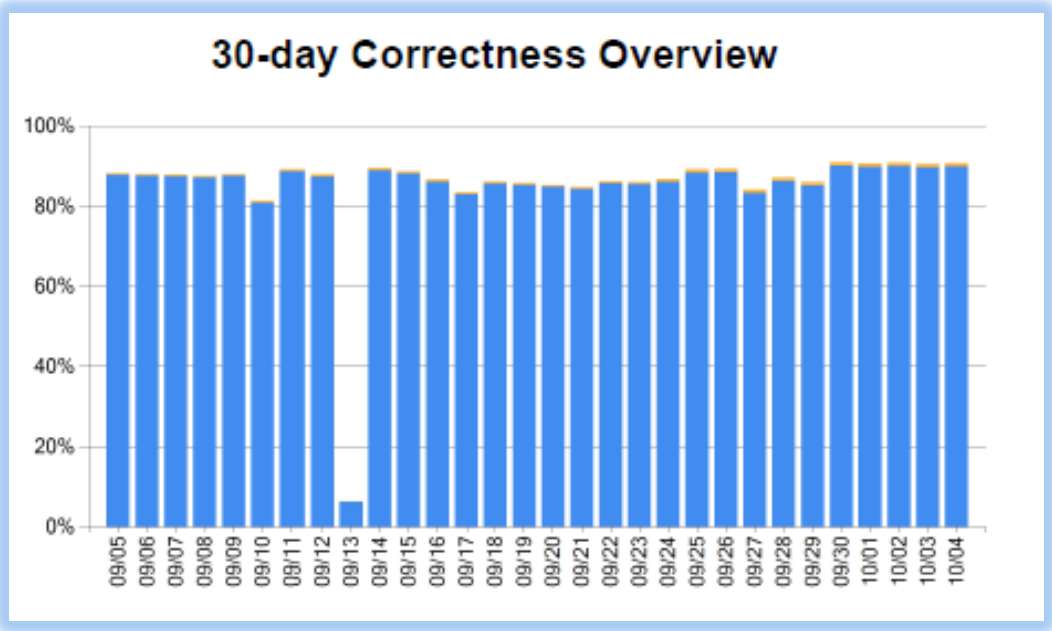
30-Day Trend

- One bar for each of the last 30 days



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Breakdown Details

Correctness is calculated as (Received – Latched – Unreasonable) / Expected

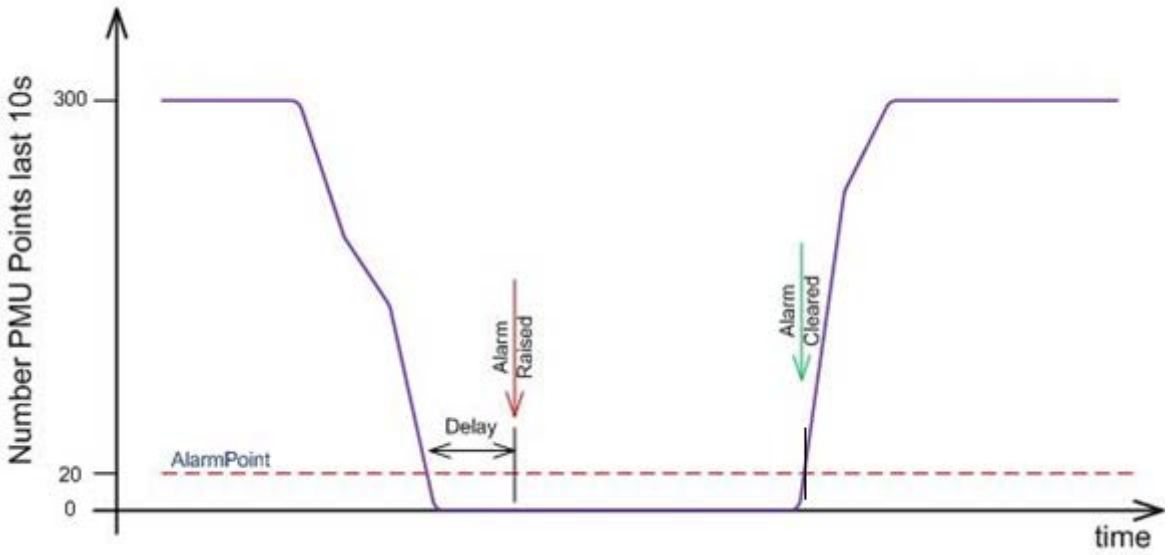
- **Good**: Not Latched and Not Unreasonable
- **Latched**: Alarm when value has changed over defined delay period (defaults to 10 seconds as defined in application, configurable)
- **Unreasonable**: Alarm when value is outside defined engineering reasonableness range (default depends on data type as defined in SQL below, configurable)

Likely that this data set will need to be refined as measurement quality continues to be evaluated.

Hierarchy of Alarms

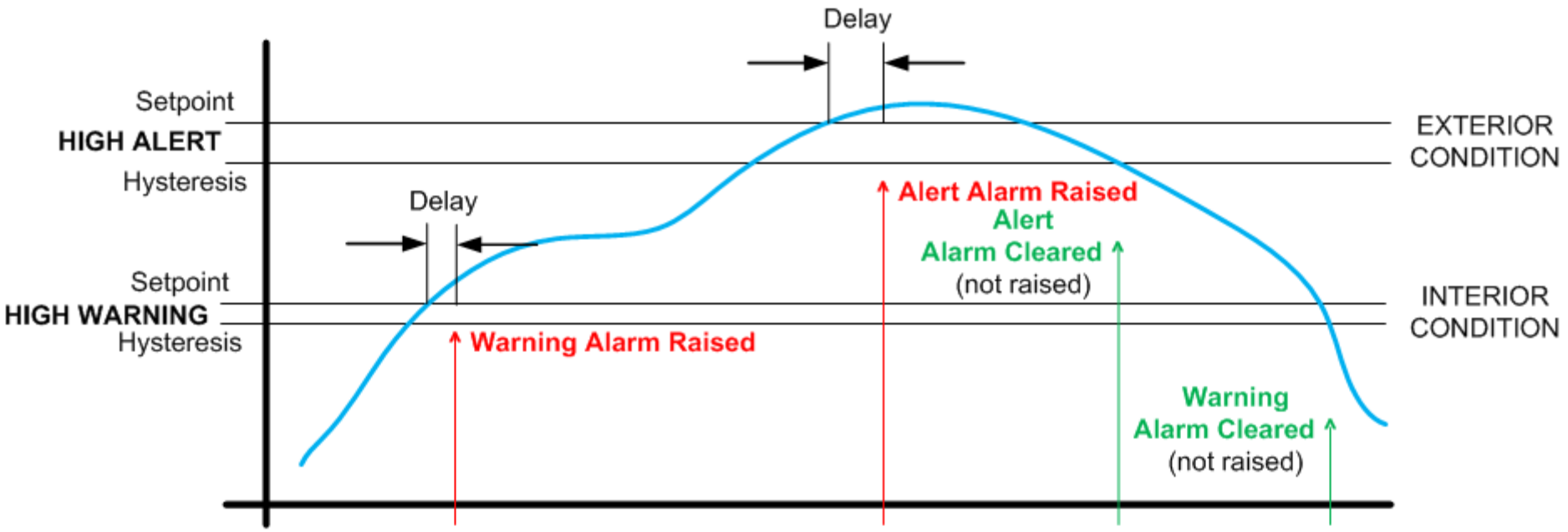
- A group of alarms is created for a “measurement point” provided to PDQ Tracker
- A measurement point can be:
  - A measured phasor magnitude or angle
  - A calculated value, such as
    - the difference between a measured value and a value from the state estimator
    - The rate of change of a measured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

Simple Alarming



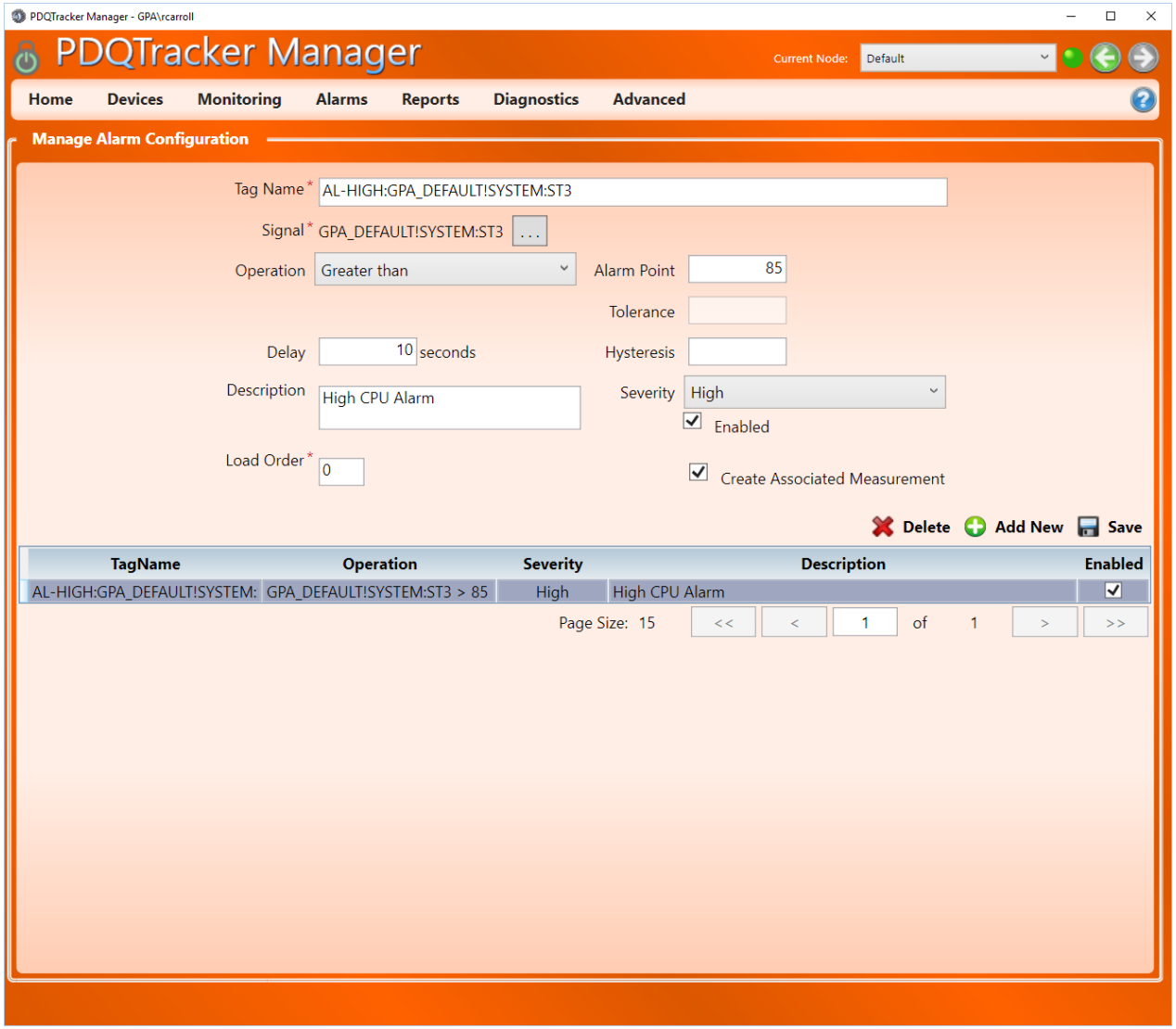
Alarm Set Point and Delay

More Complex Alarming Example



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

Configuring Alarming



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Version 1.0 Available

http://www.PDQTracker.com/

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phasor data open ECA platform

New Tool for Analytic Development Including Data Quality Analyses

DOE FOA 970
DE-OE-778

Architectural Elements

- Data Conditioning / Alarming (*Quality Check!*)
- Data Distribution Service
- Common Analytics Interface (CAI)
- Electric System Model
- Shared Platform Services
- Analytics