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Turning **insight** into **action**.

Data Validation with PI AF

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Anglo American Platinum

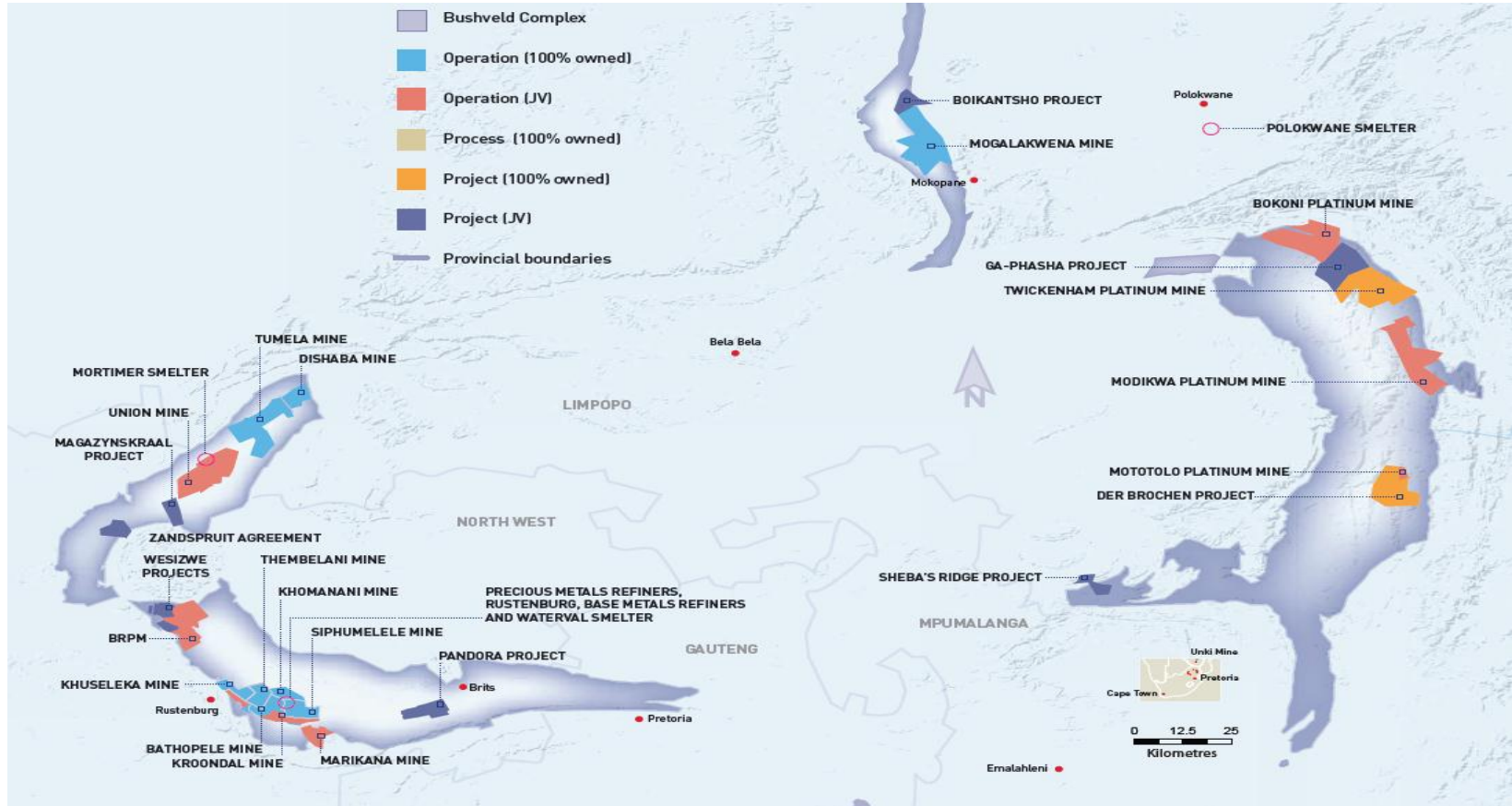
Agenda

- Introduction to Anglo American Platinum
- Business Challenge
- Process Information Architecture
- Data validation and instrument monitoring Solution
- Data validation & instrument monitoring results
- Benefits
- Future plans

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Anglo American Platinum Operations



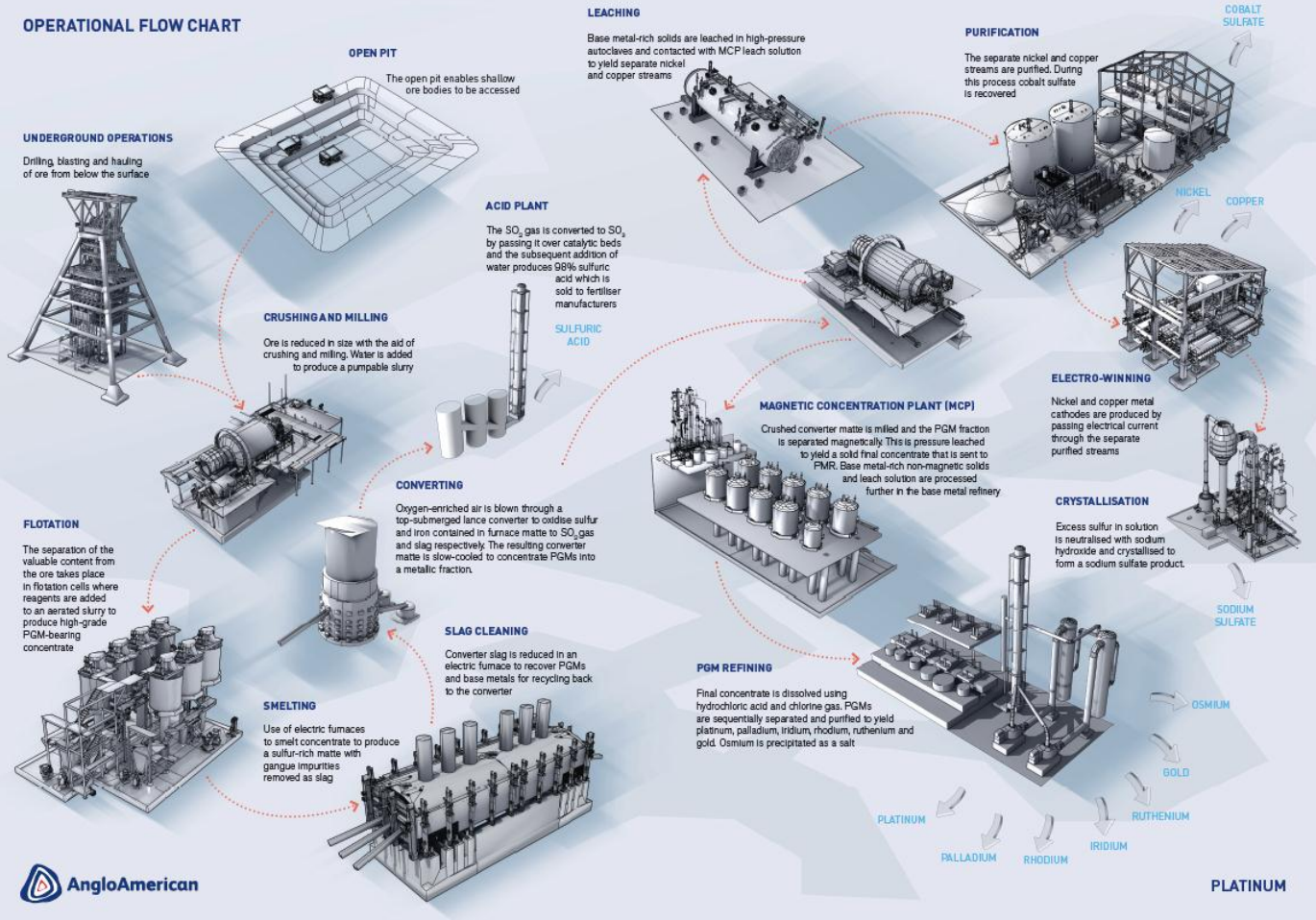
Anglo American Platinum

Anglo American Platinum is the world's premier PGM producer, supplying approximately 40% of the world's newly refined Platinum.

Process Division:

- 14 Concentrators
- 3 Smelters
- 1 Converter
- 2 Refineries
- 9 geographic operational areas

OPERATIONAL FLOW CHART



Platinum Process

- Long value chain in comparison to most minerals
- Technically complex
- Comparatively low volumes but high value
- A significant material pipe line
- Energy and water intensive

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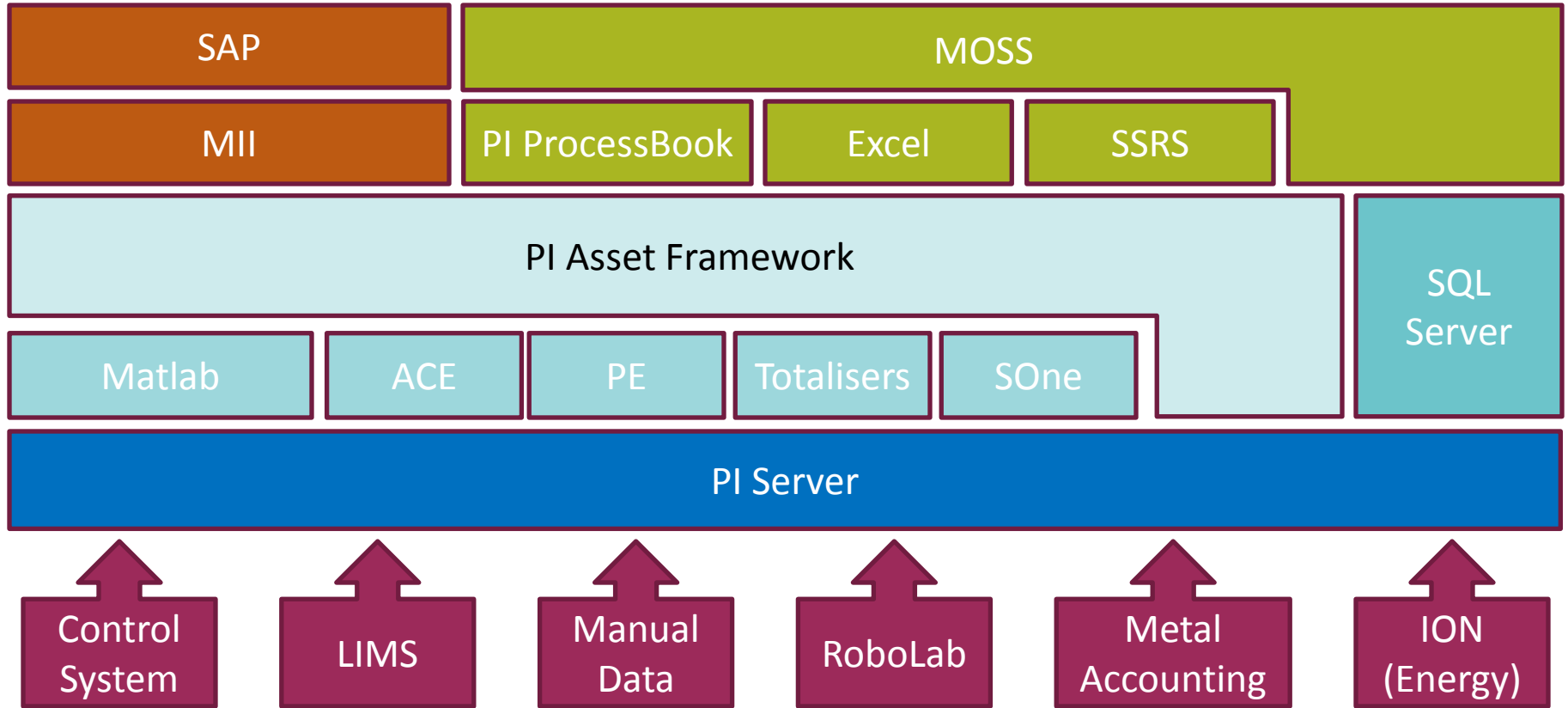
Business Challenge

- Large number of instruments across the group; approximately 100,000
- Large amount of data; approximately 700,000 tags are logged
- Minerals processing plants are a harsh environment for instruments
- Instruments form the basis of all control and information systems
- Certain instruments are critical to safety
- The quality of the data leads to better quality information
- Anglo American Platinum need a mechanism to:
 - Monitor the quality of the instruments/data
 - Clean/Reconstruct the data where practical

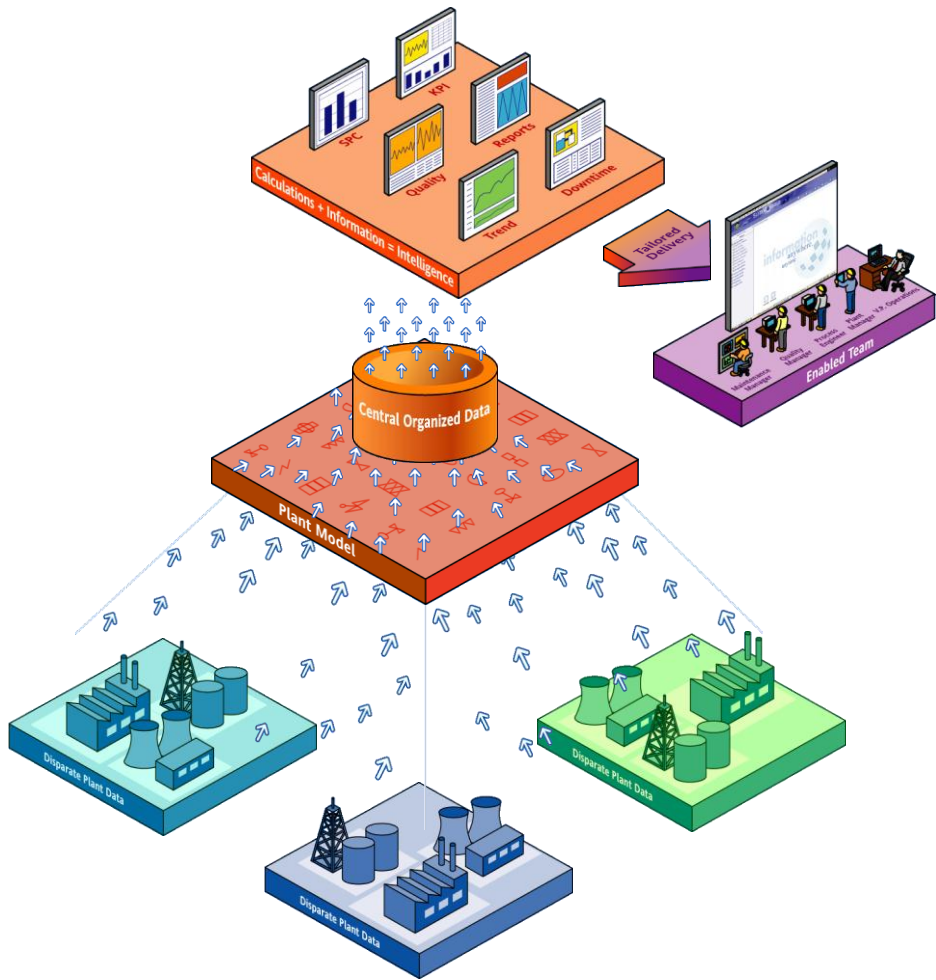
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Process Information Management Technology Stack



High level architecture



- A distributed architecture has been implemented; primarily due to limited network bandwidth
- Each operation has a complete PI System implementation
- Calculations are performed at the level they are used; primarily on the sites
- Selected data is rolled-up to a central PI System
- The master PI AF is on the central PI System and replicated to site
- Data flows in one direction
- The central PI System is used for:
 - Group wide analyses
 - Single point of integration to certain business systems

Elements

Elements

AISPH2DB04 ModuleDB

Anglo Platinum

Amandelbult

BRPM

Lebowa

Modikwa

Mogalakwena North

North Concentrator

Final Grind

Primary Mill Discharge

408CL001

408PIT726

408CL002

408SU001

408SU003

Primary Mill Feed

Primary Milling

Secondary Mill Discharge

Secondary Milling

North ICC

Mogalakwena South

Mototolo

Polokwane Section

Precious Metal Refinery

Rustenburg

Union

WLTR

Concentrators

Amandelbult

BRPM

Mogalakwena North

Mogalakwena South

Mototolo

Rustenburg

Union

WLTR

Configuration

Refineries

408PIT726

General Child Elements Attributes Ports Version

Filter

Name

Value

<None>

Active

1

FilterConstant

0

FilterType

0

InstId

PV

5.3528637886047363

ROC

0

Run

False

SPC configuration

0

StdDev

0

Target

120

Configuration

Point configuration

—

Site

MOGN

Limits

HHL

120

HL

115

HLM

250

LL

10

LLL

5

LLM

0

TrendHigh

0

TrendLow

0

OPM Configuration

CalcExpression

Category

Quality

Not Updating

False

Quality

Not Running

Sim

False

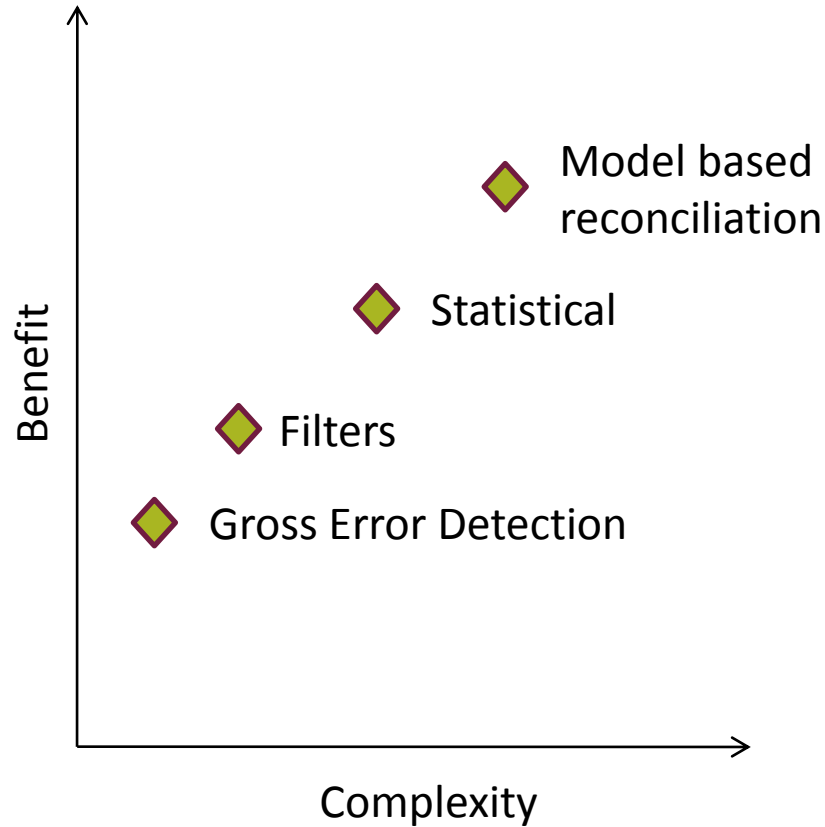
Plant Model

- The plant model provides context to the data
- The models are aligned to the S95/S88 standards
- The models are consistent across all sites
 - The models are maintained on the central PI System
 - The models are replicated to the sites.
 - This is currently a manual process. However, it will be “automated” shortly.

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Data validation methods



- The methods are not mutually exclusive
- Gross error detection (GED) is normally the basis of all validation techniques
- The graph provides a qualitative outline of popular data validation method
- The cost of implementation and maintenance increases with complexity
- The more sophisticated techniques are typically reserved for a small collection of instruments/data
- GED can be applied to everything

Gross Error Detection

- Detect data errors based on simple metrics using simple, fast mathematical algorithms
- No models are implied or used. Therefore, low maintenance
- Each data point can have a single state. The states are prioritised
- The data is classified into the following states:

Category	Description	Fault state	Analogue	Digital
Good	Good data quality		X	X
Missing Data	Data point is missing	Yes	X	X
Not Running	Equipment or process not running		X	X
High	Data point is above the process high limit	Yes	X	
Low	Data point is below process low limit	Yes	X	
Not Updating	Data is not updating	Yes	X	
ROC	High rate of change	Yes	X	
Simulated	Simulated data	Yes	X	X
Qbad	Quality bad indicator from the control system	Yes	X	X

Instrument classification

- To aid prioritisation of instruments Anglo American Platinum has classified all instruments into the following categories:
 - **Mission Critical**
 - Any instrument that is vital to safety
 - Instruments that are critical to running the operation
 - Any instrument that will result in a plant (or major equipment) trip
 - **Control Critical**
 - Any instrument that is used in the automated control of the process
 - Loss of these instruments will result in a loss of efficiency
 - **Information Critical**
 - Instruments that do not have an immediate impact on the plants operation

Instrument classification

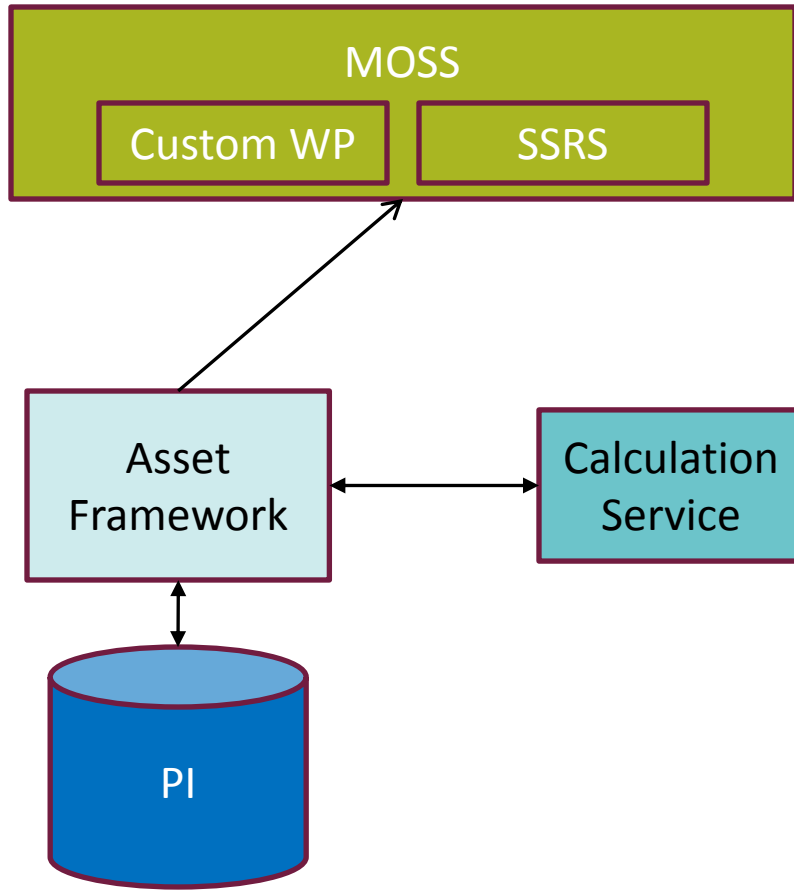
- The instrument classification is used to define:
 - Instrument availability
 - Mean time to repair
 - Spares holding
 - Instrument engineer's and technician's performance ratings
- The instrument classifications are “stored” within PI AF and synchronised with the G2 Advanced Process Control solution
- The classification process is currently manual; “automated” techniques are being investigated

Data validation calculation requirements

- Must work seamlessly with PI AF
 - Handle new elements
 - Element changes
 - Element deletion
- Must scale to handle at minimum 5000 instruments on a single server
- The configuration of the calculations must be “automatic” based on PI AF templates
- The results must be stored in the PI Server
- Each instrument must be individually configurable but with sane defaults based on instrument type
- The solution must be low maintenance
- The solution must support rapid deployment. A site roll out should not take more than an hour

Calculation method





































- The PI System has numerous calculation options:
 - Totalisers
 - Performance Equations
 - PI ACE
 - PI AF Formulas
 - PI AF Data References
- An “off-the-shelf” solution did not exist



Calculation solution

- Developed in conjunction with the OSIsoft CoE
- OSIsoft vCampus and the CoE were invaluable in developing the service; particularly performance
- PI AF holds all the configuration
- The service automatically handles changes to the elements
- The calculation services is a standard windows service application
- A custom WebPart was developed to display the dashboard
- Longer term reports implemented in SQL Server Reporting Services using PI OLEDB Enterprise

Calculation solution

Configuration		
<input type="checkbox"/>	<input type="checkbox"/>  Point configuration	--
<input type="checkbox"/>	<input type="checkbox"/>  Site	MOGN
Limits		
<input type="checkbox"/>	 <input type="checkbox"/>  HHL	2.0999999046325684
<input type="checkbox"/>	<input type="checkbox"/>  HL	2
	<input type="checkbox"/>  HLM	1.8
<input type="checkbox"/>	<input type="checkbox"/>  LL	0.89999997615814209
<input type="checkbox"/>	<input type="checkbox"/>  LLL	0.89999997615814209
	<input type="checkbox"/>  LLM	0
	<input type="checkbox"/>  TrendHigh	0
	<input type="checkbox"/>  TrendLow	0
OPM Configuration		
	<input type="checkbox"/>  CalcExpression	
	<input type="checkbox"/>  Category	
Quality		
<input type="checkbox"/>	<input type="checkbox"/>  Not Updating	False
<input type="checkbox"/>	<input type="checkbox"/>  Quality	Good
	<input type="checkbox"/>  Basic GED	Good
	<input type="checkbox"/>  DeadBand	0.05 %
	<input type="checkbox"/>  GED Enabled	True
	<input type="checkbox"/>  NU GED	Good
	<input type="checkbox"/>  NU GED Enabled	False
	<input type="checkbox"/>  PI Point	\\vaish2db04.angloil.net\MOGN:408DIT739 Quality
	<input type="checkbox"/>  ROC GED	Good
	<input type="checkbox"/>  ROC GED Enabled	False
	<input type="checkbox"/>  Sample Rate	10
<input type="checkbox"/>	<input type="checkbox"/>  Sim	False

- The bulk of the GED calculation is handled by a custom data reference and a formula data reference
- The services reads the data from PI AF and writes the results to a PI AF attribute
- PI AF seamless writes the results to PI
- Communication with PI AF is via the AF SDK


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Data validation calculation performance

- Calculation service executes every 10 seconds
- Tested up to 1,000 instrument elements; ~70% discrete instruments
- Under these conditions the calculation is completed in approximately 2 seconds; running on a 10s schedule
 - **Service start up is a little more tricky**
- CPU loading is typically less than 5% during the calculation
- Memory usage is approximately 200MB
- Test system:
 - **Windows 2003 Server Std 32bit**
 - **Dual Intel 2.6GHz Quad core processors**
 - **4GB RAM**
 - **PI AF and calculation service are installed on the same server**
- The solution has proven to be very stable

Instrument Monitoring Dashboard


 Last two hours

Mogalakwena North	Primary Mill Discharge	Primary Mill Feed	Primary Milling	Secondary Mill Discharge	Secondary Milling
AP Air Gap Meter			4		4
AP Level Meter			1		1
Density Meter					
Flow Meter	1		24	1	15
Load Cell					
Power Meter					
Pressure Meter			5		5
Temperature Meter			2		25
Weightometer					
AP Flow Switch					
AP Level Switch		1			
AP Limit Switch			1		
AP Pressure Switch					
AP Pull Switch		2			
AP Speed Switch					
AP Temperature Switch					
AP Vibration Switch					

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Instrument Monitoring Dashboard

- A simple webpart is used to display the instrument status
- Based on the PI AF SDK
- Longer term results are accessible via reports
- The webpart uses the same PI AF configuration
- All the information is derived from PI AF
- Simple intuitive design
- The webpart is dynamic providing the user with a drill down capability

Instrument Monitoring Dashboard – drill down




| My Site | 

Mogalakwena | Reports | Instrument Monitoring Dashboard

Welcome Halhead, Mike ▾

Mogalakwena ▾Instrument Monitoring Dashboard

2011/



AreaPrimary Milling ▾

ClassAP Limit Switch ▾

CategoryAll ▾

Has FailedTrue ▾

PeriodLast two hours ▾

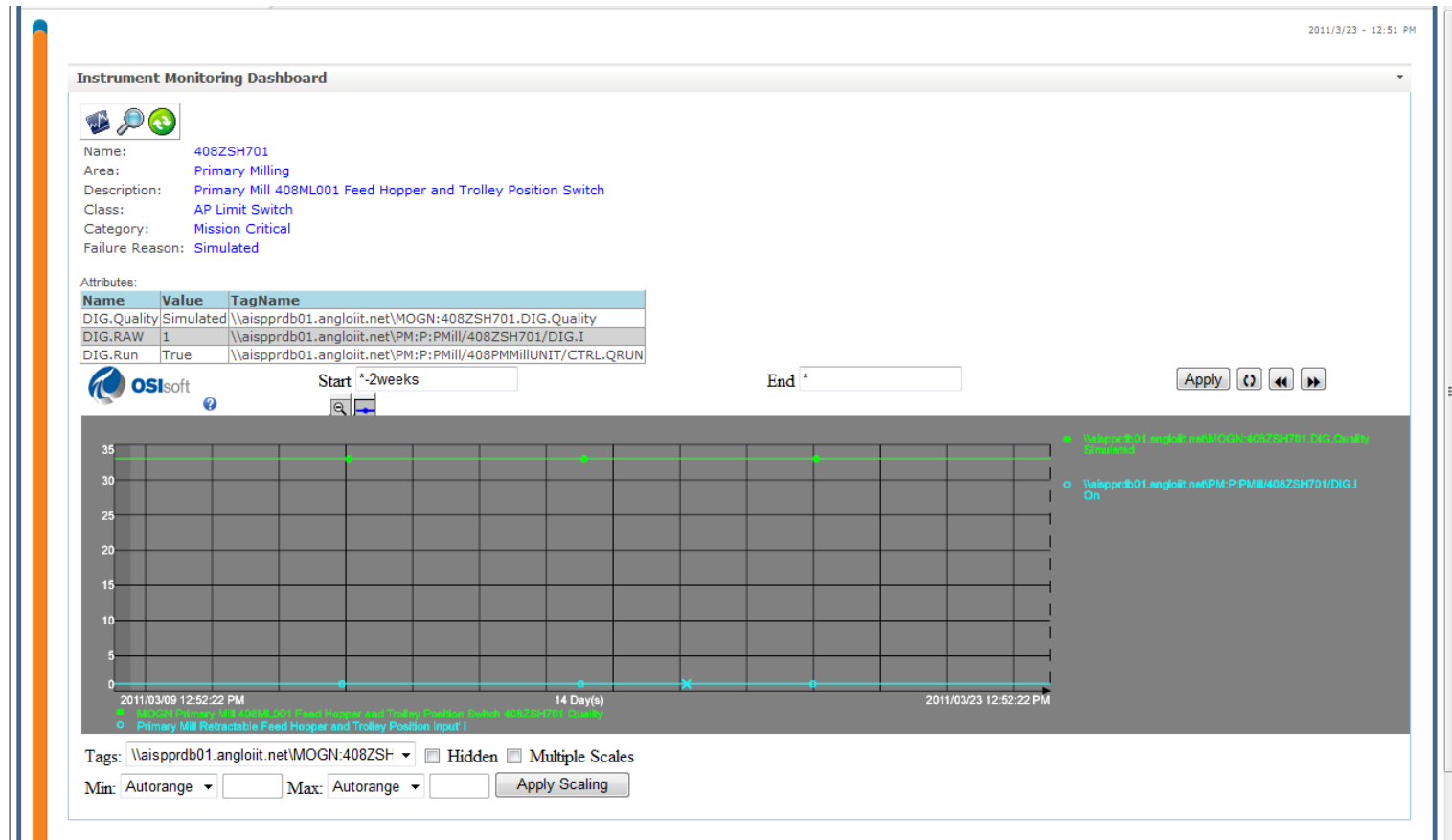
Instrument Name

Failure Reason

Search

Name	Description	Category	HasFailed	ReasonForFail	Class	Area	LastFailureDate
408ZSH701	Primary Mill 408ML001 Feed Hopper and Trolley Position Switch	Mission Critical	True	Simulated	AP Limit Switch	Primary Milling	3/23/2011 12:39:07 PM
1							

Instrument Monitoring Dashboard – Drill down



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Benefits of data validation and instrument monitoring

- Contributes to a broader vision
 - Supports the “One Version of the Truth”
 - Better quality of information
- Instruments are the basis of everything we do
- The solution make the instrument availabilities unequivocal
- The dashboard and reports provides clear visibility of the status of instruments and data
- Faulty and simulated instruments have resulted in serious equipment failures in the past. The visibility highlights these issues

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Future plans

- Implement PI Notifications on serious faults
- Expand the data validation to include statistical models; particularly useful for reconstruction of values
- Refine the user interface
- Implement OLAP style analyses for group wide analysis
- Move to event based calculations. The bulk of the instruments are digitals and therefore the event based mechanism will improve performance

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into **action.**





Thank you

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