Online Dissolved Gas Analysis (DGA) Monitoring System

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ET Ops Engineering-Engineering Analytics & Modeling

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2019 Summer Intern Project Team

➢ **Team members**

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Motivations

➤ Transformer failures cause asset damage, customer outages, and safety concerns

➤ Electric Transmission has a sophisticated monitoring process for transformers

➤ Our DGA Monitoring system and process is continually enhanced to provide further insight into transformer health and help with operational decisions

(a)

(b)

A failed transformer

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Primary Analysis

➤ **Key Gas method:** primary monitoring analysis

➤ **Gas Types:** C_2H_2, C_2H_4 and H_2

➤ **Thresholds:** Equipment Monitoring group derived from IEEE C57.104

Dominion Energy DGA concentration limits

Gases	Level 1 (PPM)	Level 2 (PPM)	Level 3 (PPM)
C_2H_2	3.33	6.66	10
C_2H_4	66.6	133.33	200
H_2	333.3	666.6	1000

Dominion Energy DGA concentration trend limits

Gases	Level 1 (PPM/day)	Level 2 (PPM/day)	Level 3 (PPM/day)
C_2H_2	1.66	3.33	5
C_2H_4	3.33	6.66	10
H_2	8.33	16.66	25

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Secondary Analysis

➤ **Roger ratio method:**

❖ $Ratio\ 1\ (R1) = CH_4/H_2$

❖ $Ratio\ 2\ (R2) = C_2H_2/C_2H_4$

❖ $Ratio\ 3\ (R3) = C_2H_2/CH_4$

❖ $Ratio\ 4\ (R4) = C_2H_6/C_2H_2$

❖ $Ratio\ 5\ (R5) = C_2H_4/C_2H_5$
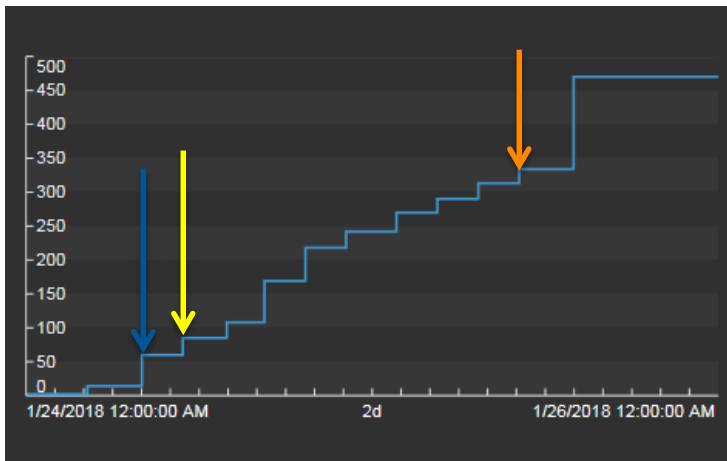
➤ **Total Dissolved Combustible Gas (TDCG) method**:

❖ $TDCGV = H_2 + CH_4 + C_2H_6 + C_2H_4 + C_2H_2 + CO$

Acetylene

C_2H_2

Case study

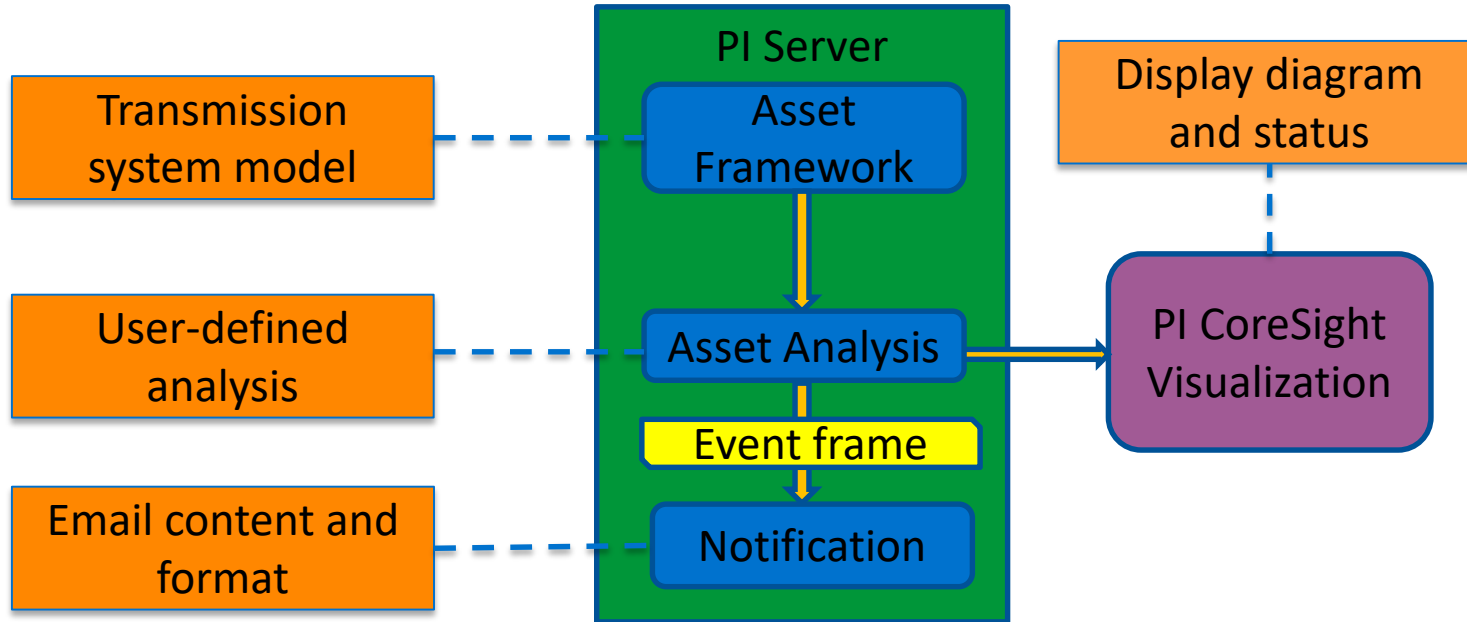- ➢ **Event:** a transformer failure
- ➢ **Time:** 1/25/2018

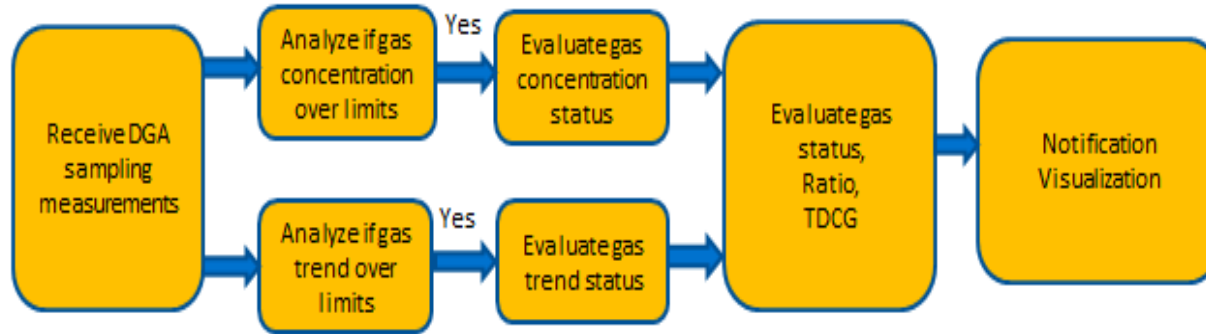

TX-1C H2 concentration level during a transformer failure

Transformer failure summary

Time	H2 concentration (PPM)	H2 Trend (PPM/day)	Time before failure
1/24 00:00	2	0	≈ 37 hours
1/24 08:02	60	16	≈ 29 hours
1/24 10:55	85	31	≈ 26 hours
1/25 10:14	334	228	≈ 3 hours
1/25 13:06	470	267	0

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Methodology

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Flow chart

Flow chart of the DGA analysis process

DGA severity of fault based on IEEE C57.104 standard

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Implementation of Online DGA Monitoring
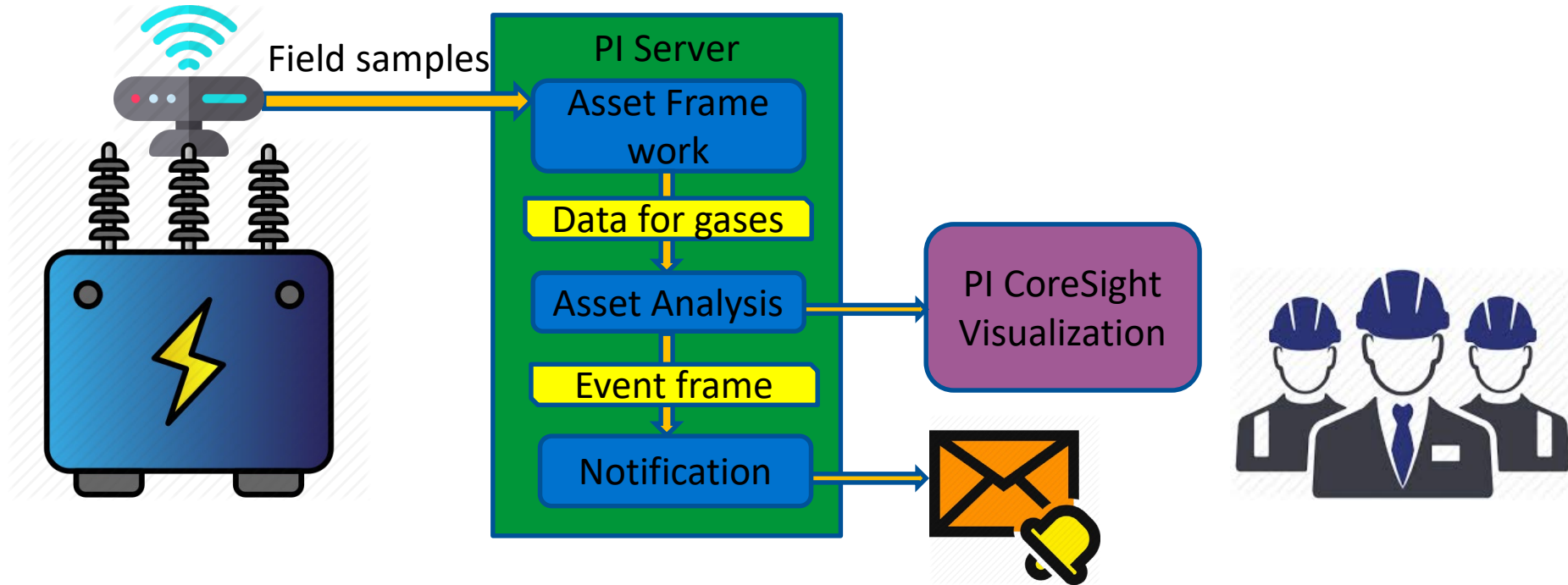
Field samples

PI Server

Asset Frame work

Data for gases

Asset Analysis

Event frame

Notification

PI CoreSight Visualization

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Notification

Event: C2H4 level 3 Analysis 2019-06-28 16:43:10.000
Name: C2H4 Level 3 notification
Server: VDCDWETPI2003
Database: TXDGA_ANALYSIS_Xianda
Start Time: 6/28/2019 4:43:10 PM Eastern Daylight Time (GMT-04:00:00)
Target: T AND D Core Branch\Northwest\Leesburg\LOUDOUN\Transformer Bank\LOU
Severity: {Alarm}
Send Time: 7/12/2019 8:25:43 PM Eastern Daylight Time (GMT-04:00:00)
Gas Concentration and Concentration Trend
C2H2 Concentration : 1.96
C2H2 Concentration Trend : 1.96
C2H4 Concentration : 68
C2H4 Concentration Trend : 68
H2 Concentration : -48.9
H2 Concentration Trend : -48.9

Ratio analysis
Ratio 1 CH4/H2 Analysis_R1 : 3.2573
Ratio 2 C2H2/C2H4 Analysis_R2 : 0.45122
Ratio 3 C2H2/CH4 Analysis_R3 : 0.56149
Ratio 4 C2H6/C2H2 Analysis_R4 : 1.6454
Ratio 5 C2H4/C2H6 Analysis_R5 : 1.3469
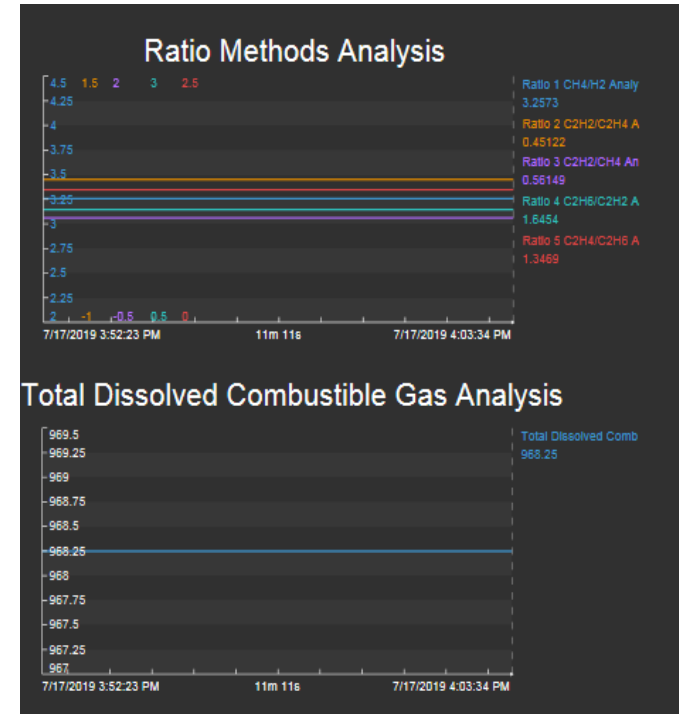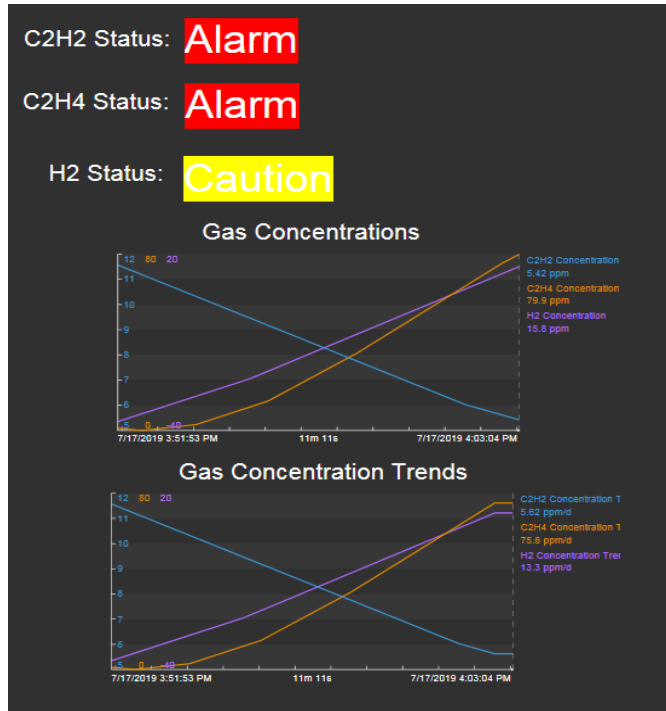
Total Dissolved Combustible Gas Analysis
Total Dissolved Combustible Gas Analysis_Output : 968.25

Visualization URL:
{http://vdcdwetpi1002/coresight/#/Displays/267/DGA-test?Asset=\\VDCl
5CPLEASANT%20VIEW%5CTransformer%20Bank%5CPLEASANT%

An email notification sample generated from a simulated test event

Visualization

PI Coresight display for a simulated test event

Conclusion

➢ **Online DGA analysis and thresholds are proposed**

➢ **Online DGA Monitoring System is implemented**

➢ **The system is validated with a transformer failure case**

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Thank you!

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