



# Using the PI System for a Recipe-Based Data Warehousing Strategy

Presented by **Nick Dani**

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# Outline

- Problem Statement
- IDM Data Warehouse Strategy
- PI System - Critical Component for Warehousing Strategy
- Where does PI System fit in this?
- Contextualizing data using PI AF and PI EF – Example
- Exporting and Accessing PI System Data
- Challenges
- Next Steps

# Problem Statement

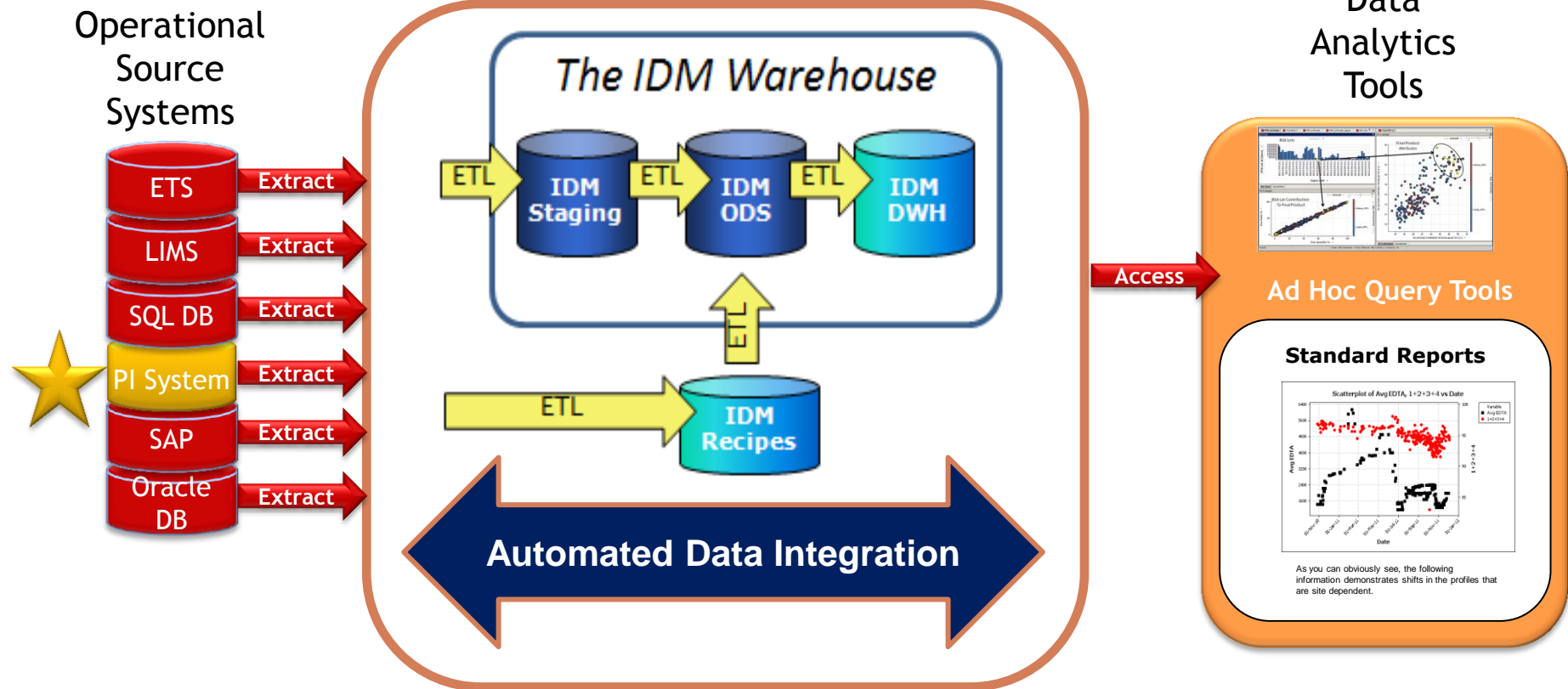


*"We've got lots of information technology. We just don't have any information."*

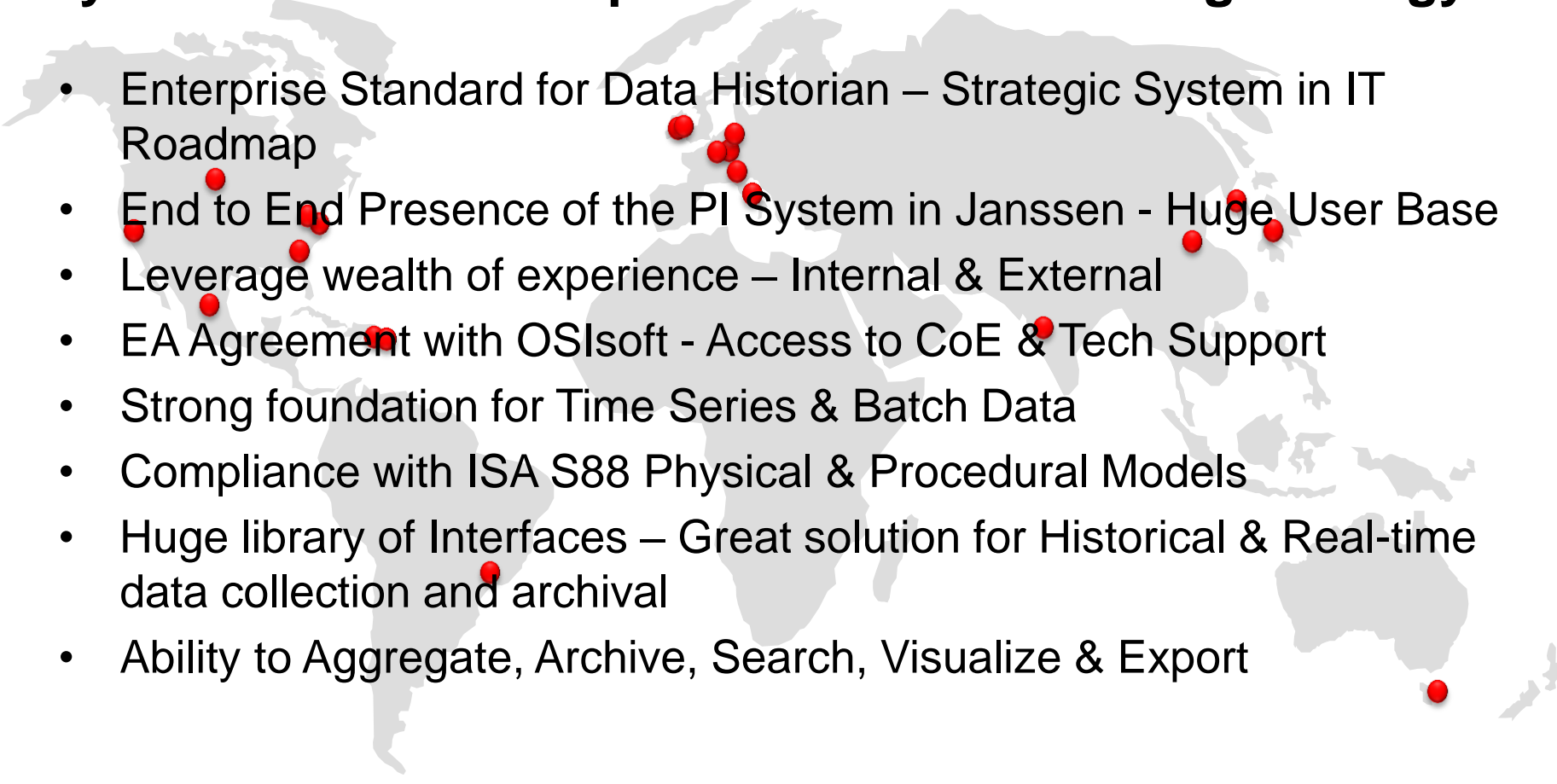
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# IDM Data Warehouse Strategy

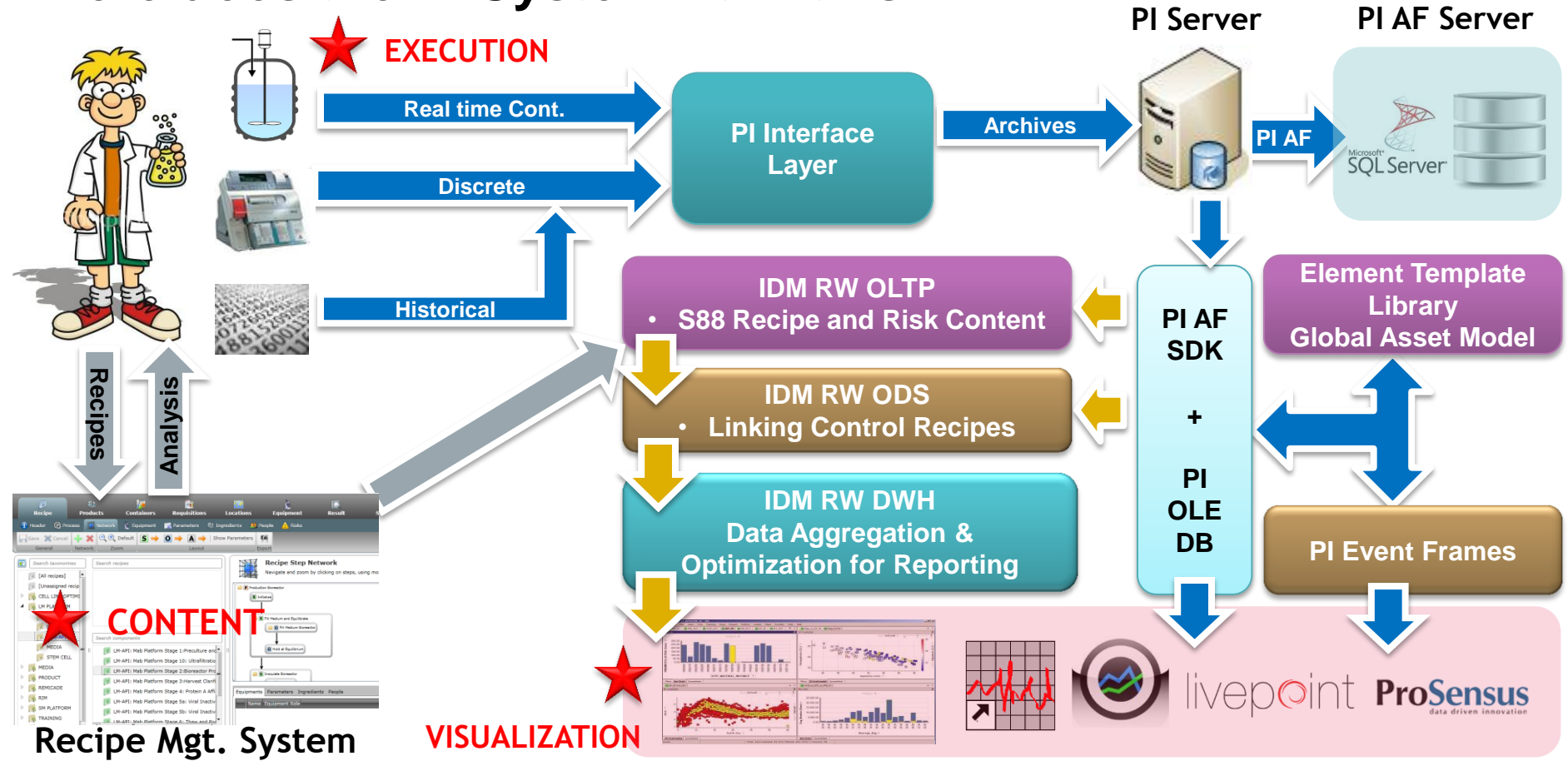
S88/S95 Model



# PI System - Critical Component for Warehousing Strategy

- 
- A light gray world map is positioned in the background. Red circular pins are placed on the map to indicate global locations, including North America, Europe, Asia, and Australia.
- Enterprise Standard for Data Historian – Strategic System in IT Roadmap
  - End to End Presence of the PI System in Janssen - Huge User Base
  - Leverage wealth of experience – Internal & External
  - EA Agreement with OSIsoft - Access to CoE & Tech Support
  - Strong foundation for Time Series & Batch Data
  - Compliance with ISA S88 Physical & Procedural Models
  - Huge library of Interfaces – Great solution for Historical & Real-time data collection and archival
  - Ability to Aggregate, Archive, Search, Visualize & Export

# Where does the PI System fit in this?



# Recipe Portal - S88 Recipe, Parameters



## Recipe Step Parameters

Drag a column header and drop it here to group by that column

	+	Name	Step	Equipment Type	Parameter
>	+	Hours elapsed	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[ELAPSED TIME_HRS]
	+	Days elapsed	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[ELAPSED TIME_DAYS]
	+	Total Viable Cells	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL COUNT VIABLE]
	+	Total Total Cells	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL COUNT TOTAL]
	+	Cumulative generations basic	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL GENERATIONS ACCUM._A]
	+	INTEGRAL_VIABLE_CELL	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL COUNT VIABLE INTEGRAL]
	+	INTEGRAL_VIABLE_CELL_CUM	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL COUNT VIABLE INTEGRAL ACCUM.]
	+	CALC_PERFUSION_RATE	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PERFUSION RATE]
	+	Reactor volume perfused per day	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PERFUSION RATE SCALED]
	+	Specific Antibody Production Rate basic	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[CELL SPECIFIC ANTIBODY PRODUCTION RATE_A]
	+	IgG output per Liter Media per day	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[SPECIFIC CELL-PRODUCTIVITY_PER VOLUME MEDIA]
	+	IgG Output per day basic	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PRODUCTION RATE_A]
	+	Cumulative IgG production in kg basic	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PRODUCT MASS ACCUM._KG_A]
	+	Cumulative IgG Production basic	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PRODUCT MASS ACCUM._G_A]
	+	Perfusion per cell	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[PERFUSION RATE_PER CELL]
	+	Medium consumption per gram	<input checked="" type="radio"/> Production Bioreactor\Continuous Perfusion\Daily Sampling	PI MDE	[MEDIUM CONSUMPTION PER G]



# Source Data - Batch Data (Static)

Form - StaticInfo opened by: Admin

Run NumberR13C001

MoleculeXXXXX

Cell LineXXXXX

Cell BankXXXXX

PC Ref:

PC Age: Days:

Media Lots

Media Lot

Feed1 Lot

Feed2 Lot

Antifoam Lot

Base Lot

ConditionXXXXX

Exp TitleXXXXX

ModeFed Batch

LocationR

Targ VCD0.6

Start Date3/1/2013

Feed1 Amt3.00%

BR Scale5L

StationBRR10006A

Targ Vol2.4

StatusFinished

Feed2 Amt0.37%

Comments

New

Save

Delete

Close

XXXXX2/27/2013XXXXX5/13/201311565

Sort by MoleculeXXXXX

List- of Runs

Batch ID

# Source Data - Batch Data (Dynamic)

PI Unit

List of Runs

Batch ID

BRR10006A

Product

Condition

Started By

Start Date

4/16/2013

Status

Running

Calculate Sheet

Import NOVA

Get PI Data

Feed1

3.00%

Feed2

0.75%

Data Entry Form

CULTI

DATE\_TIME

SAMPLED\_E

Sample S

PH

PH\_A

PH\_EX

pCO2(n

pO2(mm

Temp

DO2

AGITA

WT\_BAS

VOL\_V

Unit

0

4/16/2013 1:25:00 PM

20

7.31

7.292

33.9

76.9

36.9

49.2

202

1

4/17/2013 1:42:00 PM

20

7.3

7.282

29.5

77.5

37

51.1

199

0.158

2

4/18/2013 11:11:00 AM

20

7.15

7.188

30.9

57.1

37

50.2

199

0.142

3

4/19/2013 10:21:00 AM

20

6.91

6.939

45.2

70

37

52.1

196

0.142

4

4/20/2013 12:50:00 PM

20

6.9

6.904

63.1

76.6

37

49.4

201

0.169

5

4/21/2013 9:00:00 AM

20

6.9

6.912

83.5

70

37

44.4

200

0.176

6

4/22/2013 9:44:00 AM

20

6.9

6.919

109.2

55.6

37

44

201

0.174

7

4/23/2013 10:00:00 AM

20

7.03

7.049

90.6

37.6

37

42.9

199

0.173

8

4/24/2013 9:45:00 AM

20

7.07

7.077

90.2

67.8

37

53

198

0.168

9

4/25/2013 9:30:00 AM

20

7.11

7.095

87.4

78.4

37

52.1

203

0.171

10

4/26/2013 9:40:00 AM

20

7.12

7.134

84.9

91.5

37

51.9

202

0.173

11

4/27/2013 12:50:00 PM

20

7.12

7.124

89.4

81.8

37

52.8

201

0.179

12

4/28/2013 8:00:00 AM

20

7.1

7.094

92.4

77.6

37

52.4

203

0.171

13

4/29/2013 10:00:00 AM

20

7.13

7.126

86.7

70.4

37

48.5

200

0.159

14

4/30/2013 10:15:00 AM

15

7.12

7.094

84.1

90.5

37

53.9

200

0.155

15

5/1/2013 9:29:00 AM

15

7.17

7.144

75.8

80.5

37

50.6

202

0.168

16

5/2/2013 9:11:00 AM

20

7.21

7.199

68.5

81.4

37

51.9

199

0.163

17

5/3/2013 8:07:00 AM

20

7.3

7.252

46.8

85.3

37

55.3

197

0.149

18

5/4/2013 10:40:00 AM

20

7.31

7.303

30.9

78.5

37

50.8

202

\*

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PI AF Element Attributes

Time Series Data

Time Series Data

PI AF Element Attributes

# PI AF Element Template Configuration

PI Unit Template

PI AF Element Attributes

The screenshot shows the OSIsoft PI AF Element Template Configuration window. The 'Library' pane on the left lists various element templates, with 'CCDB' selected. The 'General' tab is active, displaying a table of attributes for the 'CARBON\_DIOXIDE\_PARTIAL\_PRESSURE' template. A red circle highlights the 'PI Unit Template' section of the table. The right pane shows the configuration details for the selected template.

Name	Description	Default Value
CARBON_DIOXIDE_PARTIAL_PRESSURE		0 torr
Category: PCO2 ARRAY		
CARBON_DIOXIDE_PARTIAL_PRESSURE_MOLAR		0
Category: pH		
ADJUSTED_pH		0
pH_EXTERNAL		0
Category: PH ARRAY		
pH		0
Category: PO2		
OXYGEN_PARTIAL_PRESSURE		0 torr
Category: PO2 MILLIMOLE PER L		
OXYGEN_PARTIAL_PRESSURE_MOLAR		0
Category: PROTEIN CONCENTRATION UG PER ML		
TITER		0
TITER_HARVEST_1		0
TITER_HARVEST_2		0
Category: PUMP SPEED ARRAY		
PUMP_BIOMASS		0
PUMP_FEED		0
PUMP_HARVEST		0
Category: REACTOR PI TAG		

Configuration details for CARBON\_DIOXIDE\_PARTIAL\_PRESSURE:

- Name: CARBON\_DIOXIDE\_PARTIAL\_PRESSURE
- Description:
- Configuration Item: ☐ Indexed: ☐
- Categories: PCO2
- Default UOM: torr
- Value Type: Double
- Default Value: 0 torr
- Data Reference: PI Point
- Settings...

## S88 Physical Model – Template tied to the PI unit

The screenshot displays the BRM01001 interface, which is divided into two main sections. On the left, the 'Corporate Hierarchy' is shown as a tree structure under the 'Elements' tab. It includes categories like 'External Partners', 'Johnson and Johnson', 'Janssen Pharmaceuticals', and 'Janssen Research and Development'. The 'BRM01001' element is highlighted in blue. On the right, the 'Time Series Data' table is visible, showing various attributes and their values for the selected element. The table has columns for 'Name' and 'Value'. The data includes attributes like 'BATCH\_LOCATION', 'CARBON\_DIOXIDE', 'CELL\_BANK', 'CELL\_LINE', 'CONDITION', 'DATE\_MODIFIED\_DYNAMIC', 'DATE\_MODIFIED\_STATIC', 'DYNAMIC\_CCDB\_ID', 'ENTERED\_BY', 'ENTERED\_DATE', 'ENTERED\_DATE\_STATIC', 'FEED1\_AMOUNT', 'FEED2\_AMOUNT', 'MEDIA\_LOT\_STATIC', 'MODIFIED\_BY\_STATIC', 'MOLECULE', 'PRECULTURE\_AGE', 'PRECULTURE\_REFERENCE', 'Gammonia', and 'Qglucose'. The 'FEED1\_AMOUNT', 'FEED2\_AMOUNT', and 'MEDIA\_LOT\_STATIC' rows are marked with a red 'X' icon, indicating missing data. The 'BRM01001' element is highlighted in blue in the table header.

**Corporate Hierarchy**


- Elements
  - External Partners
    - Johnson and Johnson
      - Janssen Pharmaceuticals
        - Janssen Research and Development
          - Beerse
            - Cork
            - Crucell
            - Higi
            - Leiden
            - Malvern
            - Radnor
            - Schaffhausen
            - Shared
              - Large Molecule API
                - Cell Culture
                  - CCDB
                    - BR3030
                    - BR3200
                    - BR3210
                    - BRM01001**
                    - BRM01002
                    - BRM01003
                    - BRM01004
                    - BRM01005
                    - BRM01006
                    - BRM01007
                    - BRM01008
                    - BRM01009
                    - BRM01010
                    - BRM01011
                    - BRM01012
                    - BRM01013
                    - BRM01014
                    - BRM01015

**Time Series Data**

| Name                  | Value                 |
|-----------------------|-----------------------|
| BATCH_LOCATION        |                       |
| CARBON_DIOXIDE        | 10.630000114440918    |
| CELL_BANK             |                       |
| CELL_LINE             |                       |
| CONDITION             |                       |
| DATE_MODIFIED_DYNAMIC | 8/29/2013 1:30:28 PM  |
| DATE_MODIFIED_STATIC  | 7/23/2013 12:00:00 AM |
| DYNAMIC_CCDB_ID       | 1151898               |
| ENTERED_BY            |                       |
| ENTERED_DATE          | 7/29/2013 6:50:40 AM  |
| ENTERED_DATE_STATIC   | 7/17/2013 12:00:00 AM |
| FEED1_AMOUNT          | No Data               |
| FEED2_AMOUNT          | No Data               |
| MEDIA_LOT_STATIC      | No Data               |
| MODIFIED_BY_STATIC    | ccarus2               |
| MOLECULE              |                       |
| PRECULTURE_AGE        | 13 d                  |
| PRECULTURE_REFERENCE  | 09JUL13C168J013: 4001 |
| Gammonia              | No Data               |
| Qglucose              | No Data               |

BRM01001 Modified:8/28/2013 2:36:01 PM. Version: 1/1/1970 12:00:00 AM, Revision 2

# S88 Process Model with PI EF



### Recipe Step Hierarchy

| Name                                 | Description |
|--------------------------------------|-------------|
| <b>P</b> Production Bioreactor       |             |
| <b>S</b> Initialize                  |             |
| <b>S</b> Fill Medium and Equilibrate |             |
| <b>S</b> Inoculate Bioreactor        |             |
| <b>S</b> Fed Batch                   |             |
| <b>O</b> Antifoam Addition:1         |             |
| <b>O</b> Daily Sampling:1            |             |
| <b>A</b> Aliquot Sample              |             |
| <b>O</b> Feed1 Addition Day 3        |             |
| <b>O</b> Feed2 Addition Day 3        |             |
| <b>O</b> Media Addition Day 0        |             |
| <b>O</b> pH Control                  |             |

### Event Frames

- Event Frame Searches
  - Event Frame Search 1
    - mAb Platform
      - Mab Platform Stage 2:Bioreactor Production
        - Production Bioreactor
          - Fill Medium and Equilibrate**
          - Fill Medium Bioreactor
          - Hold at Equilibrium
          - Store Product
          - Initialize
          - Inoculate Bioreactor
          - Fed Batch
            - Antifoam Addition:1
            - Antifoam Addition:2
            - Antifoam Addition:3
            - Antifoam Addition:4
            - Daily Sampling:1
            - Daily Sampling:10
            - Daily Sampling:11
            - Daily Sampling:12
            - Daily Sampling:13
            - Daily Sampling:14
            - Daily Sampling:15
            - Daily Sampling:16
            - Daily Sampling:17
            - Daily Sampling:18
            - Daily Sampling:2
            - Daily Sampling:3
            - Daily Sampling:4
            - Daily Sampling:5
            - Daily Sampling:6
            - Daily Sampling:7
            - Daily Sampling:8
            - Daily Sampling:9

### mAb Platform

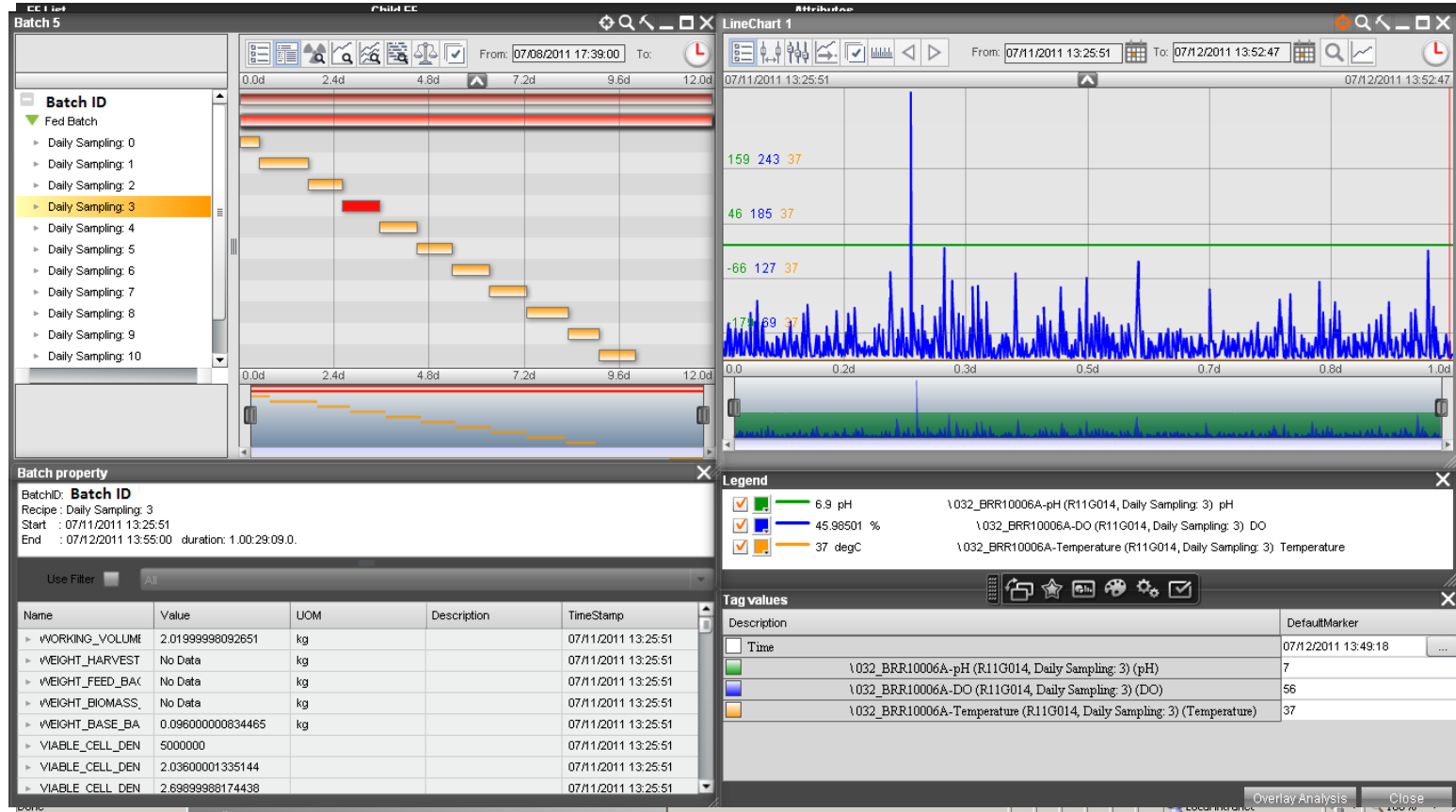
| General            | Child Event Frames   | Referenced Elements | Attributes |
|--------------------|--|---------------------|------------|
| Name:              | mAb Platform   |                     |            |
| Description:       |  |                     |            |
| Template:          |  |                     |            |
| Start time:        | 9/6/2013 9:17:00 AM  |                     |            |
| End time:          |  |                     |            |
| Default Attribute: | <None>   |                     |            |
| Find:              | <a href="#">Extended Properties</a><br><a href="#">Parents</a> |                     |            |

**Annotations:**

- Red box around "Fill Medium and Equilibrate" and "Antifoam Addition:2" with a red arrow pointing to the text: **Missing Information from Automation Layer**
- Green box around the "Daily Sampling" list with a green arrow pointing to the text: **Easily Mapped information**

**As-Is to Standard Definition**

# Visualization



# Accessing real-time PI System Data during ELN Execution

Recipe Selection  
Recipe Stage: Reaction:1 T3040 ☐ GxP? ☐ Continuous Execution?

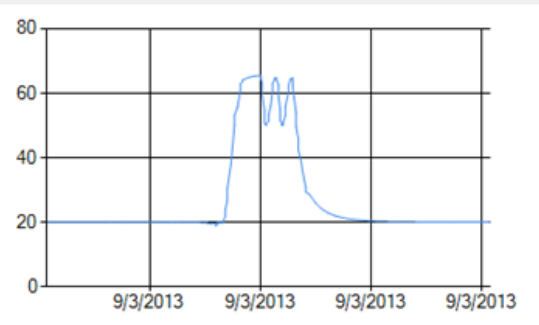
Equipment Parameter Selection

Equipment  
Instance: R032 Def Tag: none

Parameter Information  
Name: Baffle Temperature Tags: Baffle Temperature

Preview Value  
20.1021690368652 none

Selected Time: 9/3/2013 12:15:45 PM



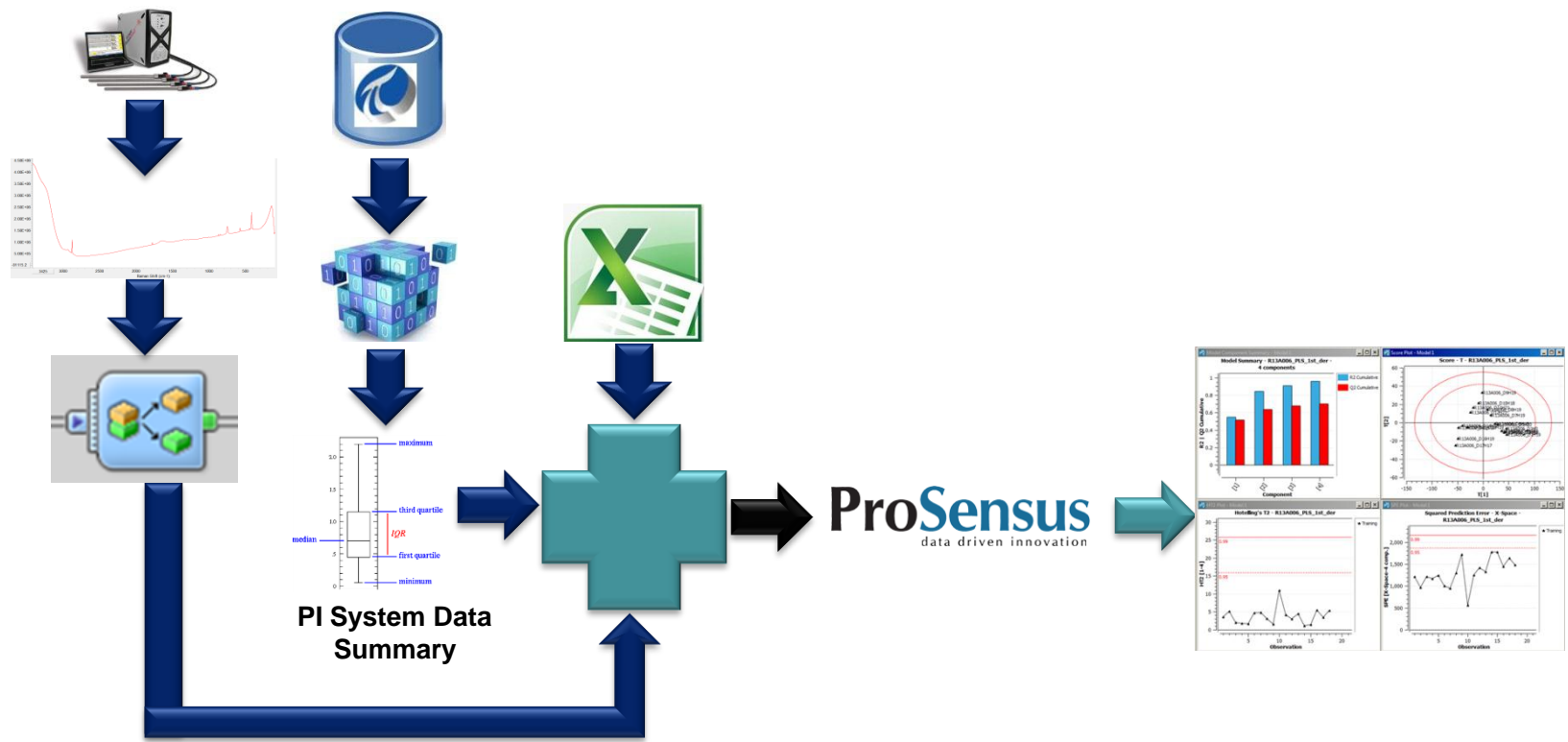
End: 9/ 3/2013 12:16:52 Span 16 hr

Display Overview Open Toolbox Show Attachments Add Remark to Stage Stage Close

Statistics: Avg: 26.793 Min: 18.9 Max: 65.448 StdDev: 14.11

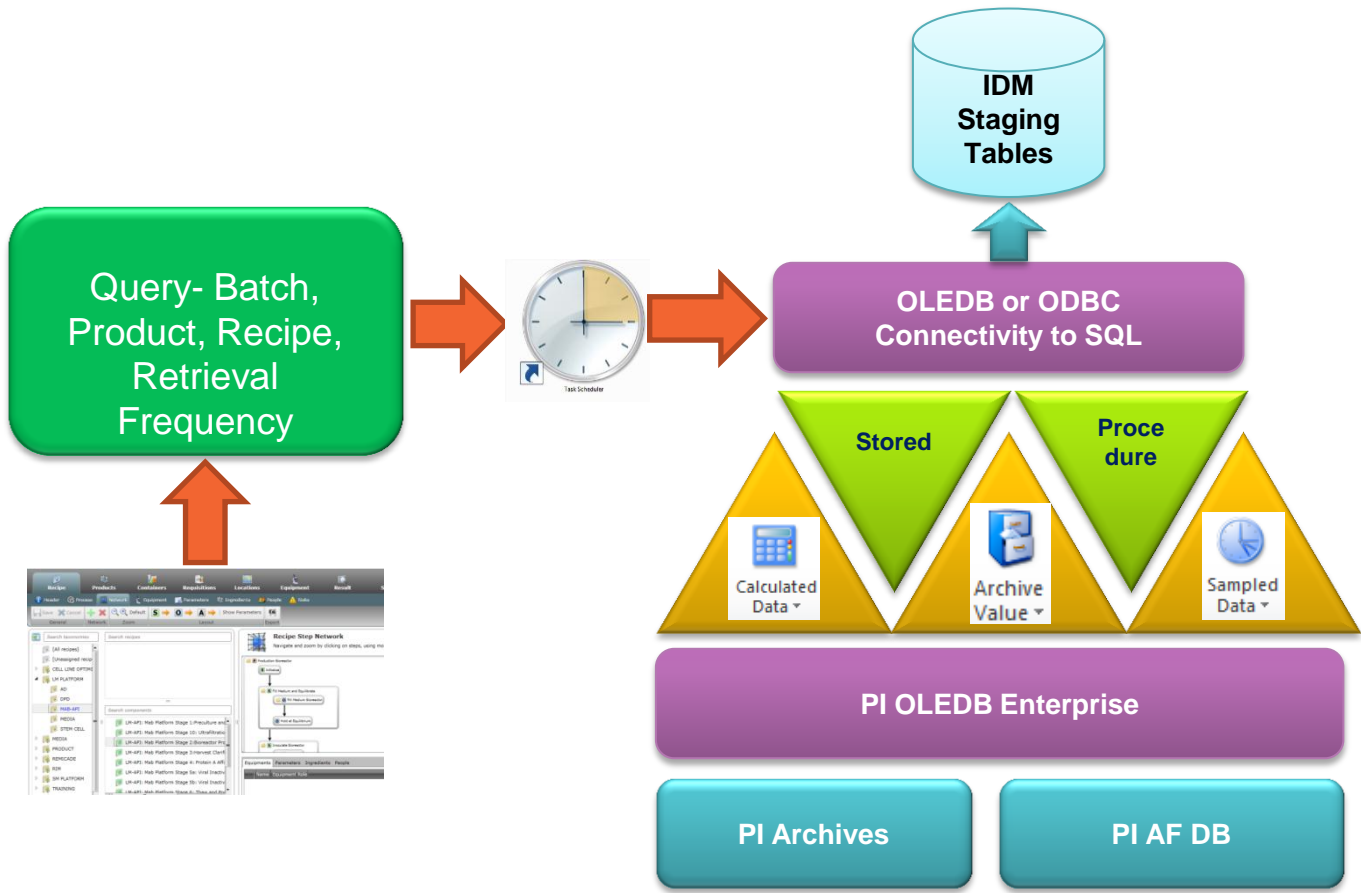
Uses PI AF SDK and  
Library Templates

# Exporting PI System Data Summary – Today





# Accessing PI System Summary – Future



# Challenges

- Data Quality – Especially manual data entries
- Missing Information
  - New approach record (almost) EVERYTHING in PI that makes sense
- Batch context alignment for legacy data
  - Aligning as-is context to platform context
- Need more Flexibility & configurable settings in PI AF & PI EF
  - Using PI ACE today
- Need Improvements to PI EF Interface Generator for complex start and end trigger definitions
- Need PI ACE access in PI EF Interface Generator
- Need parent-child relationships in PI AF and PI EF Templates configuration

# Next Steps

- PI AF configuration for all equipment and instruments in Janssen
  - Corporate Unit Class Definitions
  - Pre-Requisite for all systems to reference these classes (ELN, MES)
- PI EF prototype effort and rollout plan to implement across all platforms
  - Context transformation – AS-IS to Platform
  - PI EF Context becomes the MASTER Context for Data References
- Fix data source layer and address data quality issues
  - lack of controls for data (pH = 7.023 or 70.23?)
- Continue working with OSIsoft and other strategic partners to get more COTS features & modules

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