

A decorative graphic on the left side of the slide, consisting of a large, irregular shape made of many small blue triangles. The triangles are arranged in a way that creates a sense of depth and movement, with some triangles pointing towards the center and others pointing away from it. The overall effect is a complex, geometric pattern that resembles a stylized map or a network of connections.

# Complex Event Detection for Oil Field Monitoring

Presented by  
Hervé Delesalle, *Total*  
Tjidde Boers, *Magion*



# Agenda

- About *Total & Magion*
- Total's Field Monitoring R&D Project
  - Turning raw data into valuable Information
  - Monitoring platform architecture
- **Complex Event Detection:** Shortfall example
  - Business requirements
  - Shortfall event detection with PI System components and muSuite.
- Conclusion

# About Total

- **Total is a leading international oil and gas company.** Our expertise spans the industry value chain, from oil and gas exploration and production to the gas midstream, refining, and petroleum product marketing, trading and shipping.
- **To meet changing global energy demand, we want to promote the emergence of alternative energy solutions,** with an emphasis on solar energy, nuclear power and biomass.
- **Total is also a world-class chemical producer** and is a European or global leader in all our markets.
- Our growth model is based on **a social license to operate** and **sustained investment**.



**TOTAL**

# Total key figures

▶ Operations in more  
than **130** countries

▶ Capital expenditure  
**13 349** M€

▶ 2009 oil and gas production  
**2,28** Million boe/day

▶ Workforce  
**96 387**



▶ Sales  
**131 327** M€



▶ Adjusted net income  
**7 784** M€

▶ Reserves (Proven and Probable)  
**20** years

# Maigon Company

- Founded in 1988, Independent C&A Company, with its roots in DCS engineering.
- Over 60 engineers, specialists, software developers and consultants.



19-Apr-47	2:25.39,0	<u>Suh Yun-Bok</u>	 KOR	<u>Marathon van Boston</u>
28-Sep-08	2:03.59,0	<u>Haile Gebrselassie</u>	 ETH	<u>Marathon van Berlijn</u>

- MAGION **PCE** is specialized in Process Control Engineering
- MAGION **Universe** is specialised in Production Intelligence

## Magion Universe Services:

Outsourcing highly qualified staff

Executing and supporting PI products

Sales and support Production Intelligence software (muSuite)





# Agenda

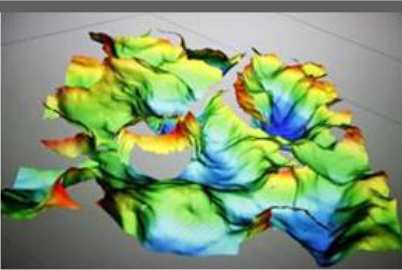
- About Total & Magion
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# TOTAL's R&D Project



## Field Monitoring

Technologies for 'digital fields'



# Turning raw data into valuable information...

- Permanent devices
- Downhole sensors
- Distributed measures
- Wireless technology

**Acquisition & telemetry**

**Real-time data management**

- Quality control
- Event detection
- Storage & access

**Integration & Optimization**

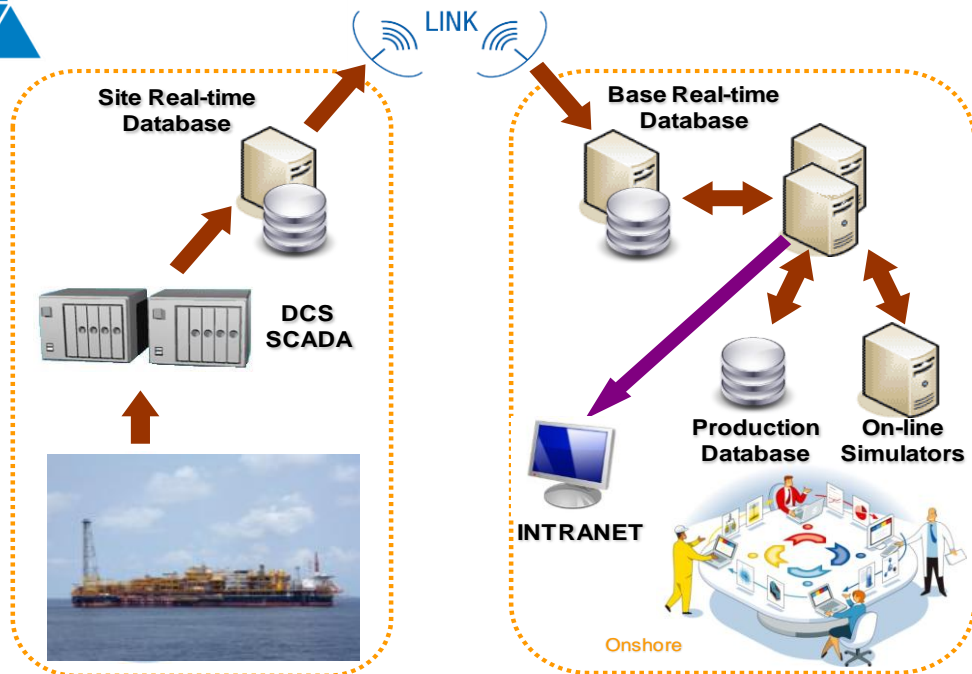
**Analysis & interpretation**

- Collaborative Environment
- Online simulation
- Advanced Control

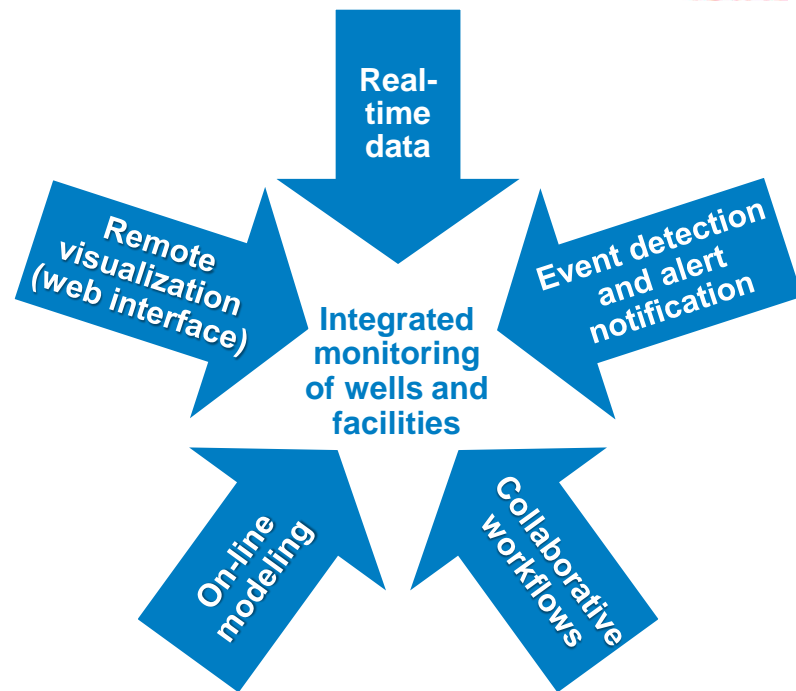
- Data mining
- Advanced diagnostics
- Inversion models



# ... thanks to a « monitoring platform »

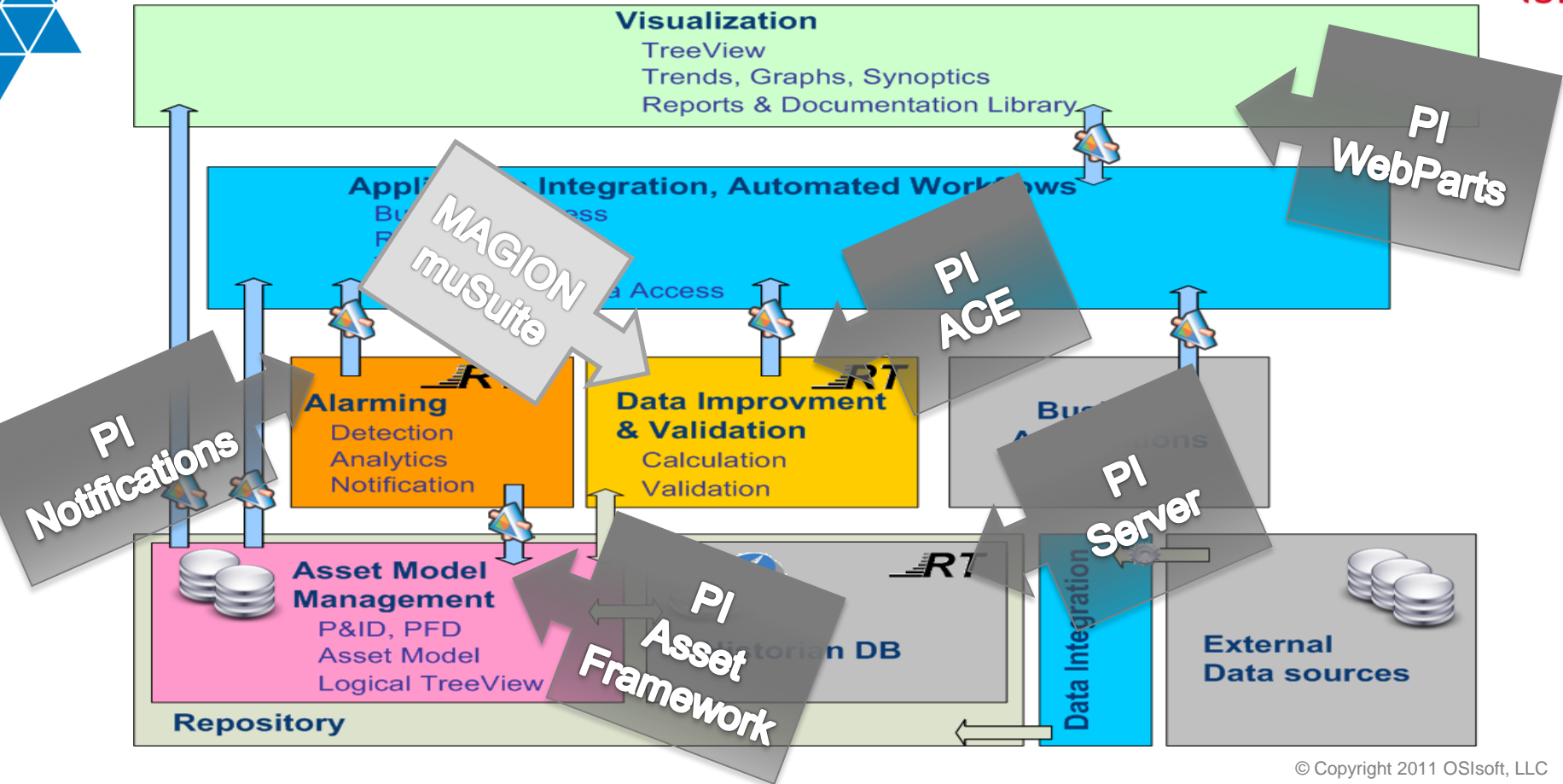


Drastic reduction of time spent  
in data collection



Noticeable impact on long-term  
production

# Monitoring platform architecture



# Asset model management

## Define site structure

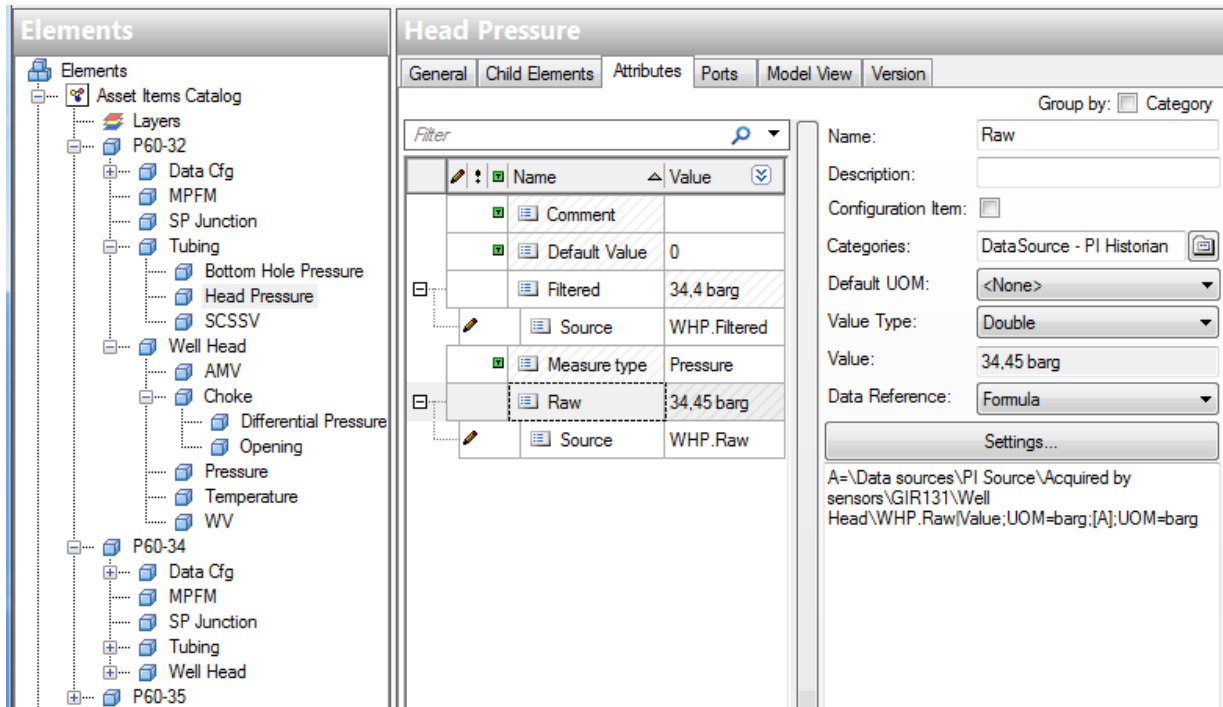
Equipments  
Attached information  
Metadata  
Relations between objects

## Connect to data sources

PI System  
Relational Database  
Specific business apps.

## PI Asset Framework

Templates objects  
Connexions  
Custom Data Reference



The screenshot displays the PI Asset Framework interface. On the left, the 'Elements' tree shows a hierarchical structure of assets. The 'Head Pressure' asset is selected, and its configuration is shown in the main window. The 'General' tab is active, displaying a table of data points and their configurations.

Name	Value
Comment	
Default Value	0
Filtered	34,4 barg
Source	WHP.Filtered
Measure type	Pressure
Raw	34,45 barg
Source	WHP.Raw

On the right, the configuration details for the 'Raw' data point are shown:

- Name: Raw
- Description:
- Configuration Item:
- Categories: DataSource - PI Historian
- Default UOM: <None>
- Value Type: Double
- Value: 34,45 barg
- Data Reference: Formula

At the bottom, the 'Settings...' button is visible, along with a text area containing the data reference formula:

```
A=\Data sources\PI Source\Acquired by sensors\GIR131\Well Head\WHP.Raw\Value;UOM=barg;[A];UOM=barg
```

# Data improvement and event detection

## Quality Control of data

Spike Filtering,  
Smoothing and averaging...

## Transition detection, alerting

State change  
Alarm level reached

## Business event detection

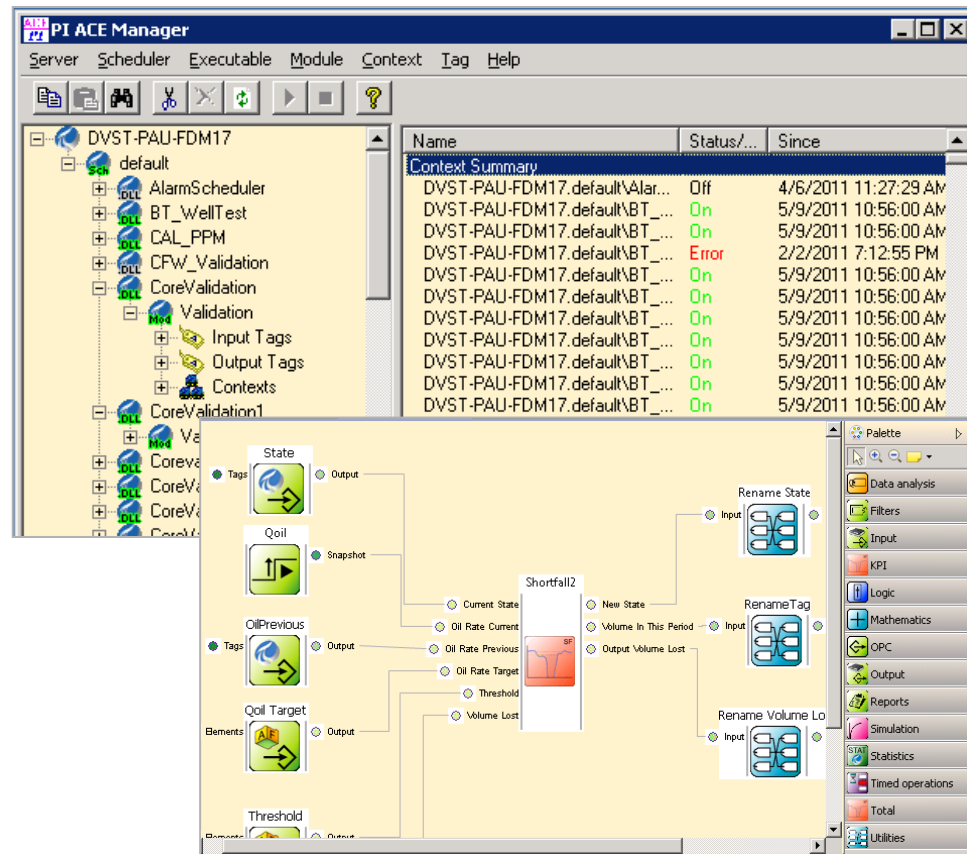
Production well testing process  
Start sequence  
Accidental spill,...

## PI ACE

Intensive PI System calculations

## Magion muSuite (trial)

Complex algorithms.



The screenshot displays the PI ACE Manager application window. The left pane shows a tree view of data sources under 'DVST-PAU-FDM17', including 'default', 'AlarmScheduler', 'BT\_WellTest', 'CAL\_PPM', 'CFW\_Validation', 'CoreValidation', 'Validation', 'Input Tags', 'Output Tags', 'Contexts', 'CoreValidation1', and 'Ve'. The right pane shows a table of context summaries with columns 'Name', 'Status/...', and 'Since'.

Name	Status/...	Since
DVST-PAU-FDM17.default\Alar...	Off	4/6/2011 11:27:29 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	Error	2/2/2011 7:12:55 PM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM
DVST-PAU-FDM17.default\BT_...	On	5/9/2011 10:56:00 AM

The bottom pane shows a logic diagram with various components like 'State', 'Coil', 'OilPrevious', 'Coil Target', 'Threshold', 'Shortfall2', 'Rename State', 'RenameTag', and 'Rename Volume Lo' connected by lines.

# Visualization: exposing useful information

## Ergonomics

Analyse user's tasks  
Identify pertinent information

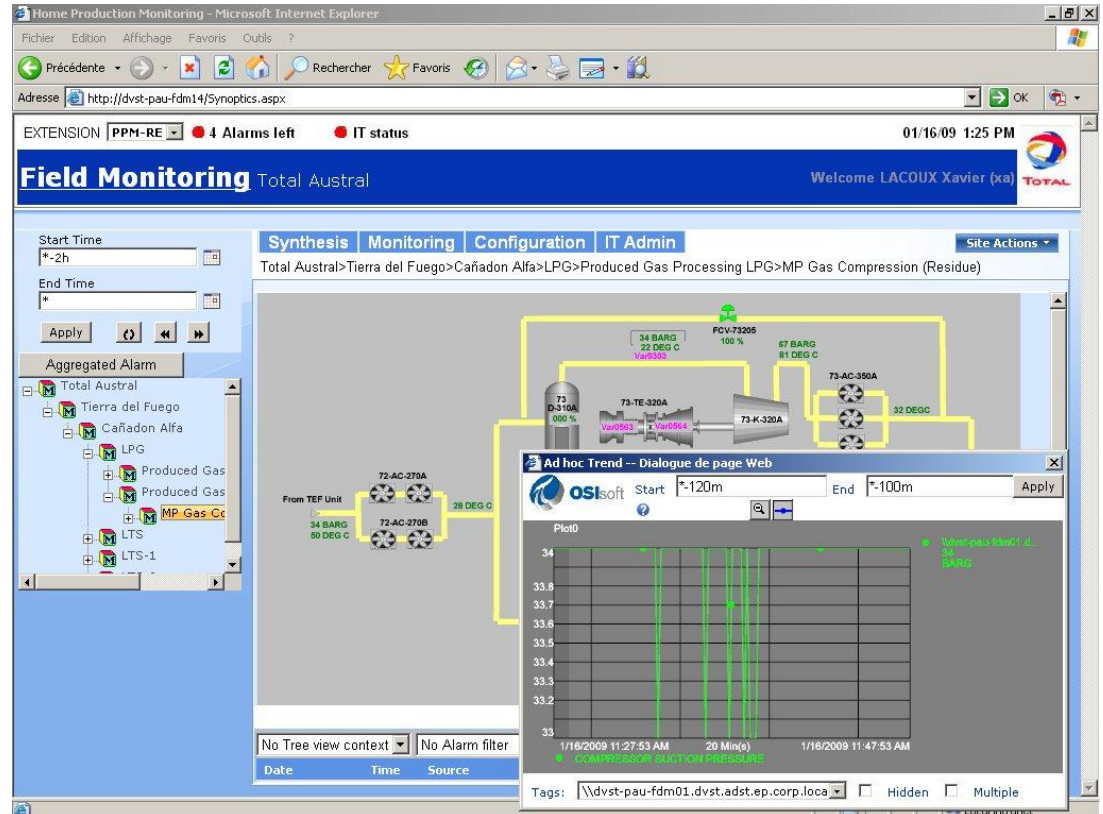
## IHM Design

Proper page layouts  
Support user interactions

## MOSS 2007

## RtWebParts

Going to PI WebParts





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# MAGION muSuite

The Business Algorithm workspace

Plug in for  
designing and  
maintaining  
algorithms

Builder and  
Engine share the  
block library.  
Blocks may be  
tailor made. Like  
MatLab blocks

Many data  
sources possible:  
PI System, PI AF,  
PI OPC, PI Web  
services, SQL.

$\mu$  Builder 3.1

View

Manage

Schedule

Test

Heart of the  
system.  
The algorithms  
are executed  
and evaluated  
here.

$\mu$  Engine 3.1

Blocks

Control

Custom

Data

Statistic

Test

Operation

Web  
services

OPC UA

Queue

Open  
connectivity via  
PI OPC UA or  
PI Web  
Services

Web  
Service

OSI PI

AF 2.1

MS-SQL

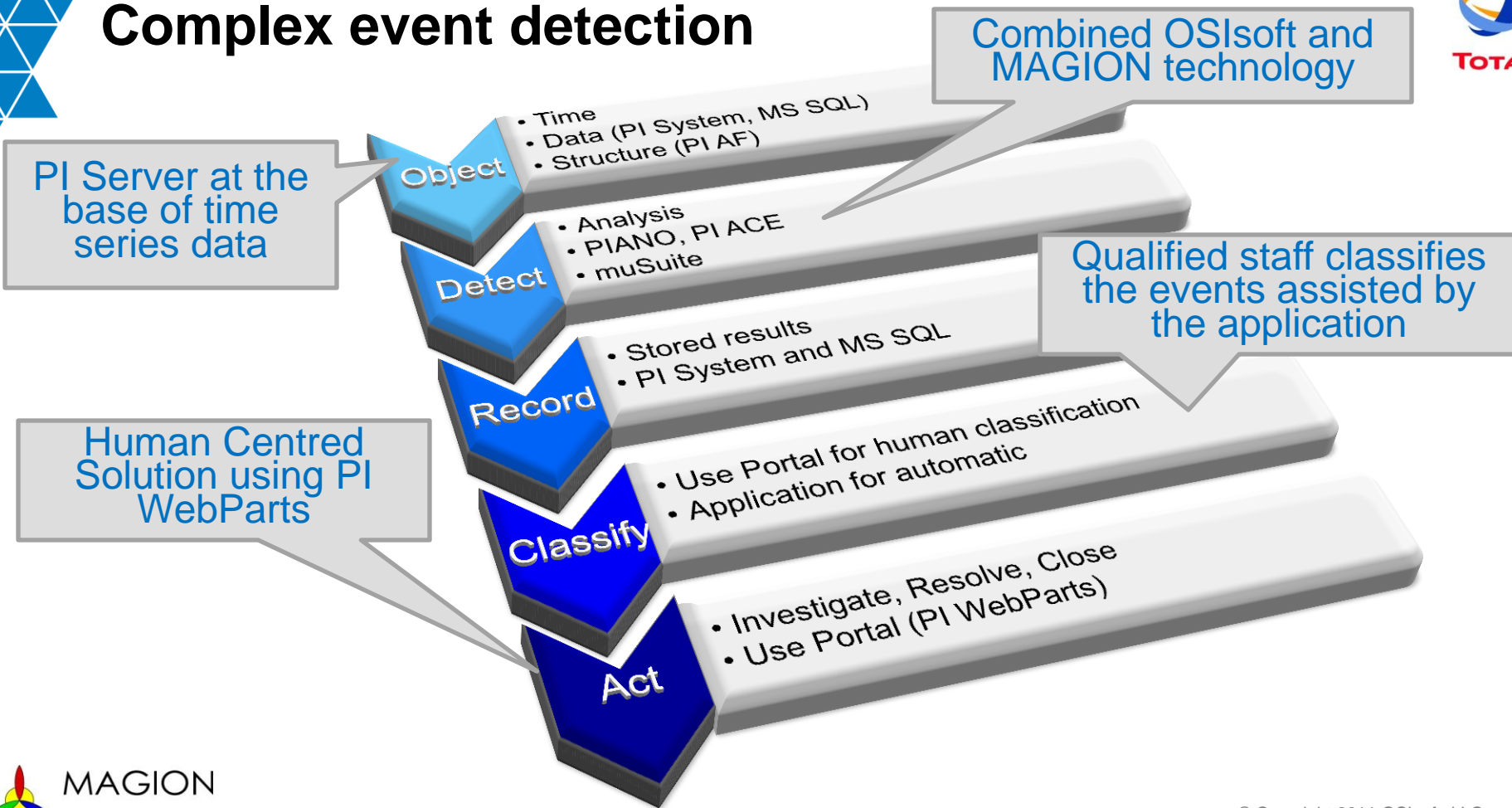
DSL x



MAGION



# Complex event detection





# Shortfall event detection: business goals

Each well should produce as close as possible to its potential.

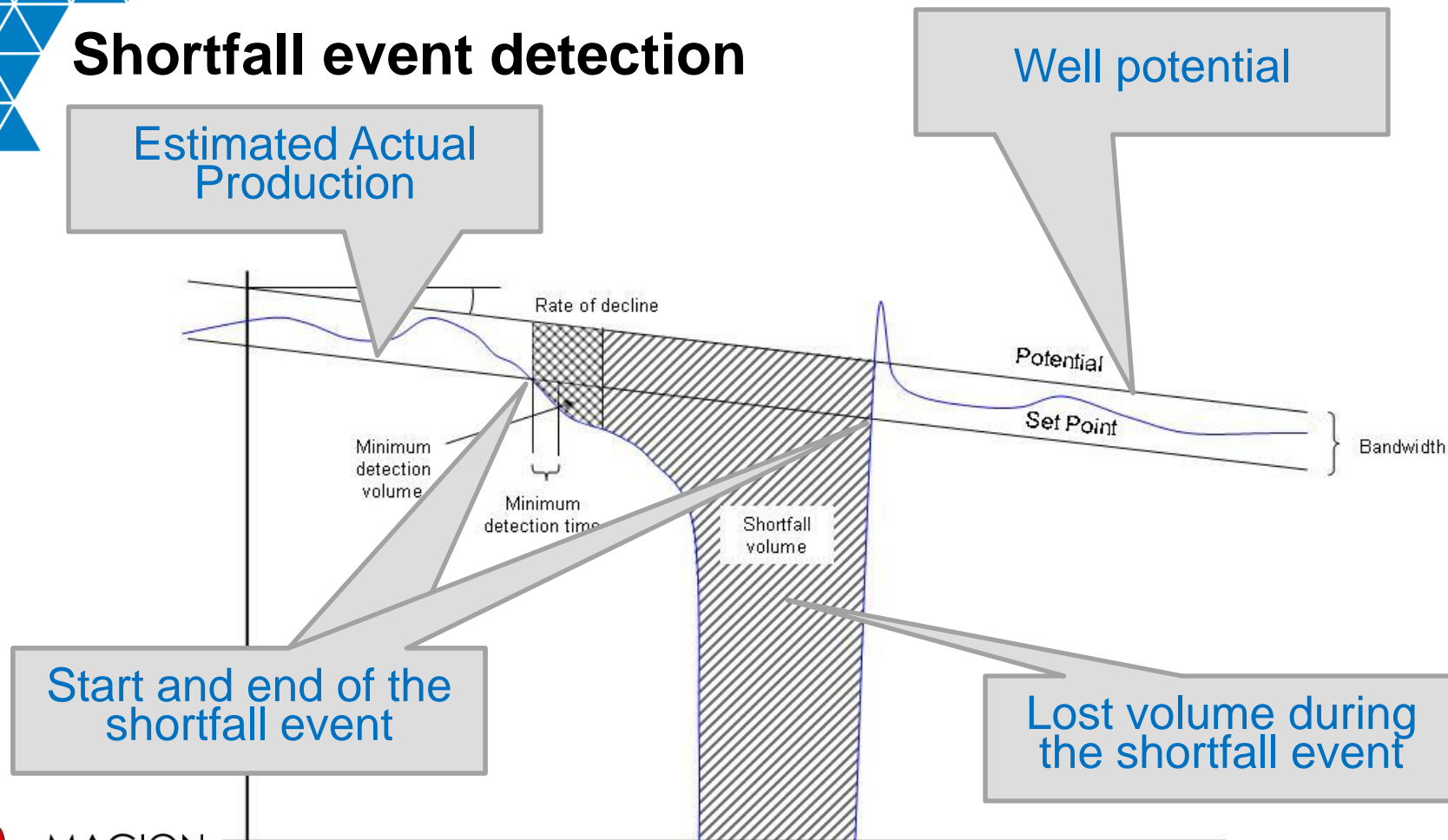
Any under-production (“shortfall”) has to be explained.

Field Operation team has to

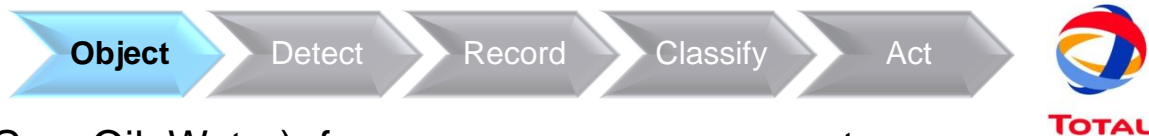
- Estimate actual production of wells
- Detect operational shortfalls events
- Identify and assign causes to each shortfall
- Share shortfall history for performance management



# Shortfall event detection



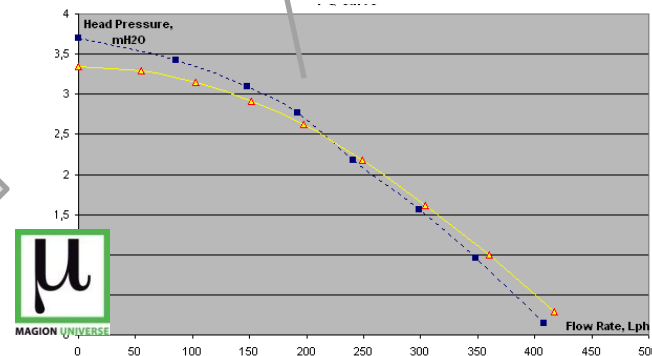
# Shortfall



Estimate actual production rates (Gas, Oil, Water) from pressure measurement (captured via PI System) and well model (Polynomial equation parameters stored in Production DB).

Name	Value
<None>	
Last Shortfall	
Poly Setting	
a	-2005
b	1.31
c	-1.31
d	0.0065
e	1E-08
GDR	78
WC	23 %
Production	
Qgas	1387.13721818932 KNm3/day
Qliq	3671.94795227888 Nm3/day
Qoil	2827.39992325474 Nm3/day
Qwater	5312.04728910328 Nm3/day
Shortfall	
Well	
WHP	214.903854370117 bar

Characterises data from production database, linked into the PI AF table



# Shortfall

Object

Detect

Record

Classify

Act



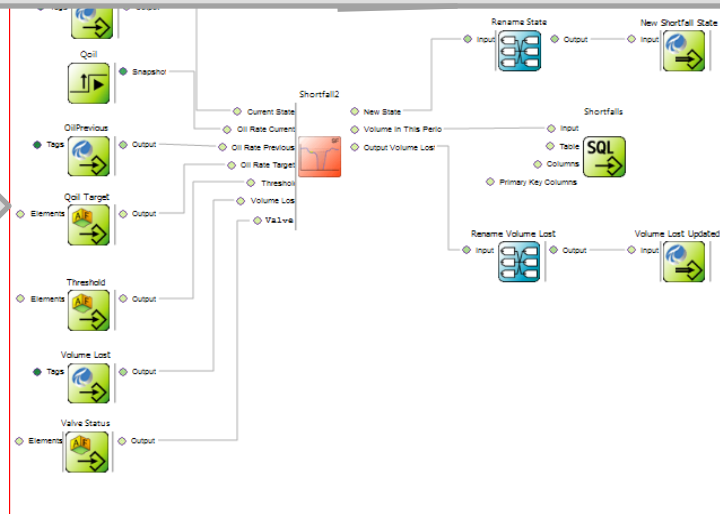
Detect “shortfall status” and progressively enrich a “shortfall event” via a state machine defined in muSuite that compare actual flowrate to well potential in the context of the well.

The screenshot shows the mu-Pilot - PI System Explorer interface. The left pane lists elements 1001 through 1015. The main pane displays the details for element 1002, which is a well. The 'Production' section shows flow rates for Qgas, Qliq, Qoil, and Qwater. The 'Shortfall' section shows Delta Qoil, Qoil Target, Shortfall Status (Normal), Threshold, Threshold Factor, and Volume Lost.

Name	Value
Qgas	1387.13721818932 KNm3/day
Qliq	3671.94795227888 Nm3/day
Qoil	2827.39992325474 Nm3/day
Qwater	5312.04728910328 Nm3/day
Delta Qoil	-0.824131292981995 m3
Qoil Target	600 Nm3/day
Shortfall Status	Normal
Threshold	1.2 m3
Threshold Factor	0.2 %
Volume Lost	0 m3

Potential is retrieved from production database.

Shortfall calculation is a state machine triggered with each rate estimation.

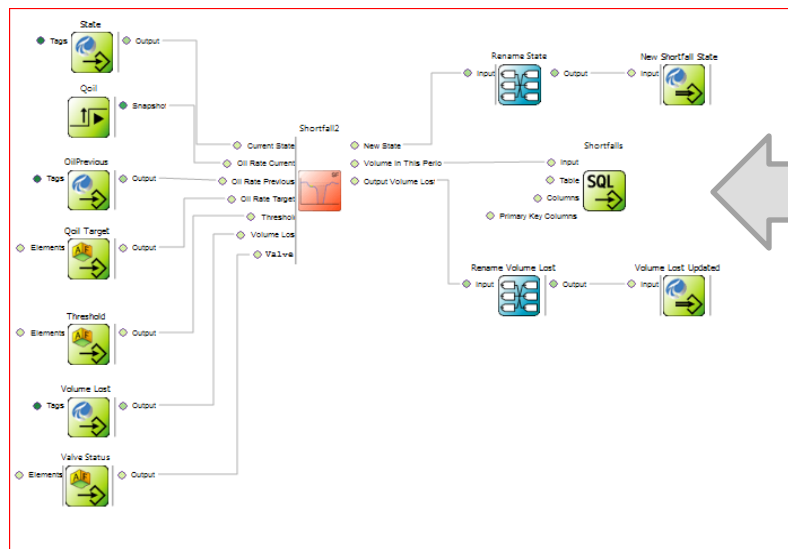


MAGION



# Shortfall

The shortfall event is recorded in the production database and in the PI System.



mu-pilot - PI System Explorer

Database Query Date Back Check In New Table Search

Library

- mu-pilot
  - Categories
  - Templates
  - Enumeration Sets
  - Reference Types
  - Tables
    - Configuration
    - Events
    - Events1
    - MinMax
    - Polynom
    - Target

Events

General Table Define Table Version

Events

	WELLNAME	START_DATE	END_DATE	VOLUME	STATUS
	2032	3/30/2011 2:47:22 PM	3/30/2011 3:36:22 PM	2.39008833951314	Shortfall
	2032	3/25/2011 3:36:46 PM	3/30/2011 2:45:22 PM	659.8101134419397	Shortfall
	4012	5/4/2011 2:19:24 PM		0.0333218467535473	Possible
	4012	5/3/2011 8:08:20 AM	5/3/2011 8:35:50 AM	3.1170710611048	Shortfall
	4012	5/3/2011 7:09:50 AM	5/3/2011 8:07:50 AM	6.17924335055542	Shortfall
	4012	5/3/2011 6:39:50 AM	5/3/2011 7:09:20 AM	3.54712928059302	Shortfall
	4012	5/3/2011 5:58:20 AM	5/3/2011 6:39:20 AM	4.69820576149901	Shortfall
	4012	5/3/2011 3:57:50 AM	5/3/2011 4:19:20 AM	2.79624788154433	Shortfall
	4012	5/3/2011 3:23:50 AM	5/3/2011 3:57:20 AM	4.01319330191549	Shortfall
	4012	5/3/2011 1:53:19 AM	5/3/2011 2:21:50 AM	2.86033225512441	Shortfall
	4012	5/3/2011 12:49:49 AM	5/3/2011 1:19:19 AM	3.7071607249113	Shortfall
	4012	5/2/2011 11:41:19 PM	5/3/2011 12:28:49 AM	3.80373035195075	Shortfall
	4012	5/2/2011 11:00:50 PM	5/2/2011 11:39:49 PM	3.51786343221148	Shortfall
	4012	5/2/2011 10:27:20 PM	5/2/2011 11:00:20 PM	2.8839661075453	Shortfall
	4012	5/2/2011 9:36:20 PM	5/2/2011 10:03:50 PM	3.81969878596666	Shortfall
	4012	5/2/2011 8:39:50 PM	5/2/2011 9:29:50 PM	5.68375071900534	Shortfall
	4012	5/2/2011 8:39:20 PM	5/2/2011 9:29:50 PM	5.68375071900534	Shortfall
	4012	5/2/2011 8:20:50 PM	5/2/2011 8:36:20 PM	2.23991096737596	Shortfall
	4012	5/2/2011 8:18:50 PM	5/2/2011 8:36:20 PM	2.23991096737596	Shortfall

Events Modified: 3/30/2011 4:41:25 PM. Version: 1/1/1970 12:00:00 AM, Revision 6

# Shortfall

Object

Detect

Record

Classify

Act



Shortfall - Microsoft Internet Explorer

Address: http://nl-dhg-tst01.nl.ad.sp.corp.local:7788/Shortfall/Default.aspx

Friday, April 02, 2010

Daily Total Values  
Potential: -1 (KWH) Production Day: -1 (KWH) Shortfall: -1 (KWH)

Well: F15A3  
Start Time: 06:00 02-04-2010 PCLE: 122 (KWH)  
End Time: 06:00 03-04-2010 PCLV: 12 (KWH)  
Classification: Production Dynamics  
Comment: well is flowing under setpoint  
Status: Open

Well: F15A4  
Start Time: 06:00 02-04-2010 PCLE: 1116 (KWH)  
End Time: 06:00 03-04-2010 PCLV: 110 (KWH)  
Classification: Reservoir and Well Servicing  
Comment: well closed due to sand  
Status: Open

Well: K1A1  
Start Time: 06:00 02-04-2010 PCLE: (KWH)  
End Time: 06:00 03-04-2010 PCLV: (KWH)  
Classification: Maintenance & Inspection  
Comment: 1  
Status: No status

Well: K1A4  
Start Time: 06:00 02-04-2010 PCLE: (KWH)  
End Time: 06:00 03-04-2010 PCLV: (KWH)  
Classification: Production Dynamics  
Comment: well is flowing under setpoint  
Status: No status

Well: K4A1  
Start Time: 03:28 03-04-2010 PCLE: 182 (KWH)  
End Time: 06:00 03-04-2010 PCLV: 16 (KWH)  
Classification: Production Dynamics  
Comment: well is flowing under setpoint  
Status: Open

Well: K4BE1  
Start Time: 22:30 02-04-2010 PCLE: 40 (KWH)  
End Time: 23:28 02-04-2010 PCLV: 3 (KWH)  
Classification: Production Dynamics  
Comment: Accepted  
Status: Open

Well: K5A4  
Start Time: 02:19 03-04-2010 PCLE: 566 (KWH)  
End Time: 06:00 03-04-2010 PCLV: 49 (KWH)  
Classification: Production Dynamics  
Comment: well is flowing under setpoint  
Status: Open

shown 1 to 10 of total 21

F15A4

Platform Code: F15 - F15A  
Platform TCode: F15A  
Well Code: F15A4  
Well Group: 1  
Shortfall event: (none)  
Start Time: 06:00 02-04-2010  
End Time: 06:00 03-04-2010  
Shortfall Energy: 1116 (KWH)  
Shortfall Volume: 110 (KWH)  
Actual Potential: 106  
Classification: Reservoir and Well Servicing (S1PRW)  
Comment: well closed due to sand

Shortfall date details  
Start Time: 23:28 12-02-2010 End Time: (not available)

Recent Notifications

Time	State Change	Choke	Energy (KWH)	Volume (KWH)
06:02 13-02-2010	Active, Shortfall. → Active, Shortfall.	Open	48	5
06:38 13-02-2010	Active, Shortfall. → Active, Shortfall with valve closed.	Closed	57	6
13:04 13-02-2010	Active, Shortfall with valve closed. → Active, Shortfall.	Open	358	35
06:02 15-02-2010	Active, Shortfall. → Active, Shortfall.	Open	1112	109
11:26 16-02-2010	Active, Shortfall. → Active, Shortfall.	Open	3316	326
06:02 17-02-2010	Active, Shortfall. → Active, Shortfall.	Open	-2989	-294
06:56 17-02-2010	Active, Shortfall. → Active, Shortfall with valve closed.	Closed	135	13
06:02 18-02-2010	Active, Shortfall with valve closed. → Active, Shortfall with valve closed.	Open	1119	110
06:02 19-02-2010	Active, Shortfall with valve closed. → Active, Shortfall with valve closed.	Open	1119	110

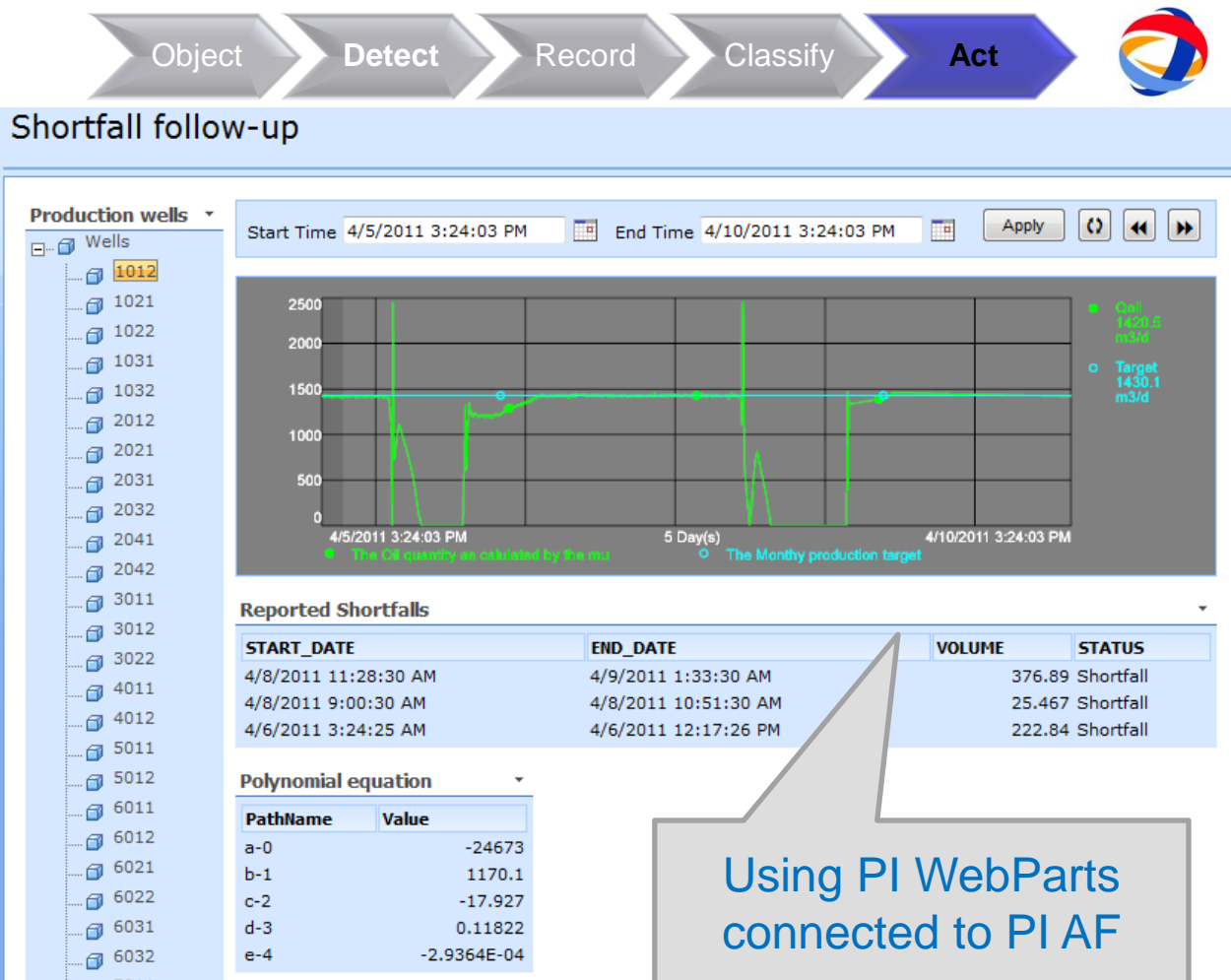
Operator classifies the shortfall according to TOTAL standard classification table.

# Shortfall

Shortfall information is made available

- in the portal
- in reports.

Portal example.





# Conclusion

- Layered architecture of TOTAL's Field Monitoring Platform matches quite well with OSIsoft PI System architecture
- PI Asset Framework enables good data integration from different sources. Total requires more Data Reference (e.g SAP) and access performance.
- Complex event detection is a process involving the whole monitoring platform.
- muSuite brings graphical tools to design business algorithms with the PI System and PI AF integration.







# Thank you

# Need to know more?

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*Contact:* Tjidde BOERS for the muSuite software and OSIssoft integration projects.

*E-Mail:* [t.boers@magion.nl](mailto:t.boers@magion.nl)