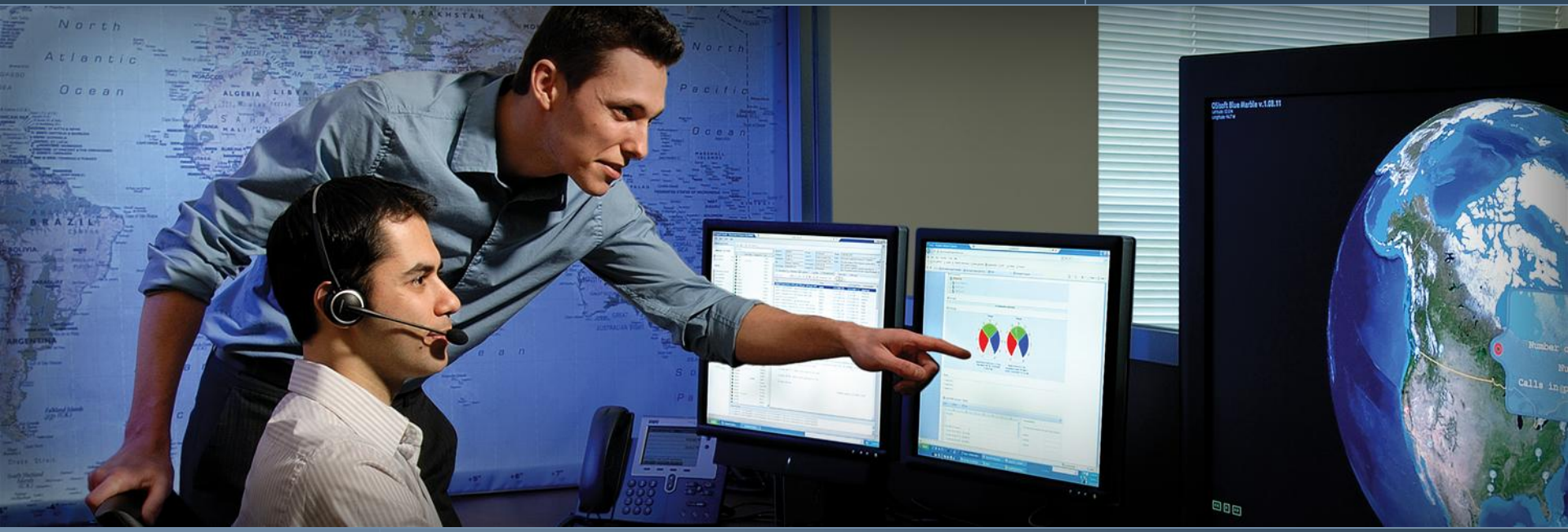
Regional Seminar Series
Aberdeen, UK



AF Applications - Customer Examples

Dave Smith
Account Manager
OSIsoft UK Ltd

Sept 28, 2010

Empowering Business in Real Time.

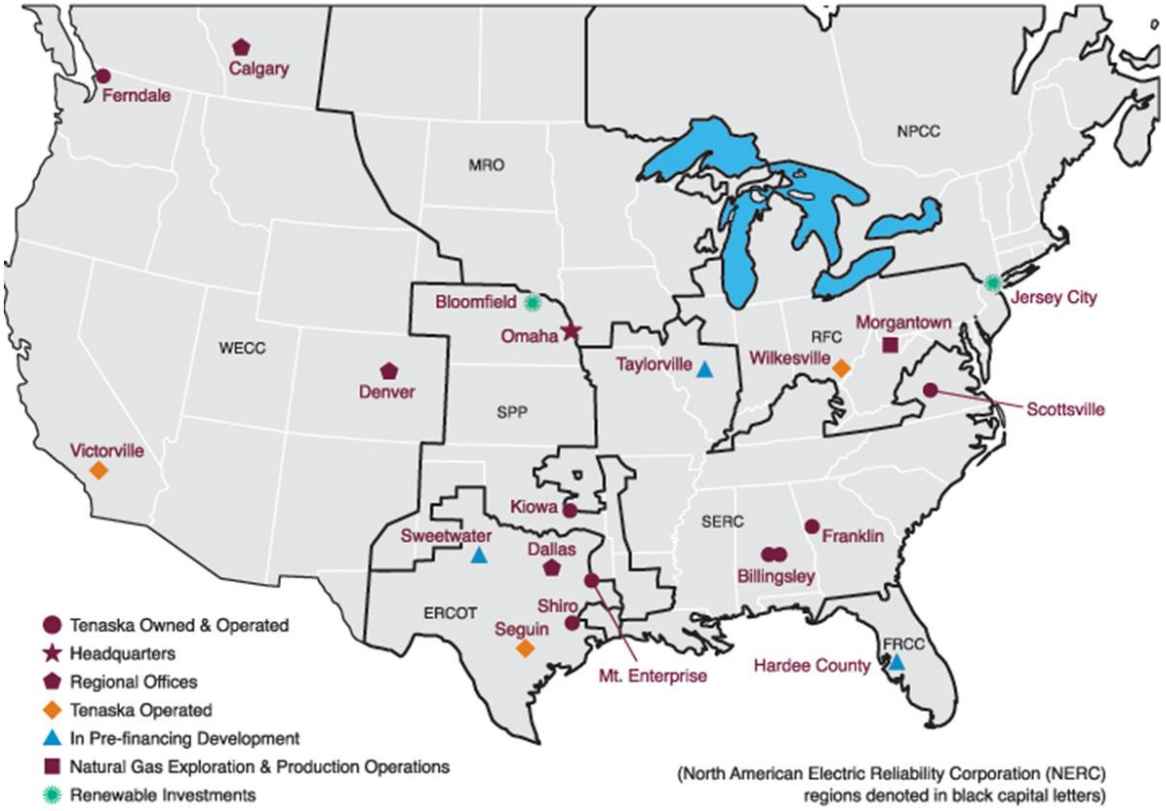
TENASKA

About Tenaska

- Develops, constructs, owns & operates electric generating plants. Has developed 9,000 MW in 15 domestic and international projects
  - Markets natural gas, electric power and biofuels
  - Manages private equity funds totaling nearly $5 billion
- Headquartered in Omaha, Nebraska
- 2009 revenues of approximately $8 billion
- Employee owned
- Forbes #16 – 2009 Privately Held Companies

TENASKA

About Tenaska



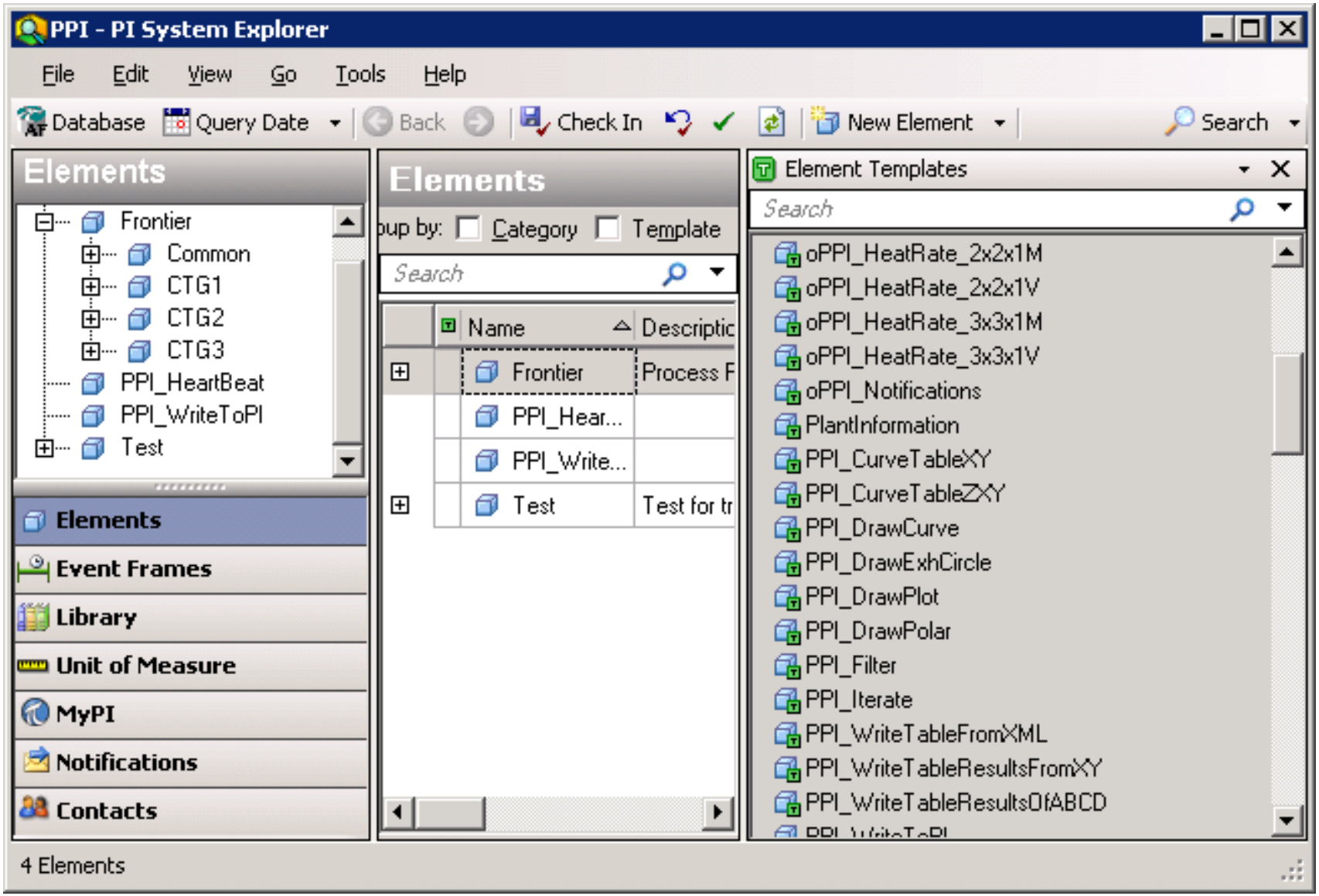
Need to Monitor the Condition and Performance of Turbines

- Turbine reliability and performance is critical to the bottom line.
- There is a wide array of offerings in the market for monitoring and performance but all are third party software.
- Tenaska has a solid foundation of OSIsoft technology in place at all of our plants and needs a solution in PI.

Need to Monitor the Condition and Performance of Turbines

- We wanted a proprietary configuration for our gas turbines and other packages were too restrictive to allow this flexibility and the calculations occurred in a “Black Box” and we wanted to know what was being calculated and how.

AF Provides Logical Layout



PI ProcessBook - [PFE_CTG.pdi*]

Base Load

Frontier Combustion Turbine Generator 1

3/9/2010 3:51:58 PM 67 °F

AIR INLET

Compressor Inlet T	66 °F	67 °F	67 °F	66 °F
Compressor Inlet dP				4 inH2O
Barometric Pressure			14 psi	29 inHg
Wet Bulb T				66 °F

COMPRESSOR

Isentropic Efficiency	%
Polytropic Efficiency	%
Air Flow	No Data
Compressor Outlet Temp	738 °F

GENERATOR

Corrected Gross Output	136,165 kW
Generator Output:	148,424 kW
Power Factor	0.97
Design	164,200 kW

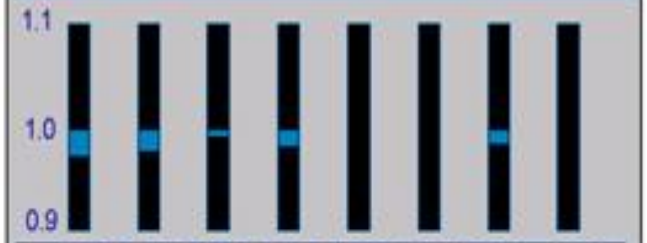
HEAT RATE

	Corrected	Measured
LHV Heat Rate:	Btu/kWh	11,122 Btu/kWh
HHV Heat Rate:	Btu/kWh	10,018 Btu/kWh

COMBUSTION

Firing Temp	2,318 °F
Inlet Guide Vane	72 °
Base Load	0.97

OUTPUT CORRECTIONS



EXHAUST

Exhaust Temperature:
Measured 1,152 °F
Corrected 1,156 °F

Exhaust Flow:
Measured 751 lb/s
Corrected 728 lb/s

NOTIFICATION SUMMARY

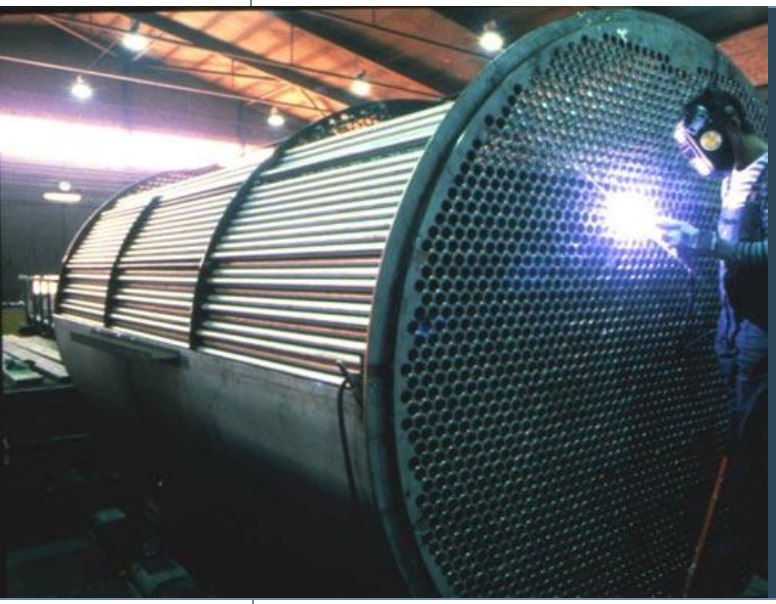
16-MAR-2010 14:22 FR CTGX LOW CORRECTED OUTPUT DETECTED
16-MAR-2010 14:21 FR CTGX BP CORRECTION OUT OF RANGE - CHECK CAL

Design Considerations

- Fleet wide deployment needs to be scalable and repeatable
- AF gives us the perfect platform.
- Copy and paste for all similar turbines
- Site level deployment can also copy and paste

FUTURE PLANS / NEXT STEPS

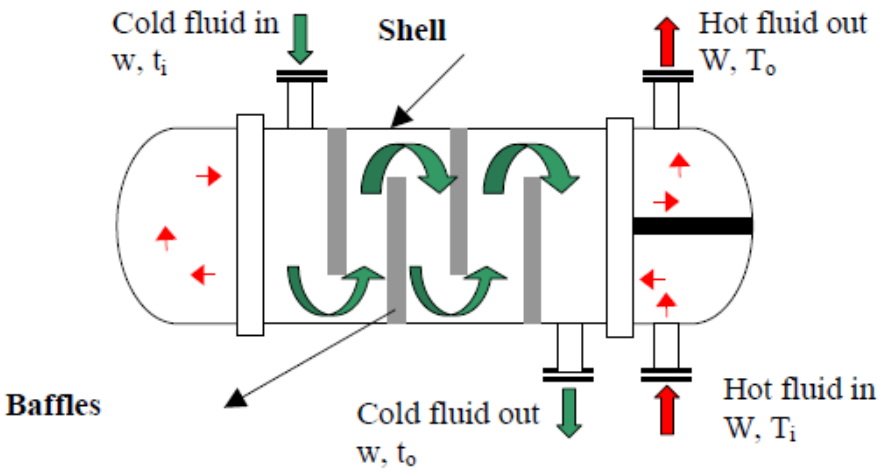
- We are in the early stages of development of the project. We Started Feb. 23rd and had one plant configured by March 15th. We are in the data validation phase for this plant.
- Continue our fleet deployment of the monitoring and performance tools.
- Build additional reporting and visualization
- Add other equipment monitoring beyond our turbines



Examples for Leveraging the Value of PI in Operations & Maintenance

- Heat Exchanger Performance Monitoring

Example: Heat Exchanger Performance Monitoring
CALCULATION ALGORITHM



Heat Exchanger Key Performance Indicator:

Overall heat transfer coefficient

$$U = \frac{Q}{A \times \text{Corrected LMTD}}$$

RULE: *IF the heat transfer coefficient is decreasing, THEN the* ***Heat Exchanger FOULING*** *!!! Cleaining is required!*

Calculation Steps:

1. Heat Duty, $Q = q_s + q_l$
   $q_s = W \times C_{ph} \times (T_i - T_o)/1000/3600$
   $q_s = w \times C_{pc} \times (t_o - t_i)/1000/3600$
2. Hot Fluid Pressure Drop, $\Delta P_h = P_i - P_o$
3. Cold fluid pressure drop, $\Delta P_c = p_i - p_o$
4. Temperature range hot fluid, $\Delta T = T_i - T_o$
5. Temperature range cold fluid, $\Delta t = t_o - t_i$
6. Capacity ratio, $R = W \times C_{Ph} / w \times C_{pc}$ (or) $(T_i - T_o) / (t_o - t_i)$
7. Effectiveness, $S = (t_o - t_i) / (T_i - t_i)$
8. LMTD

   LMTD Counter current Flow $= ((T_i - t_o) - (T_o - t_i)) / \ln ((T_i - t_o)/(T_o - t_i))$
   LMTD Co current Flow $= ((T_i - t_i) - (T_o - t_o)) / \ln ((T_i - t_i)/(T_o - t_o))$
   Correction factor for LMTD to account for Cross flow

$$F = \frac{(R+1)^{1/2} \times \ln ((1 - SR)/(1 - S))}{(1 - R) \times \ln \left\{ \frac{2 - S(R + 1 - (R+1)^{1/2})}{2 - S(R + 1 + (R+1)^{1/2})} \right\}}$$

9. Corrected LMTD $= F \times$ LMTD

Example: Heat Exchanger Performance Monitoring
INFORMATION FLOW

OSIsoft.

CONNECT *Data Sources* → **COLLECT & ARCHIVE** *Heat Exchanger Data* → **CALCULATE** *Performance* → **VISUALIZE & NOTIFY** *The Right People* → **CORRECTIVE ACTION**

Control System
- DCS
- PLC
- SCADA

Real-time data:

Parameters	Units
Hot fluid flow,W	kg/h
Cold fluid flow,w	kg/h
Hot fluid Temp, T	^{o}C
Cold fluid Temp,t	^{o}C
Hot fluid Pressure,P	bar g
Cold fluid Pressure, p	bar g

Lab System
- LIMS

Offline data:

Parameters	Units
Hot fluid density, ρ_h	kg/m^3
Cold fluid density, ρ_c	kg/m^3
Hot fluid Viscosity, μ_h	MpaS*
Cold fluid Viscosity, μ_c	MPaS
Hot fluid Thermal Conductivity, k_h	kW/(m. K)
Cold fluid Thermal Conductivity, k_c	kW/(m. K)
Hot fluid specific heat Capacity, C_{ph}	kJ/(kg. K)
Cold fluid specific heat Capacity, C_{pc}	kJ/(kg. K)

Databases
- HANDBOOK
- ASSAY DB
- SIMULATION
- PROPERTIES DB

CALCULATION ALGORITHM

Heat Transfer Coefficient; (U = Q / A x LMTD)

RULE

IF „U" IS BELOW A CERTAIN LIMIT, THEN HEAT EXCHANGER FOULING

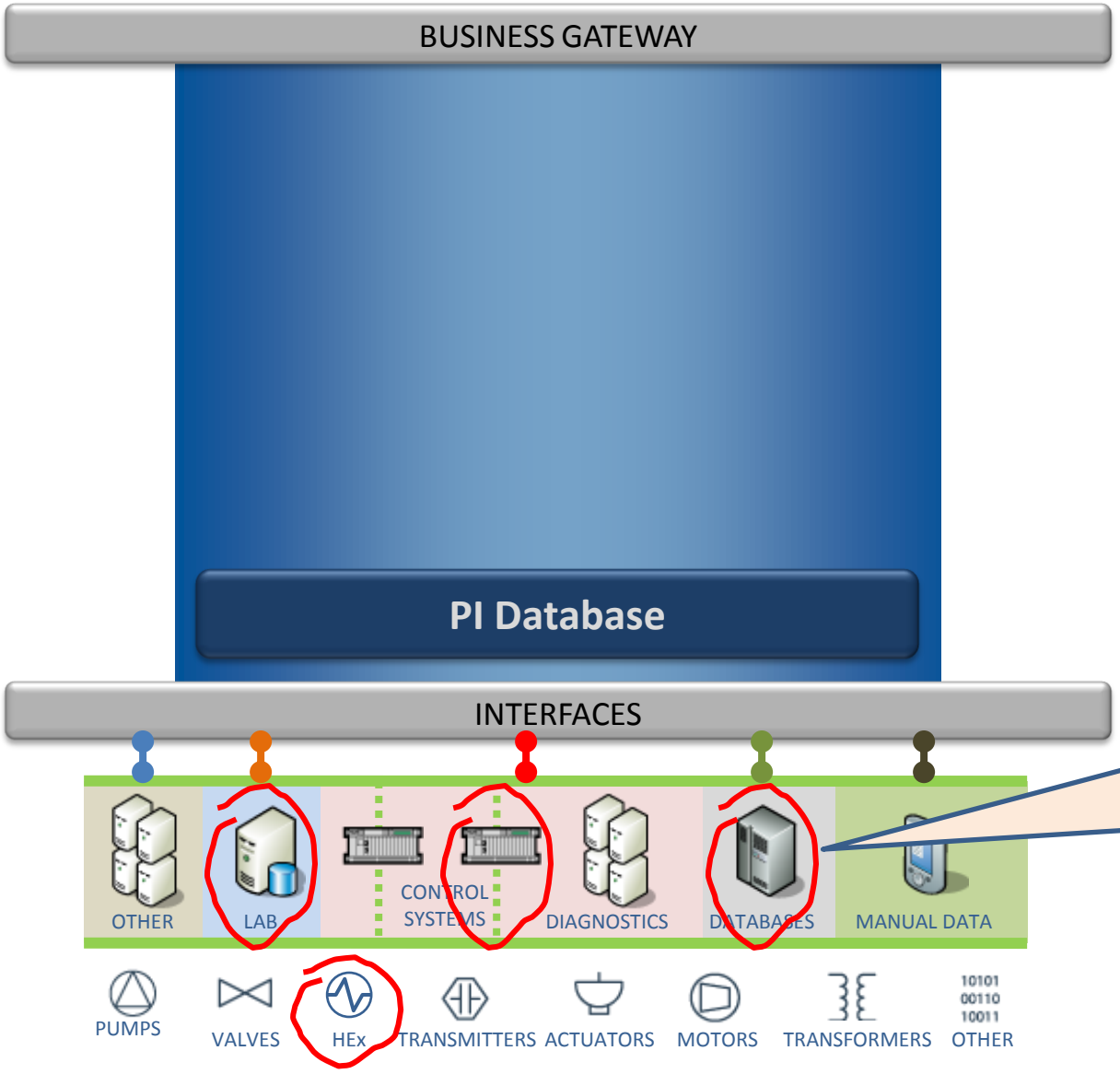
- Maintenance task prioritization
- Heat Exchanger Cleaning
- Changing Operating Mode
- Re-planning / re-scheduling

Requirements:

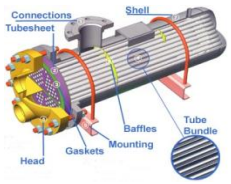
- Connect all relevant data sources
- Collect & Archive Data
- Put the Data into Context
- Asset Centric Information
- Rigorous Calculation Capabilities
- Archive results
- Trending capabilities
- Visualisation capabilities
- Implementing rules
- Notify O&M Personnel

Example: Heat Exchanger Performance Monitoring
STEP 1: CONNECT RELEVANT DATA SOURCES

CONNECT
Data Sources



Heat Exchanger **Data appears in different systems** (data sources):
- Control System *(T, p, W)*
- LIMS *(density, viscosity)*
- Databases *(thermal conductivity, heat capacity)*



HEx101

Example: Heat Exchanger Performance Monitoring
STEP 2: COLLECT AND ARCIVE EQUIPMENT DATA (Tag-based)

OSIsoft.

COLLECT & ARCHIVE
Heat Exchanger Data

BUSINESS GATEWAY

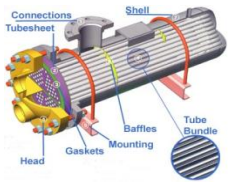
PI Database

INTERFACES

OTHER | LAB | CONTROL SYSTEMS | DIAGNOSTICS | DATABASES | MANUAL DATA

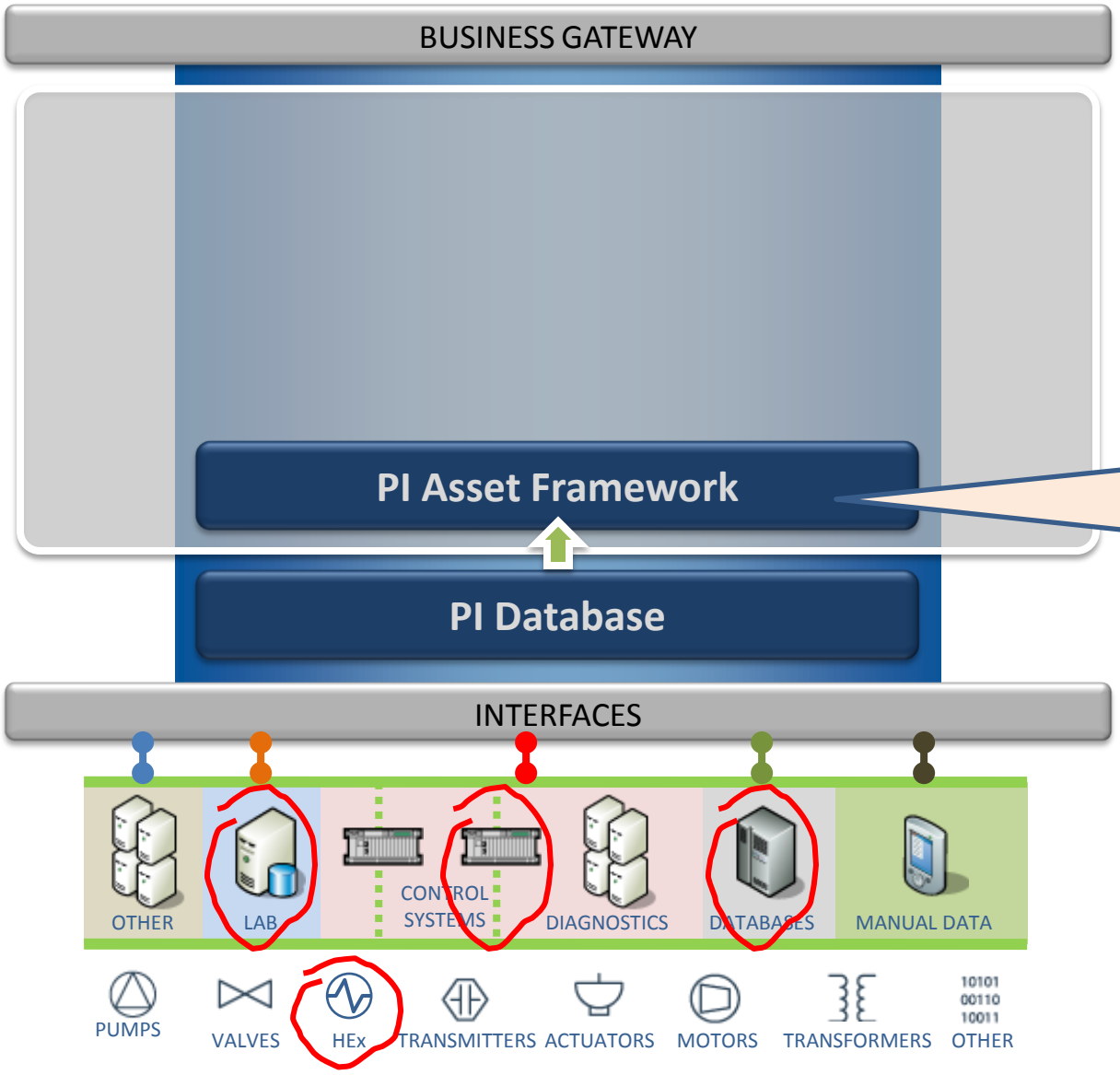
PUMPS | VALVES | HEx | TRANSMITTERS | ACTUATORS | MOTORS | TRANSFORMERS | OTHER

Heat Exchanger Data **is collected and archived** in PI Database *(TAGS)*



HEx101

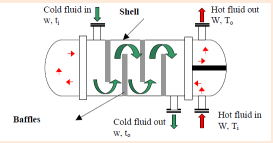
Example: Heat Exchanger Performance Monitoring
STEP 3: ASSIGN CONTEXT (Asset-based)

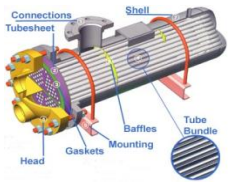


COLLECT & ARCHIVE
Heat Exchanger Data

Data is assigned to an individual equipment (heat exchanger 101):
• Asset-centric representation of data

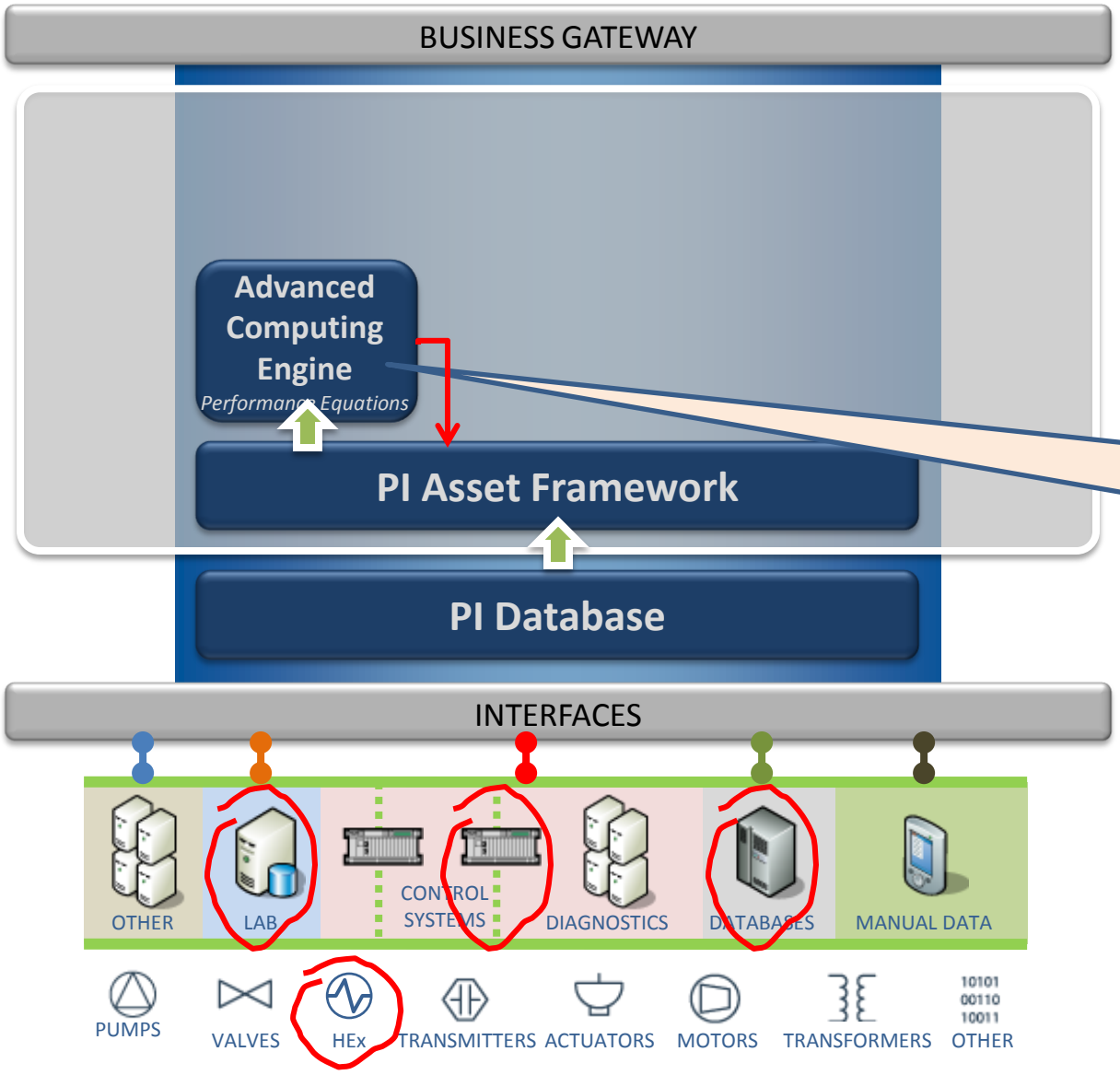
HEx101





HEx101

Example: Heat Exchanger Performance Monitoring
STEP 4: CALCULATE PERFORMANCE MEASURES

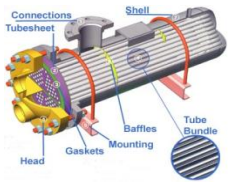


CALCULATE
Performance

Heat Exchanger **Performance is Calculated** in real-time:

$$U_{101} = Q_{101} / A_{101} \times LMTD_{101}$$

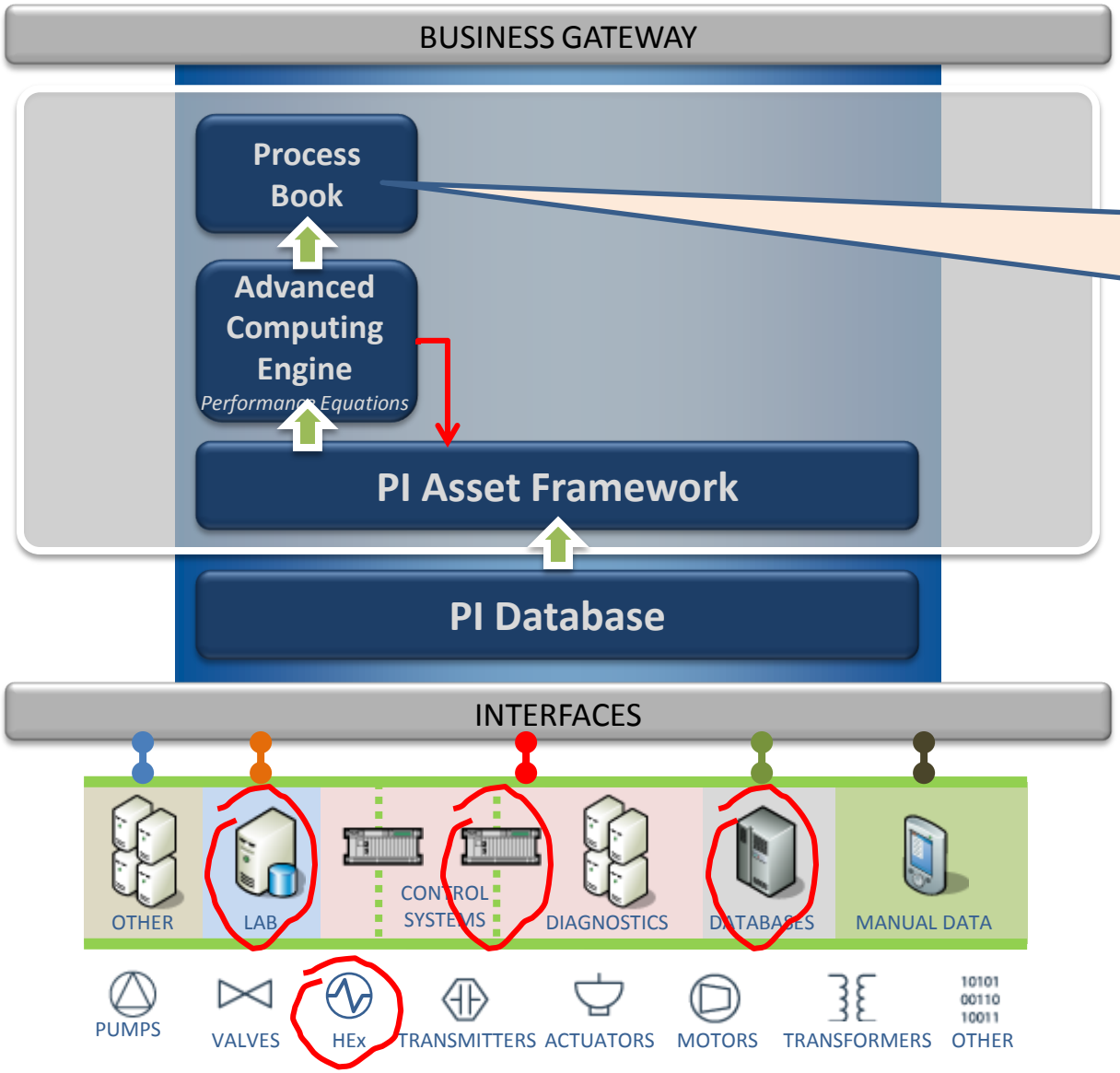
- **Archive** the result (U)



HEx101

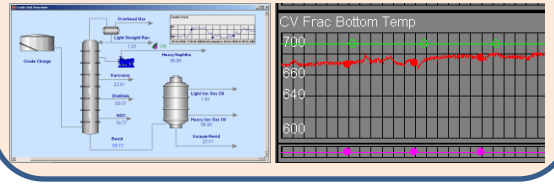
Example: Heat Exchanger Performance Monitoring
STEP 5: VISUALIZE EQUIPMENT PERFORMANCE REAL-TIME

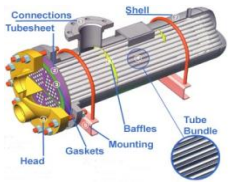
OSIsoft.



VISUALIZE & NOTIFY
The Right People

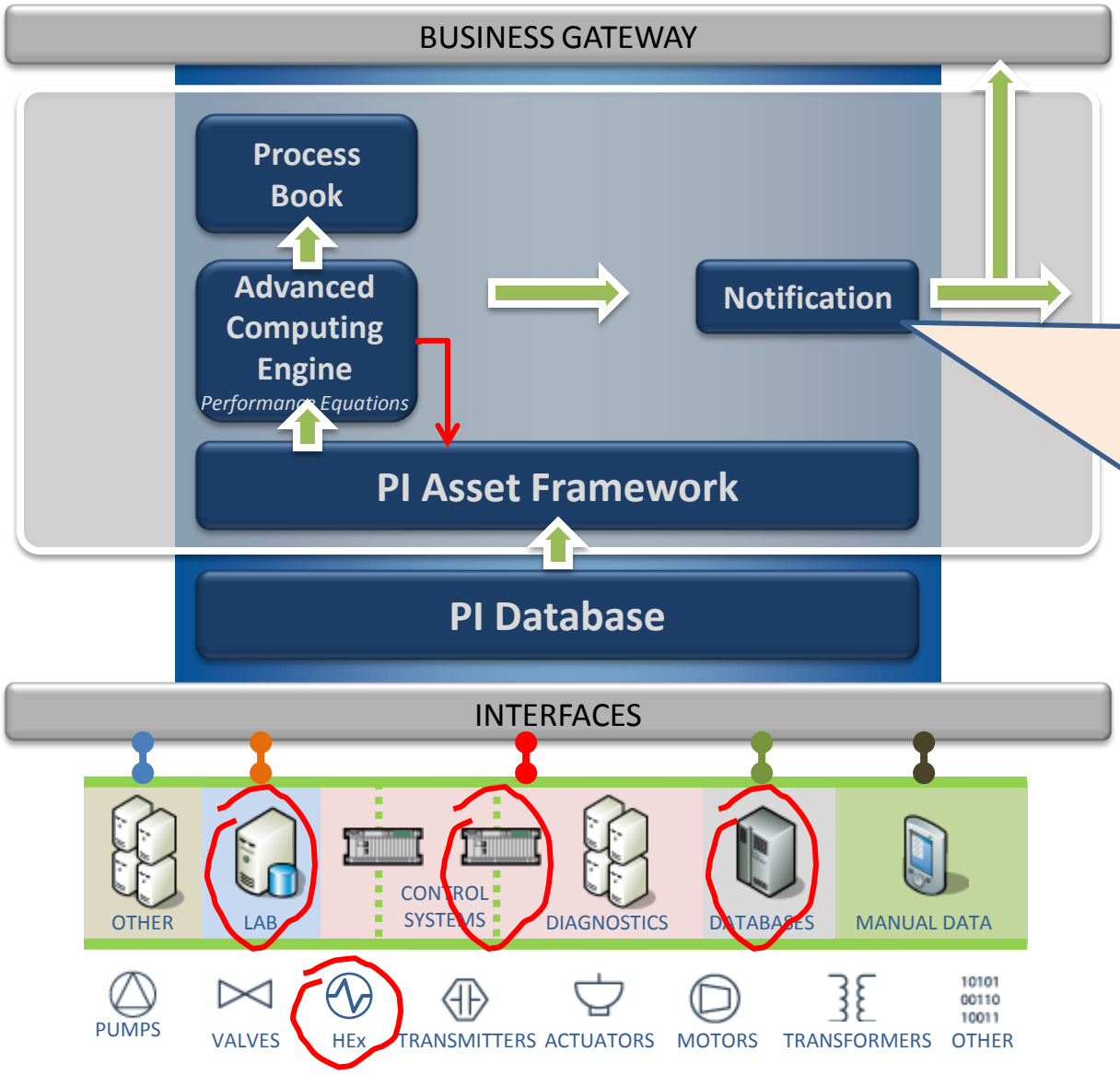
Trend and Visualize heat exchanger data:





HEx101

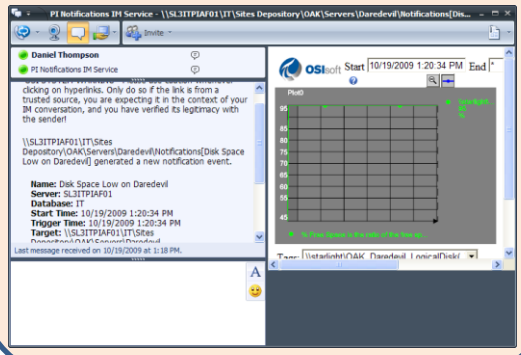
Example: Heat Exchanger Performance Monitoring
STEP 6: NOTIFY THE RIGHT PEOPLE AT THE RIGHT TIME

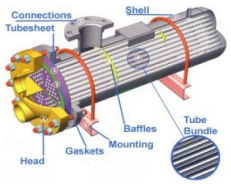


VISUALIZE & NOTIFY
The Right People

Notification is sent to shift operators and maintenance personnel, that:
HEAT EXCHANGER 101 IS FOULING

Maintenance Notification is sent to CMMS (SAP PM)

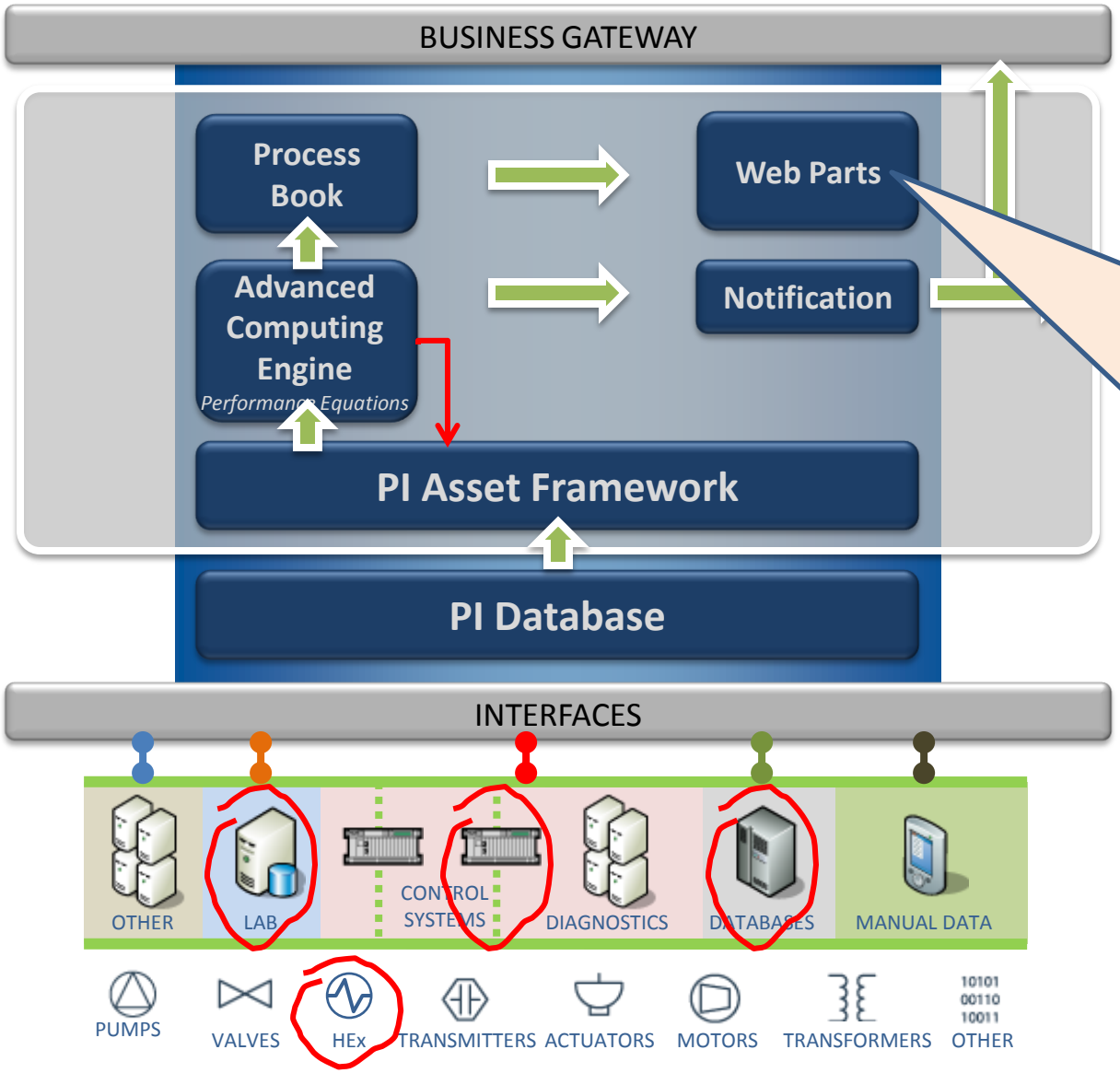




HEx101

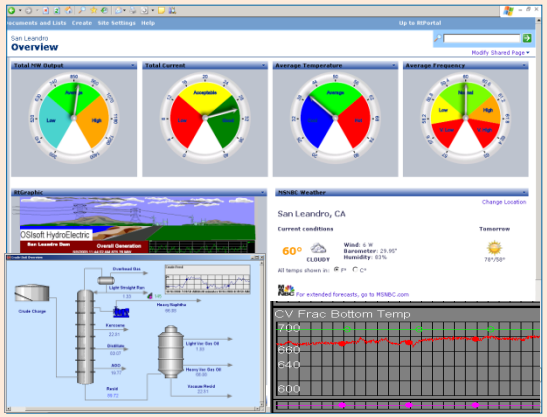
Example: Heat Exchanger Performance Monitoring
STEP 7: VISUALIZE OVERALL PERFORMANCE REAL-TIME

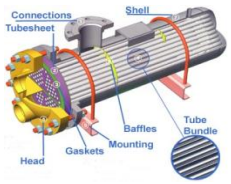
OSIsoft.



VISUALIZE & NOTIFY
The Right People

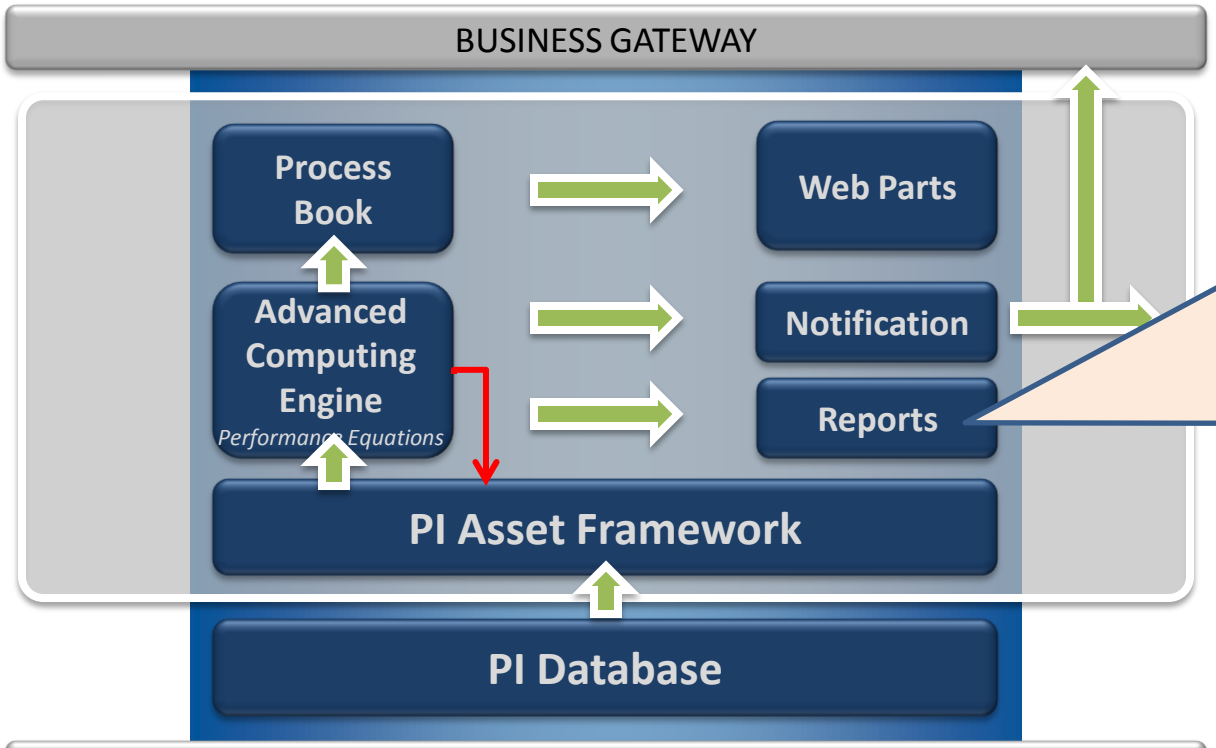
Visualize equipment, unit, plant, area **KPIs on Corporate Dashboard**

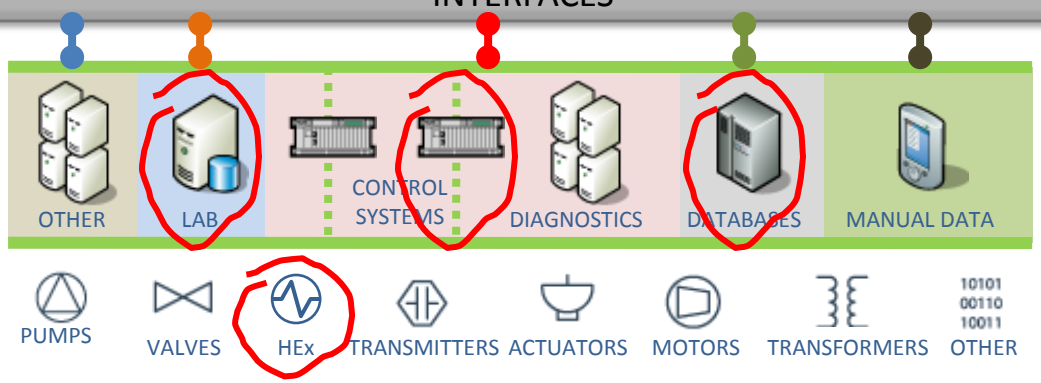




HEx101

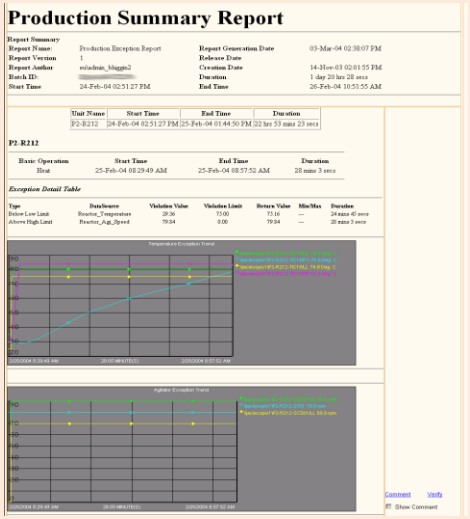
Example: Heat Exchanger Performance Monitoring
STEP 8: REPORT ANOMALIES IN THE RIGHT FORMAT

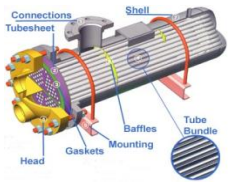




VISUALIZE & NOTIFY
The Right People

Send report



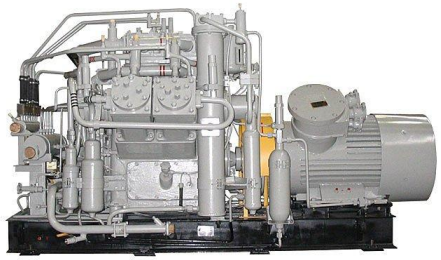


HEx101

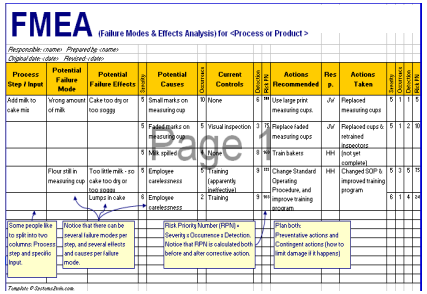
Examples for Leveraging the Value of PI in Operations & Maintenance

- Compressor Condition Based Monitoring

Example: Operations & Maintenance
Compressor Condition Based Monitoring - Bearing Failure



FMEA
Failure Mode & Effect Analysis



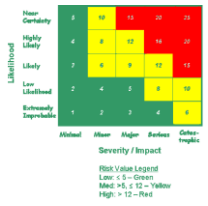
Fault Tree

Symptom		*Failure*
V_B	Vibration	
T_B	Temperature	F_B
Q_{LO}	Lube Oil Quality	

Risk Based Assessment

Business Criticality Analysis

Prioritization Matrix
(Risk-based)



CMMS
SAP PM
Maximo

RULE:
*IF 2 out of 3 is under limit, THEN the **BEARING FAILURE** is predicted on the Compressor!!! Send Maintenance Notification!*

RULE:
What is the PRIORITY of the Failure?

ACTION:
Work Order is generated!

Example: Compressor Condition Based Monitoring
INFORMATION FLOW

OSIsoft.

CONNECT *Data Sources* → **COLLECT & ARCHIVE** *Compressor Data* → **CALCULATE** *Performance* → **VISUALIZE & NOTIFY** *The Right People* → **CORRECTIVE ACTION**

Real-time data:

Control System
DCS
PLC
SCADA

Compressor Bearing Temperature, T_B

Diagnostic Systems
VIBRATION MONITORING SYSTEM

Compressor Bearing Vibration, V_B

Offline data:

Lab System
LIMS

Lube Oil Quality, Q_{LO}

Databases
FMEA
RBA
BCA

Fault Tree
Failure Critivality
Failure Priority

LOGIC
IF 2 out of 3 are below limit, THEN COMPRESSOR BEARING FAILURE

RULE
IF F_B is ON, THEN Send a MAINTENANCE NOTIFICATION

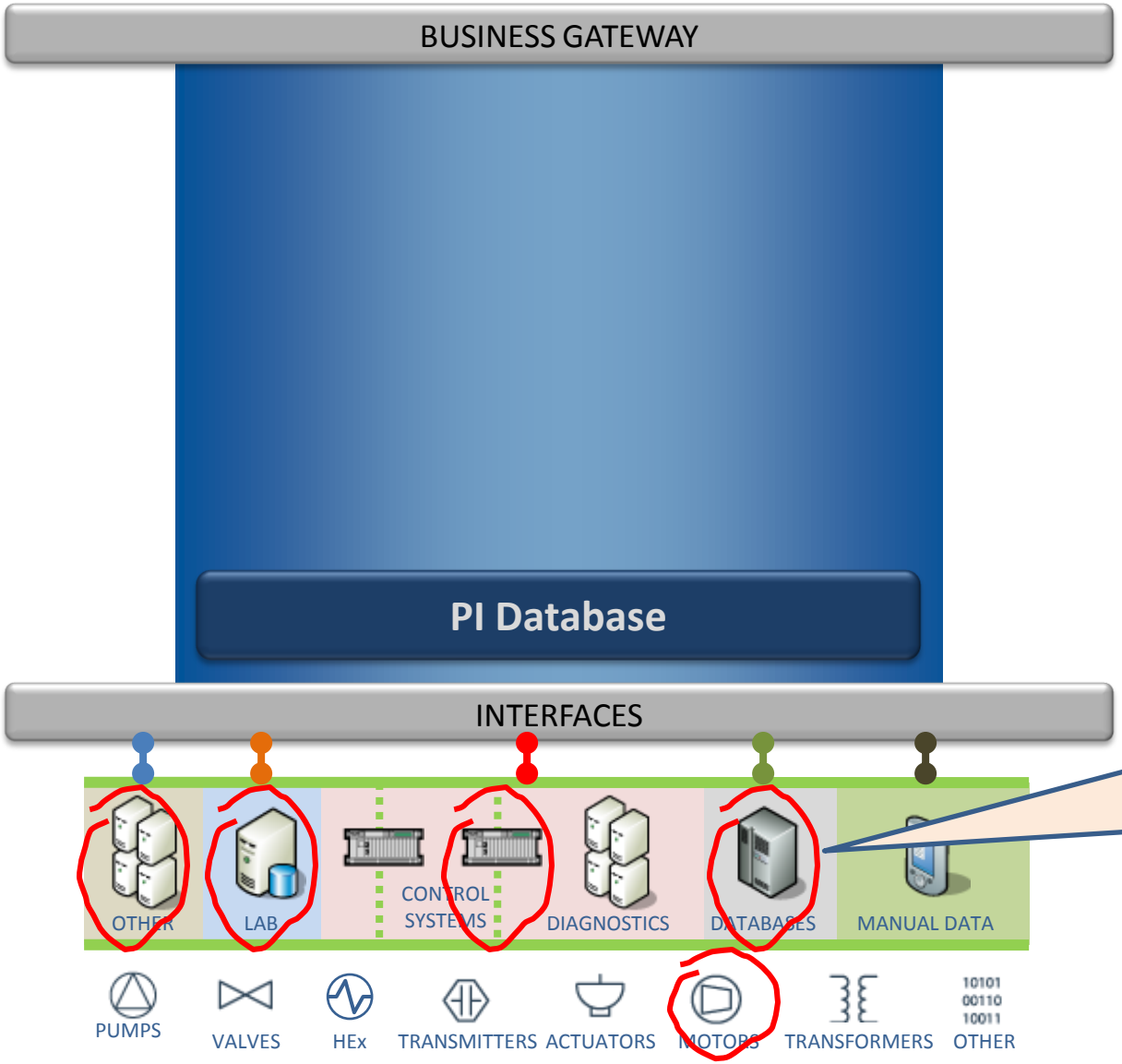
- Risk-based Maintenance Prioritization
- Send Work Order
- Use spare Compressor
- Re-planning / re-scheduling

Requirements:

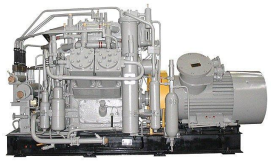
- Connect all relevant data sources
- Collect & Archive Data
- Put the Data into Context
- Asset Centric Information
- Rigorous Calculation Capabilities
- Archive results
- Trending capabilities
- Visualisation capabilities
- Implementing rules
- Notify O&M Personnel

Example: Compressor Condition Based Monitoring
STEP 1: CONNECT RELEVANT DATA SOURCES

CONNECT
Data Sources



Compressor **Data appears in different systems** (data sources):
- Control System *(T)*
- Vibration Monitoring (V)
- LIMS *(Lube Oil Quality)*
- Databases



C-201

Example: Compressor Condition Based Monitoring
STEP 2: COLLECT AND ARCIVE EQUIPMENT DATA (Tag-based)

COLLECT & ARCHIVE
Heat Exchanger Data

BUSINESS GATEWAY

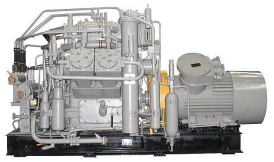
PI Database

INTERFACES

OTHER | LAB | CONTROL SYSTEMS | DIAGNOSTICS | DATABASES | MANUAL DATA

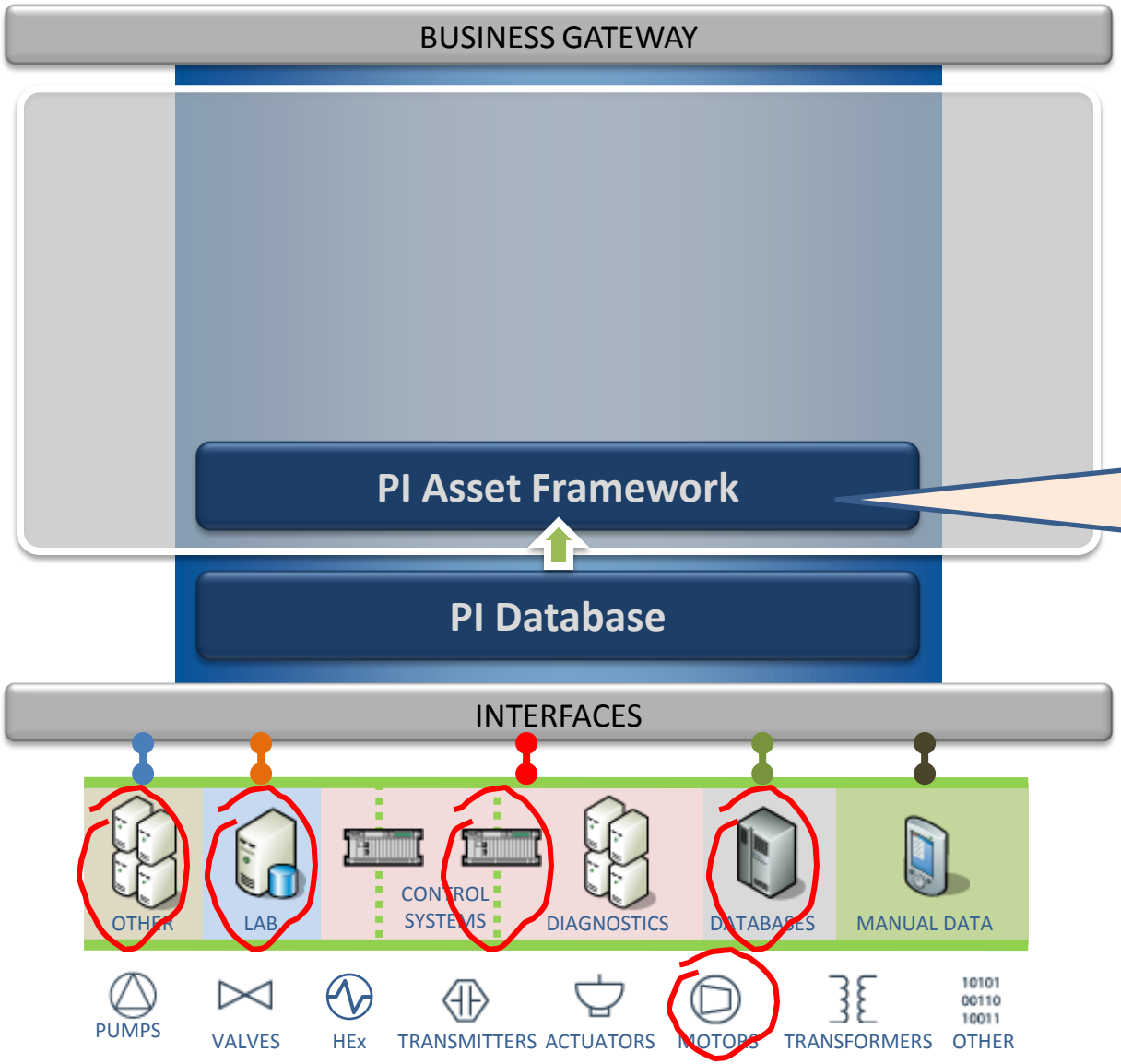
PUMPS | VALVES | HEx | TRANSMITTERS | ACTUATORS | MOTORS | TRANSFORMERS | OTHER

Compressor Data **is collected and archived** in PI Database *(TAGS)*



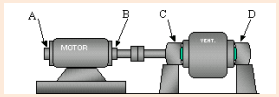
C-201

Example: Compressor Condition Based Monitoring
STEP 3: ASSIGN CONTEXT(Asset-based)

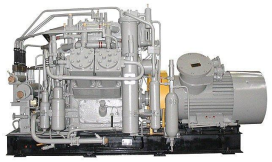


COLLECT & ARCHIVE
Heat Exchanger Data

Data is assigned to an individual equipment (Compressor 201):
- Asset-centric representation of data

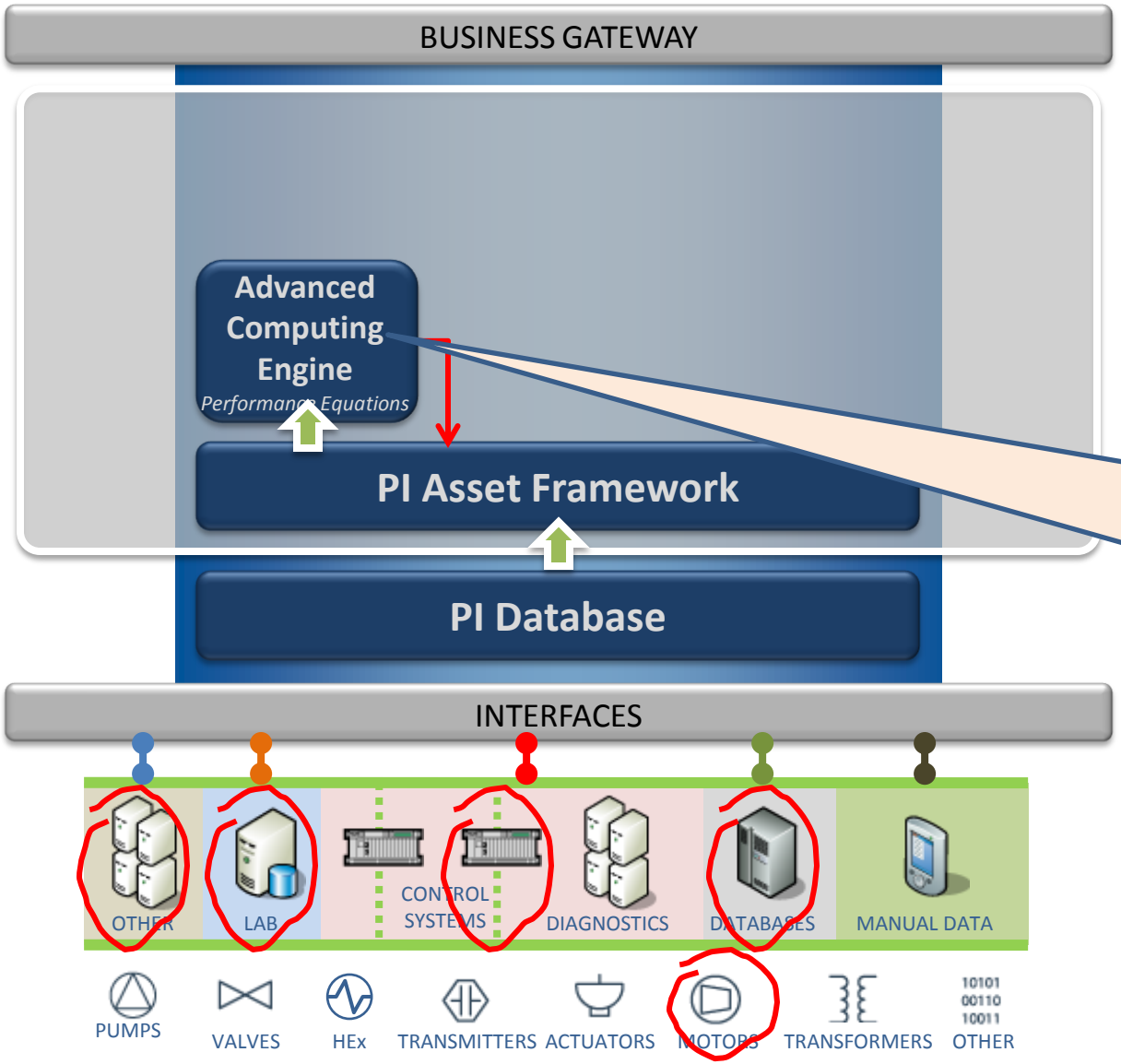


C-201



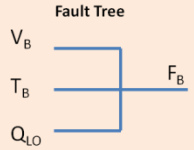
C-201

Example: Compressor Condition Based Monitoring
STEP 4: EXECUTE FAILURE PREDICTION LOGIC

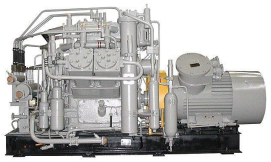


CALCULATE
Performance

Fault tree logic is implemented in Performance Equations



Failure is recorded in PI Database as Event (Abnormal Situation)



C-201

Example: Compressor Condition Based Monitoring
STEP 4: CALCULATE PERFORMANCE MEASURES

OSIsoft.

BUSINESS GATEWAY

Process Book

Advanced Computing Engine

Performance Equations

PI Asset Framework

PI Database

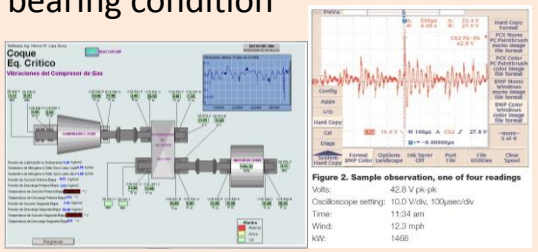
INTERFACES

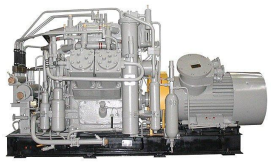
OTHER | LAB | CONTROL SYSTEMS | DIAGNOSTICS | DATABASES | MANUAL DATA

PUMPS | VALVES | HEx | TRANSMITTERS | ACTUATORS | MOTORS | TRANSFORMERS | OTHER

VISUALIZE & NOTIFY
The Right People

Trend and Visualize compressor bearing condition

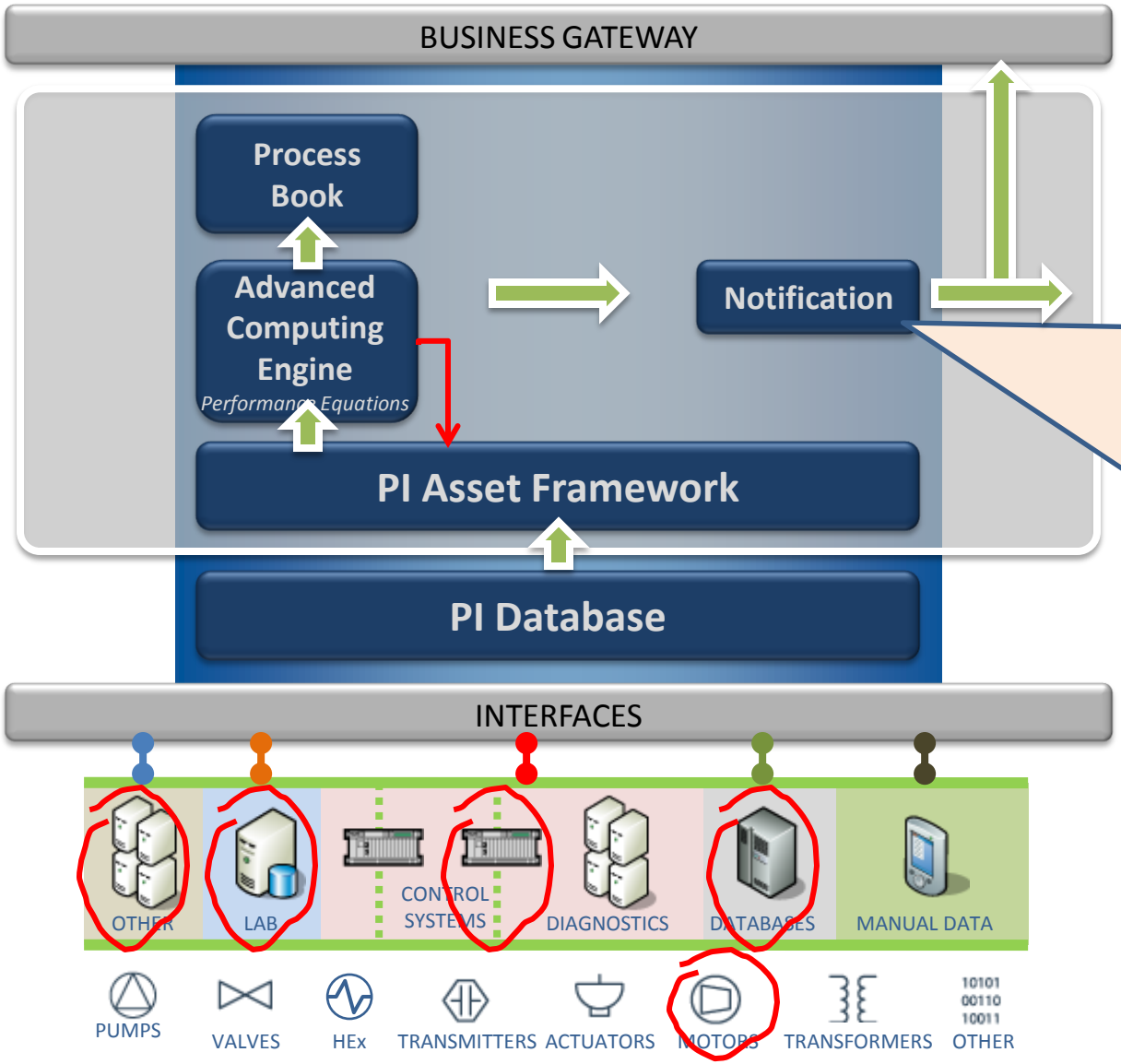




C-201

Example: Compressor Condition Based Monitoring
STEP 5: VISUALIZE EQUIPMENT CONDITION REAL-TIME

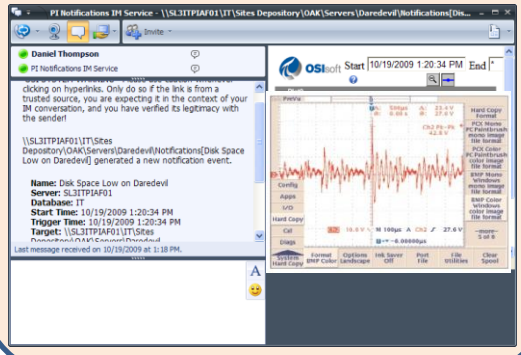
OSIsoft.

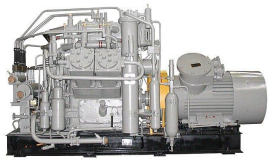


VISUALIZE & NOTIFY
The Right People

Notification is sent to shift operators and maintenance personnel, about:
COMPRESSOR BEARING FAILURE

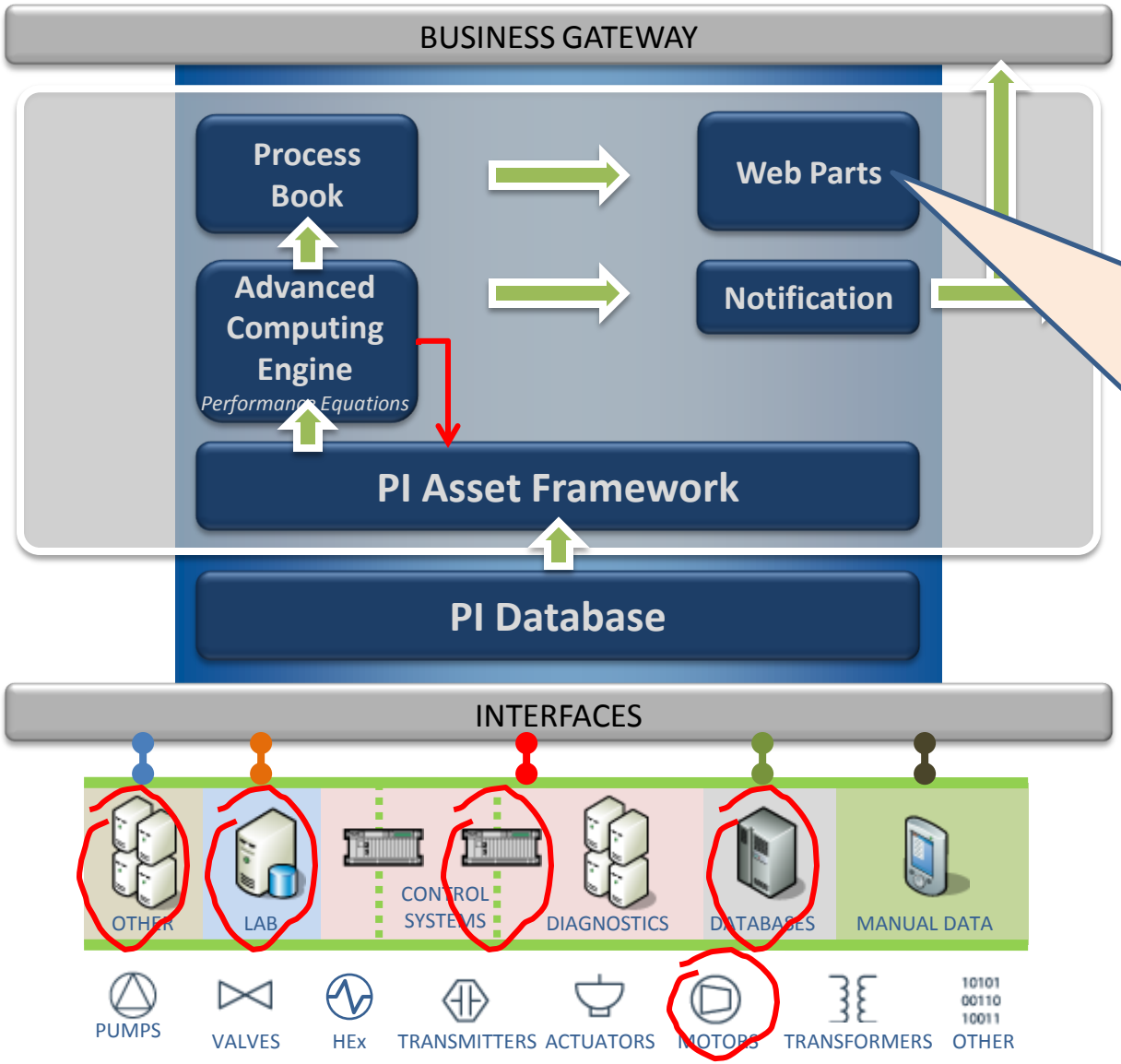
Maintenance Notification is sent to CMMS (SAP PM)





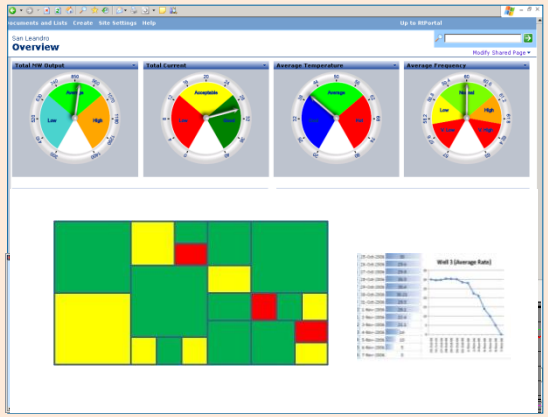
C-201

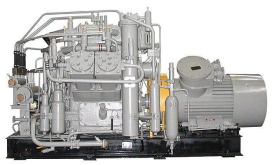
Example: Compressor Condition Based Monitoring
STEP 6: EVALUATE BUSINESS CRITICALITY AND RISK



VISUALIZE & NOTIFY
The Right People

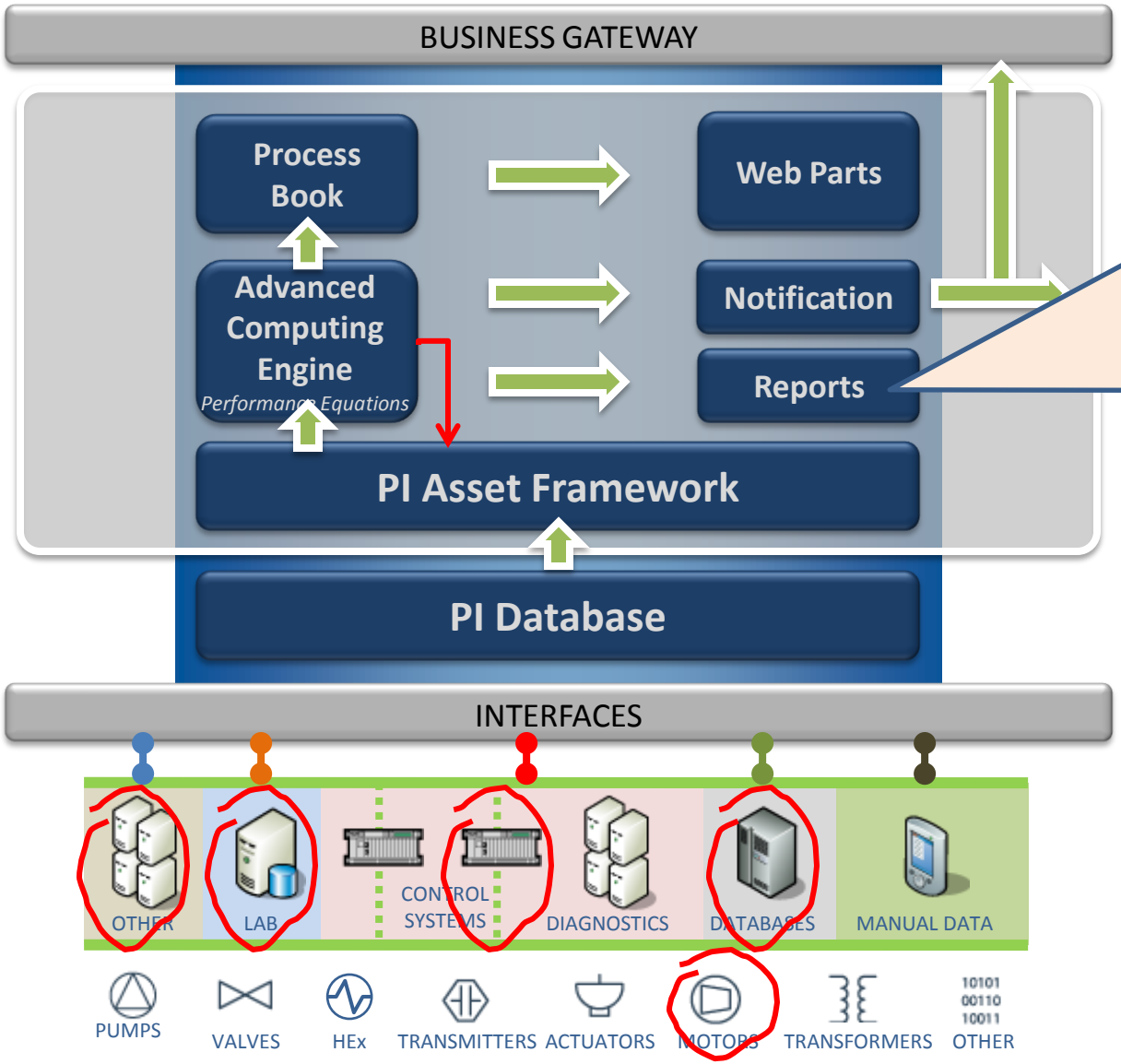
Visualize maintenance priority matrix





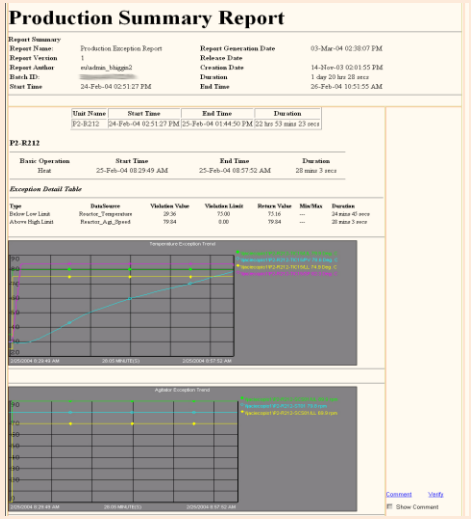
C-201

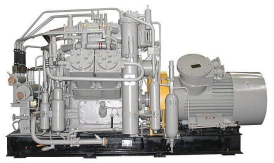
Example: Compressor Condition Based Monitoring
STEP 7: NOTIFY THE RIGHT PEOPLE & PROCESSES



VISUALIZE & NOTIFY
The Right People

Send report



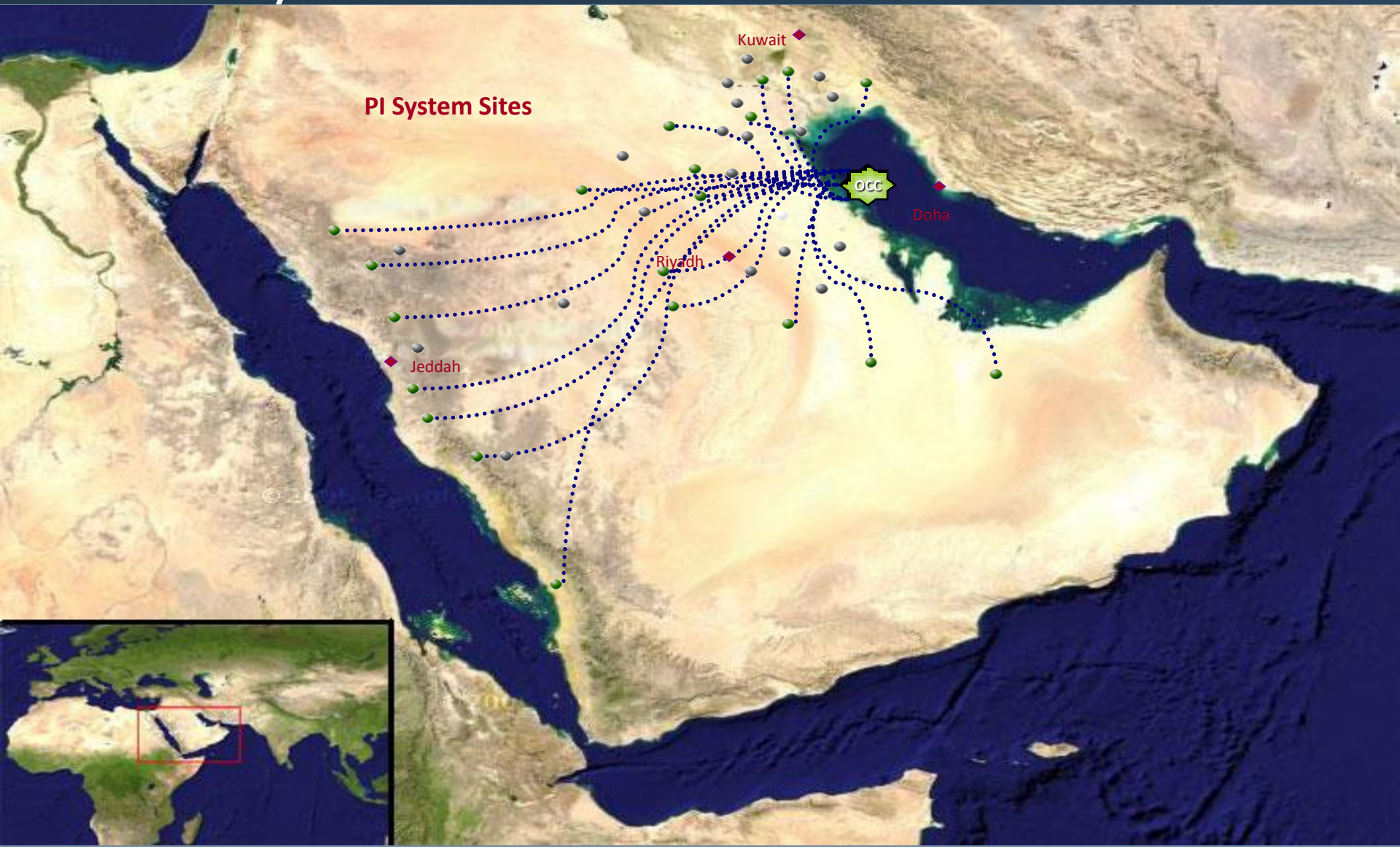


C-201

Middle-east Operator

Empowering Business in Real Time.

“Convergence of Time and Space – Real Time Visibility Asset and Fleet Performance



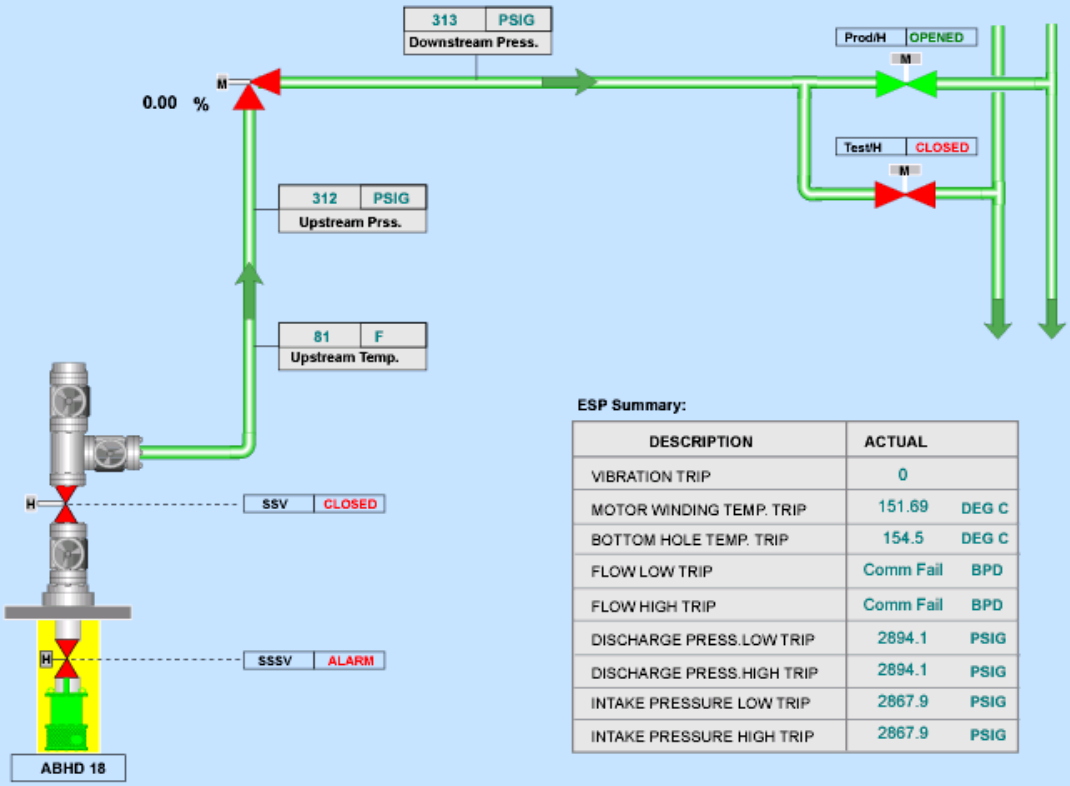
Web Part Pages - Production - Windows Internet Explorer

http://nashare/AFK/Web%20Part%20Pages/Production.aspx?RtTreeView_SelectedNodeTag=\\Tanpicluster\NAOO\AFK\Abu%20Hadriya\Oil\AP-02\ABH

Live Search

Web Part Pages - Production

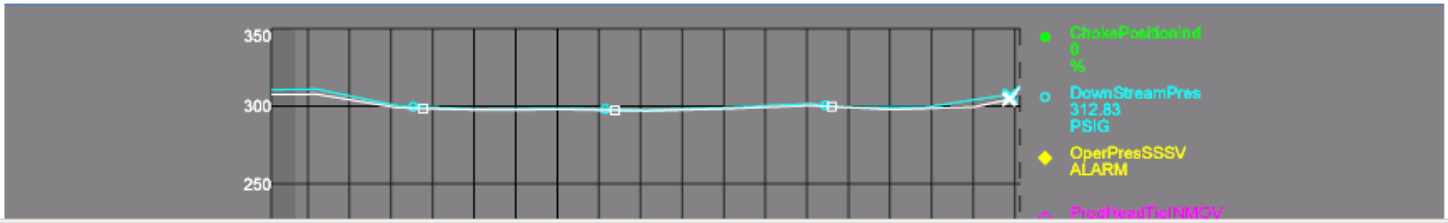
Page Tools



ESP Summary:

DESCRIPTION	ACTUAL	
VIBRATION TRIP	0	
MOTOR WINDING TEMP. TRIP	151.69	DEG C
BOTTOM HOLE TEMP. TRIP	154.5	DEG C
FLOW LOW TRIP	Comm Fail	BPD
FLOW HIGH TRIP	Comm Fail	BPD
DISCHARGE PRESS.LOW TRIP	2894.1	PSIG
DISCHARGE PRESS.HIGH TRIP	2894.1	PSIG
INTAKE PRESSURE LOW TRIP	2867.9	PSIG
INTAKE PRESSURE HIGH TRIP	2867.9	PSIG

RtTrend



URL Site

Well Type : ABHD Injector (11)

Well Type : ABHD Producer (22)

ABHD-5	AP-06
ABHD-7	AP-16
ABHD-10	AP-13
ABHD-11	AP-07
ABHD-12	AP-08
ABHD-13	AP-14
ABHD-18	AP-02
ABHD-20	AP-01
ABHD-25	AP-04
ABHD-27	AP-11
ABHD-30	AP-12
ABHD-32	AP-03
ABHD-100	AP-01
ABHD-101	AP-05
ABHD-102	AP-05
ABHD-104	AP-10
ABHD-105	AP-10
ABHD-106	AP-11
ABHD-107	AP-13
ABHD-108	AP-15
ABHD-109	AP-15
ABHD-110	AP-09

Well Type : Disposal (3)

Well Type : FDHL Injector (12)

Well Type : FDHL Producer (15)

Well Type : KRSN Injector (32)

Well Type : KRSN Producer (33)

Well Type : Observation (2)

Done

Local intranet

100%

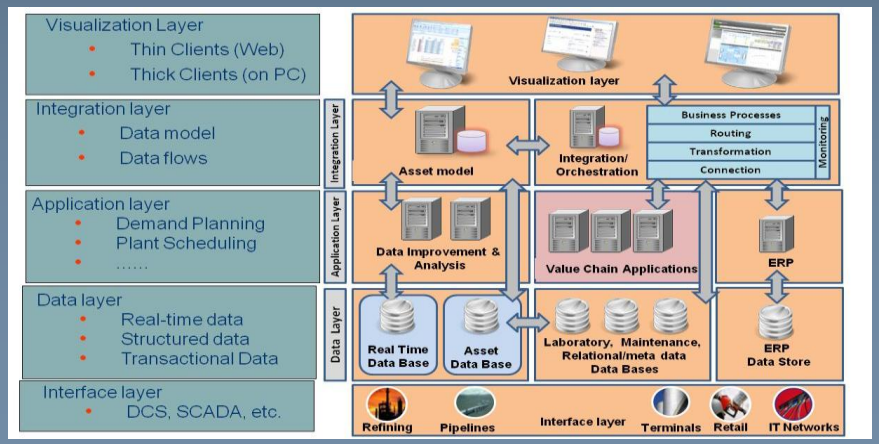
Start

Web Part Pages - Pro...

trend - Paint

11:30 AM

Global Value Chain Real Time Visibility



Well Tests

Well Tests

Hierarchy

- GOM Deepwater
  - VK 786
    - A21 ST
    - VK741 A-8
    - VK786 A13
    - VK786 A005
    - VK786 A010 ST01
    - VK786 A012
    - VK786 A019 ST1
    - VK786 A020
    - VK786 A-1
    - VK786 A-11
    - VK786 A-15
    - VK786 A-16
    - VK786 A-17
    - VK786 A-18
    - VK786 A-2
    - VK786 A-3ST1
    - VK786 A-4
    - VK786 A-6
    - VK786 A-7 ST2
    - VK786 A-9
    - VK830 A014

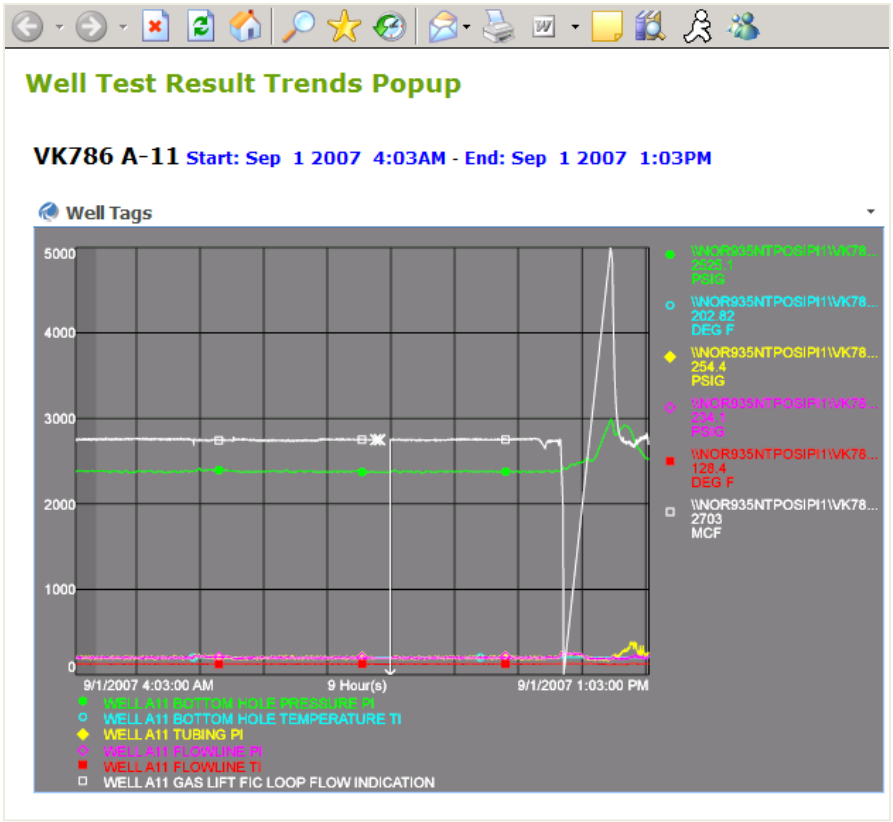
Time Range

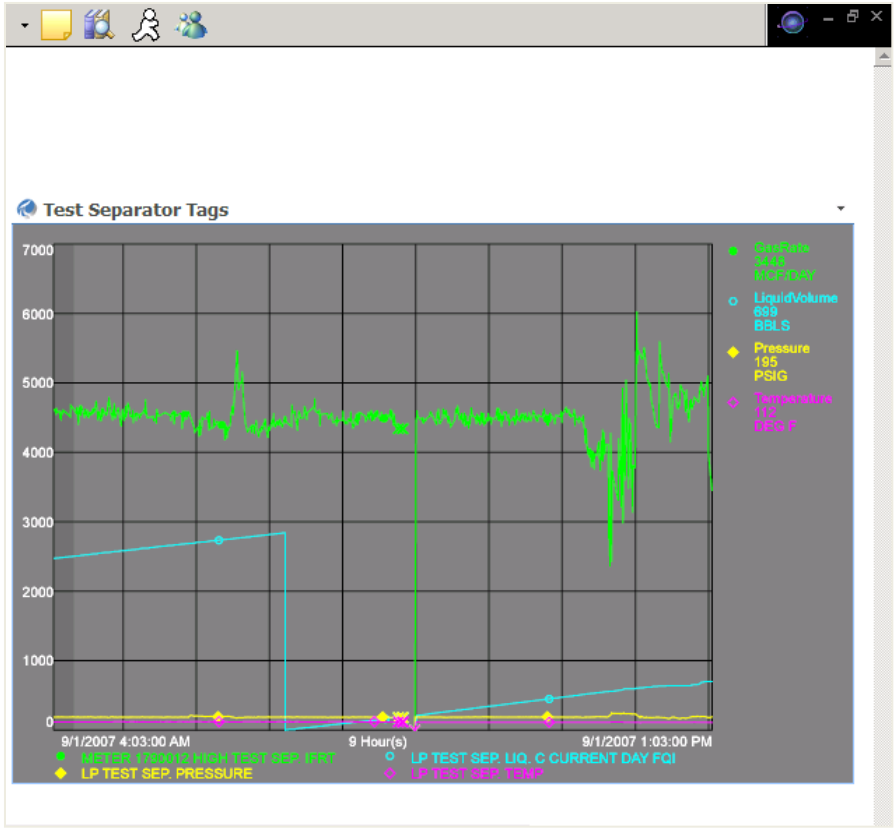
Start Time: *-6mo End Time: *

Well Test Results

WellName	TimeStamp	Status	VLP/IPR Error (%)	Duration (hrs)	Oil (STB/d)	WC (%)	GOR (scf/STB)	Choke (%)
VK786 A-4	9/5/2007 2:55:00 AM	Valid	2.5201E-02	17.57	6191		1716	0.78125
VK741 A-8	9/5/2007 2:21:00 AM	Valid	-0.48833	17	45			1.5625
VK786 A-18	9/5/2007 2:21:00 AM	Critical	15.086	17	1601		1030	2
VK786 A-16	9/3/2007 4:08:00 AM	Valid	6.6791	8.65	1590			2
VK786 A-11	9/1/2007 4:03:00 AM	Critical	-18.138	9.67	1284			3
VK786 A-4	8/30/2007 3:21:00 AM	Valid	2.5724	10.92	6462		1746	0.78125
VK786 A-2	8/30/2007 3:18:00 AM	Valid	3.297	10.82	476			3
VK741 A-8	8/30/2007 3:18:00 AM	Critical	100	10.87	44			1.5625
VK786 A-1	8/29/2007 2:17:00 AM	Valid	-2.0589	12.23	6433		739	2
VK786 A-7 ST2	8/28/2007 1:42:00 AM	Critical	44.453	8.15	731		885	1
VK786 A-9	8/28/2007 1:10:00 AM	Valid	4.9934	11.35	4330		1167	1.3281
VK786 A020	8/27/2007 5:14:00 PM	Valid	-1.5364	8.83	1227		1399	1.7813
VK786 A-4	8/26/2007 2:15:00 AM	Valid	3.5456	8.17	6458		1772	0.78125
VK786 A13	8/26/2007 2:14:00 AM	Valid	-3.6832	12.25	947		914	0.3125
VK786 A-6	8/25/2007 12:37:00 AM	Critical	-78.283	9.67	688			2
VK741 A-8	8/25/2007 12:37:00 AM	Critical	100	9.08	46			2
VK786 A-4	8/24/2007 2:05:00 AM	Valid	1.8604	8.58	6495		1773	0.78125
VK786 A-3ST1	8/24/2007 2:05:00 AM	Valid	2.9321	12.3	3100		820	0
VK786 A-9	8/24/2007 2:05:00 AM	Valid	5.5297	8.65	4318		1164	1.3281
VK786 A-16	8/23/2007 1:41:00 AM	Valid	7.8385	10.95	1597			2

Trend Data PIWebparts in Dashboard





Well Performance Monitoring via PIWebparts

General information

P30

Stability:

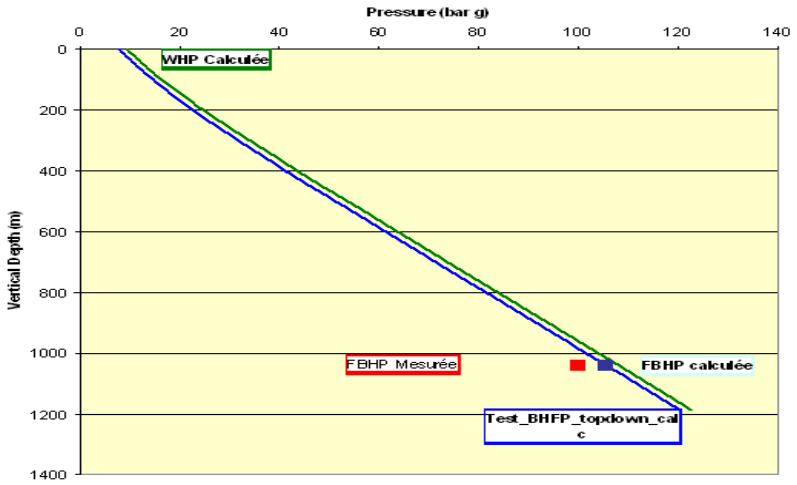
Data	Alarm
WHP	
RHP	
Qgl	
Stability	

Detailed steps	Date
Well connexion date	03/08/09 -18:59
Well test stability time	03/08/09 -13:09
First instability timestamp	03/08/09 -13:28
Well test start time	03/08/09 -11:09
Well test end time	03/08/09-18:59
Well test duration	07:50

Parameter	Units	Measured
GOR	Sm^3/Sm^3	24.70
WC	%	69.47
Reservoir Ps WPM	Bar a	150.00
Qoil VFM during the test	Sm^3/d	2 000
Qwater VFM during the test	Sm^3/d	22 004
Qgas VFM during the test	Sm^3/d	236 873

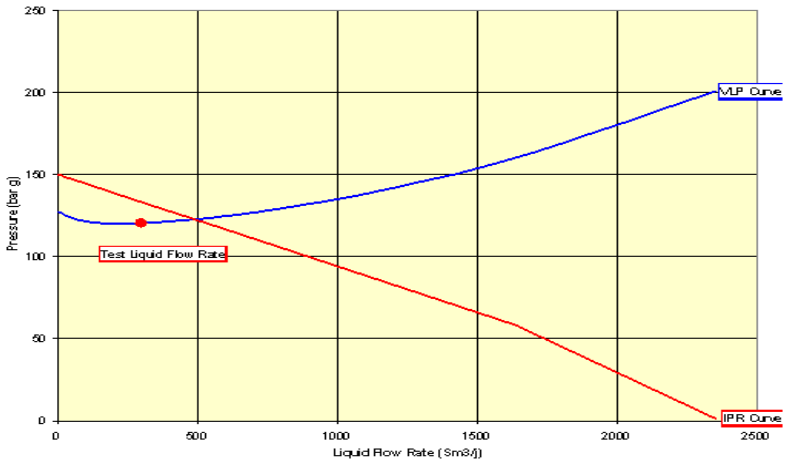
Bottom>up>top>down fitting test

Parameters	Units	Simulated	Measured	Difference	Thresold	Alarm
WHP	Bar g	9.34	7.90	-1.44	5	
BHFP	Bar g	105.54	100.00	-5.54	5	
BHFT	°C	65.00	62.00	-3.00	4	
Gauge Depth BHFP & BHFT	m		1039.65			
Test BHFP topdown calc	Bar g	120.30				
PI anhydrous	Sm^3/d/b	5.66	10.00	+4.34	4	



VLP / IPR curve and operating points

Parameters	Units	Simulated	Measured	Difference	Thresold	Alarm
WHT	°C	55.80	40.00	-15.80	20	
Liquid Flow Rate	Sm^3/d	487.39	300.00	-187.39	50	



Validate Reject Back

Empowering Business in Real Time

RTRM Dashboard Page
Producing Wells Page

Inside Home | Find & Search | People Finder | Help

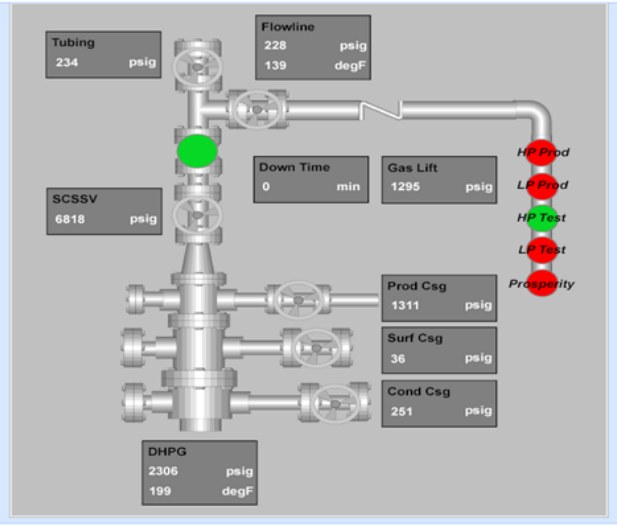
Real Time Reservoir Management

Field Summary Reservoirs Wells Systems Reports Administration

Producing Wells

- Producing Wells
  - VK741
    - J1 Prosperity
      - A08
  - VK786
    - J1
      - A01
      - A02
      - A04
      - A13
      - A16
      - A17
    - J2
      - A03 ST1
      - A06
      - A07 ST2
      - A11
      - A13 STK
    - J3
      - A15
    - J4
      - A18
      - A20
    - J6
      - A09

Latest MRS Prod Date	MRS Well Status
5/7/2008 12:00:00 AM	FL



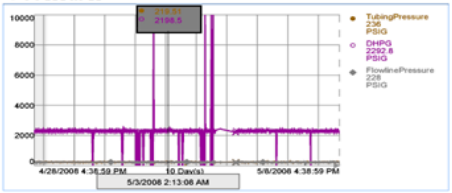
Start Time "-30d End Time "* Apply

Start Time "-10d End Time "* Apply

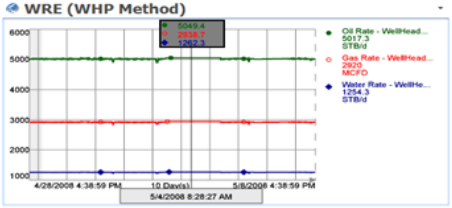
Well Details

Data Point	Current Value	Previous Day Value
For VK786 A-1	5/8/2008 4:40:47 PM	5/7/2008
Oil (bopd)	5001	5256
GOR (scf/stb)	582	582
Water Cut (%)	20	20
Total Fluid (bpd)	6252	6565
GL Inj Rate (mcfd)	No Data	No Data
GLR (scf/stb)	No Data	No Data
WHP (psig)	223	219
DHPG (psig)	2230	2283
FBHP (psig)	2327	2380
Res. Pr. (psig)	4326	4326
Drawdown (psig)	1999	1946
Liquid PI (bpd/psi)	3.13	3.37
CUM Oil (MMBO)		14.17
CUM Gas (BCF)		11.348
CUM Water (MMBW)		1.045
CUM OEG (MMBOE)		16.061

Pressures



WRE (WHP Method)



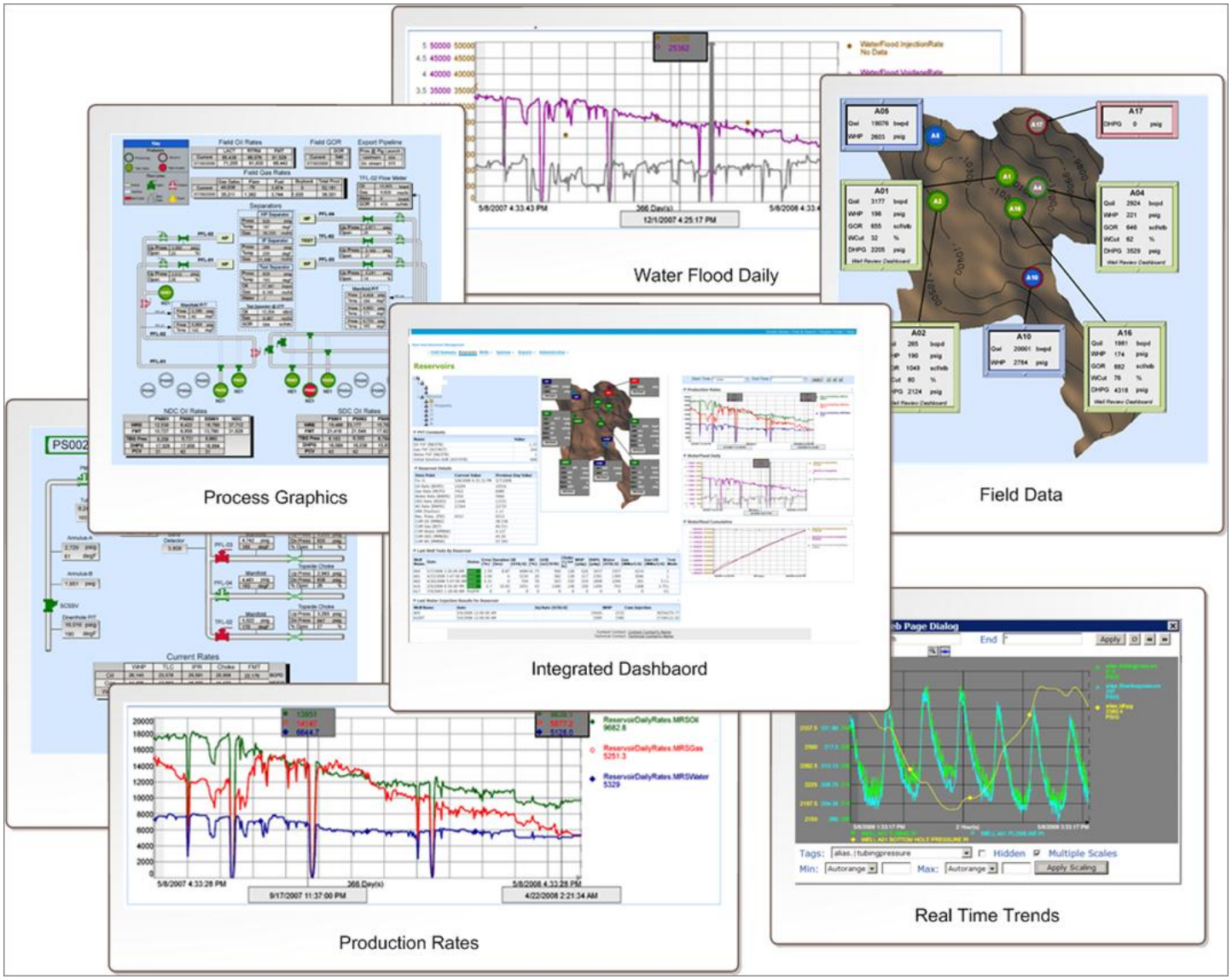
Well Tests

Well Name	Date	Status	Error (%)	Duration (hrs)	GOR (scf/STB)	WHP (psig)	Oil (STB/d)	Gas (MMscf/d)	Water (STB/d)	Choke (1/64 in)	WC (%)	Gas Lift (MMscf/d)	DHPG (psig)	GaugeDepth	Test Mode
A01	4/25/2008 3:47:00 AM	Valid	-3.94	6.00	582.00	217	5234	3046	1309	128.00	20.00		2391	9922	L
A01	4/22/2008 2:11:00 AM	Valid	-4.10	5.72	581.00	238	5062	2941	1345	128.00	21.00		2419	9922	L
A01	4/17/2008 10:18:00 PM	Valid	0.63	8.97	542.00	311	4315	2340	1147	128.00	21.00		2535	9922	L
A01	4/9/2008 2:24:00 AM	Valid	9.68	8.08	630.00	306	4325	2724	1149	128.00	21.00		2535	9922	L

Content Contact: Content Contact's Name
Technical Contact: Technical Contact's Name

Empowering Business in Real Time

RTRM Dashboard
Page Collage



Empowering Business in Real Time

CBM Application Development - choice

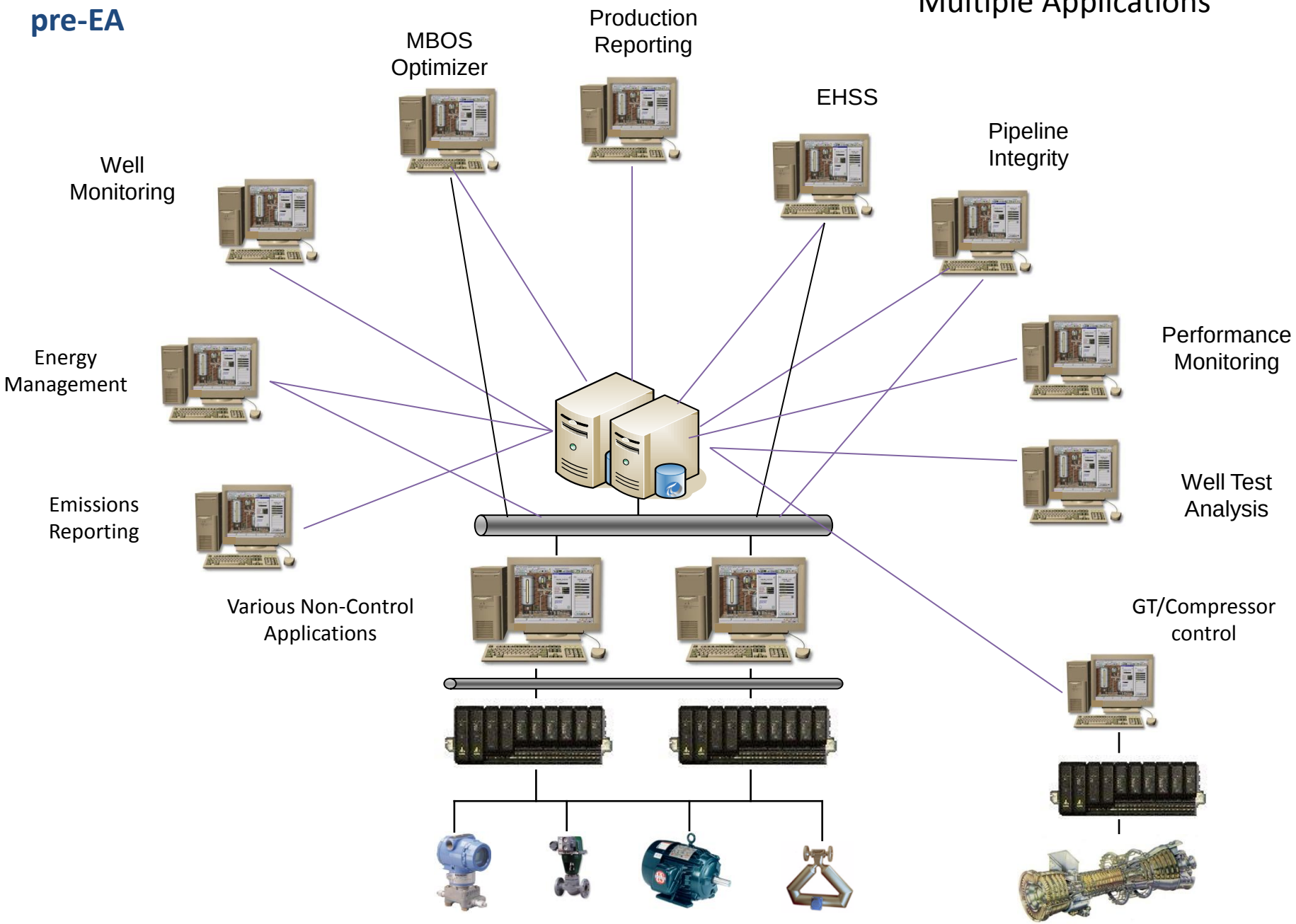
- 3rd party route
  - Traditional vendor selection, short list, ITT preparation, bid solicitation, evaluation, clarification, trials etc.
  - Price per individual piece of equipment e.g. $25k per GT or compressor, $15k per pump
  - One platform/site averaged = $300k
  - Over 11 sites = $3.3M plus hardware costs on each site, over 3 years to install

CBM Application Development - choice

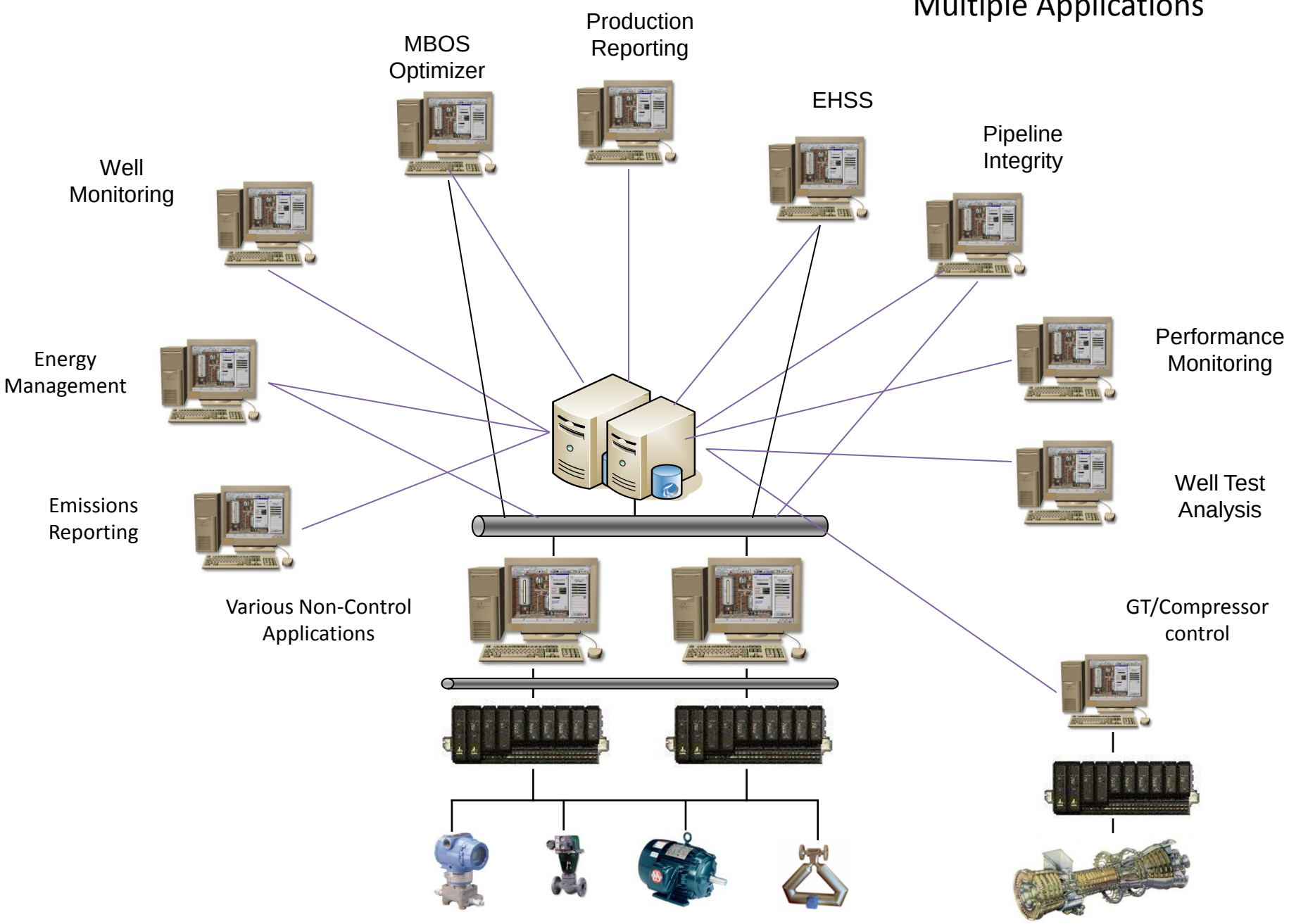
- Using PI infrastructure route & advice from COE
  - Develop once for each type of equipment
  - Use ACE/AF - standard OSIsoft software tools
  - Once developed can be integrated on all sites
  - Development costs = $30k – GTs or compressors, $15k pumps
  - First platform/site = $100k
  - Over 11 sites = $150k
  - Savings of over $3M and installation within 12 months
- Use this same methodology for new applications and some existing ones

Platform/site pre-EA

Multiple Applications



Platform post-EA



Customer example

The PI/AF solution has resulted in several benefits:

- Reduced turnaround time for projects sourcing and delivering real time data streams from **5 months to 2 weeks**
- Rationalized process control naming standards from several (before PI) to **one uniform standard** across the business units
- Enabled development and deployment of centralized & reusable services to source data from PI for multiple applications, thereby **significantly reducing development time** for such applications.

Application Architect
Data Asset & Analytics Division

Thank you

777 Davis St., Suite 250 San Leandro, CA 94577