PI System Based Industrial Big Data Applications

Presented by **Jeremy Kuo & Nancy Jiang**

Outline

A. Introduction

B. Requirements

C. Application at DSC/CSC

D. PI System + iEM

E. Conclusion

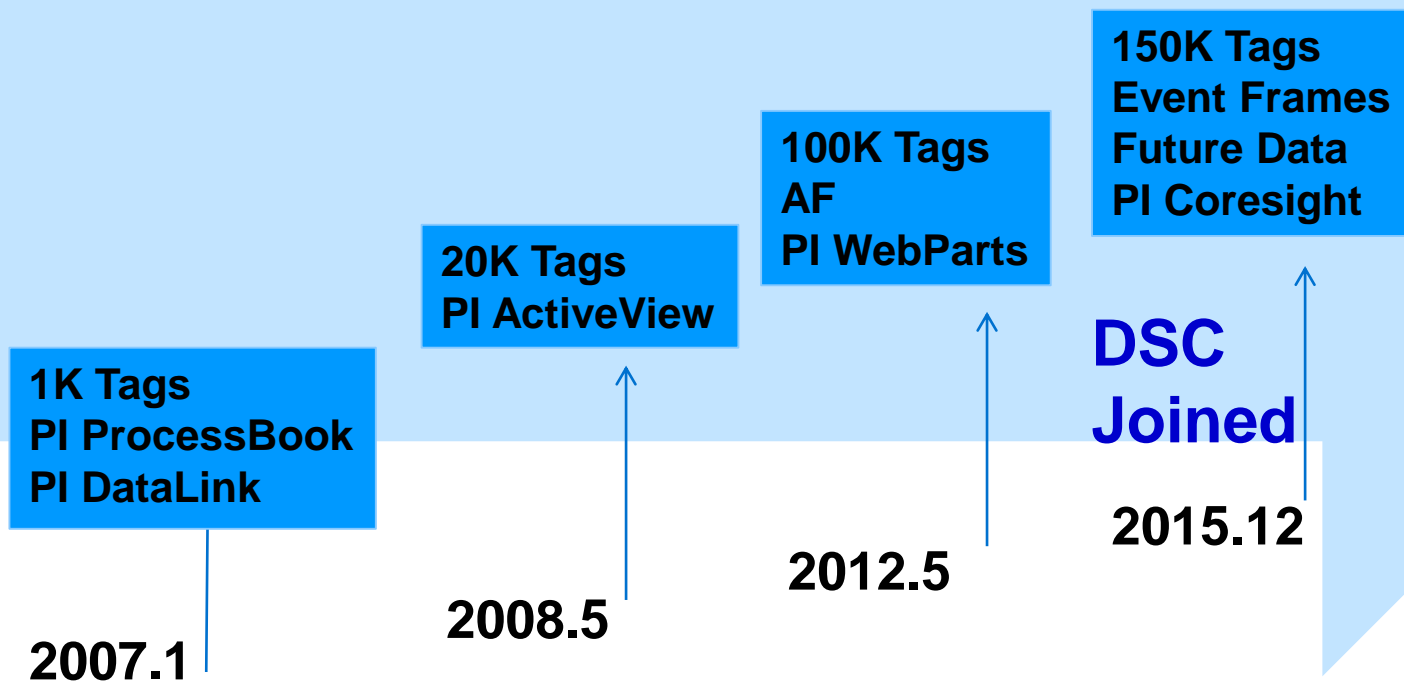# Introduction of CSC (China Steel Corporation)

- Founded in December 1971

- Located at Kaohsiung, Taiwan

- Annual production (crude steel) around 10 million tones

- Products include plates, bars, wire rods, hot and cold rolled coils, electrogalvanized coils, electrical steel coils, hot-dip galvanized coils and Ti/Ni-base alloy

- CSC is the largest steel company in Taiwan including investment in transport, resource and environment protection, etc.

Introduction of DSC (Dragon Steel Co.)

- Nov 1993: Kuei-Yi Industrial Co.
- July 2004: Kuei-Yi Industrial Co. renamed as DSC
- Feb 2010: 1st BF blow in
- Mar 2013: 2nd BF blow in
- Yield
  - BF: 5 million tones/year
  - EAF: 1 million tones/year
- Employees: 3,200
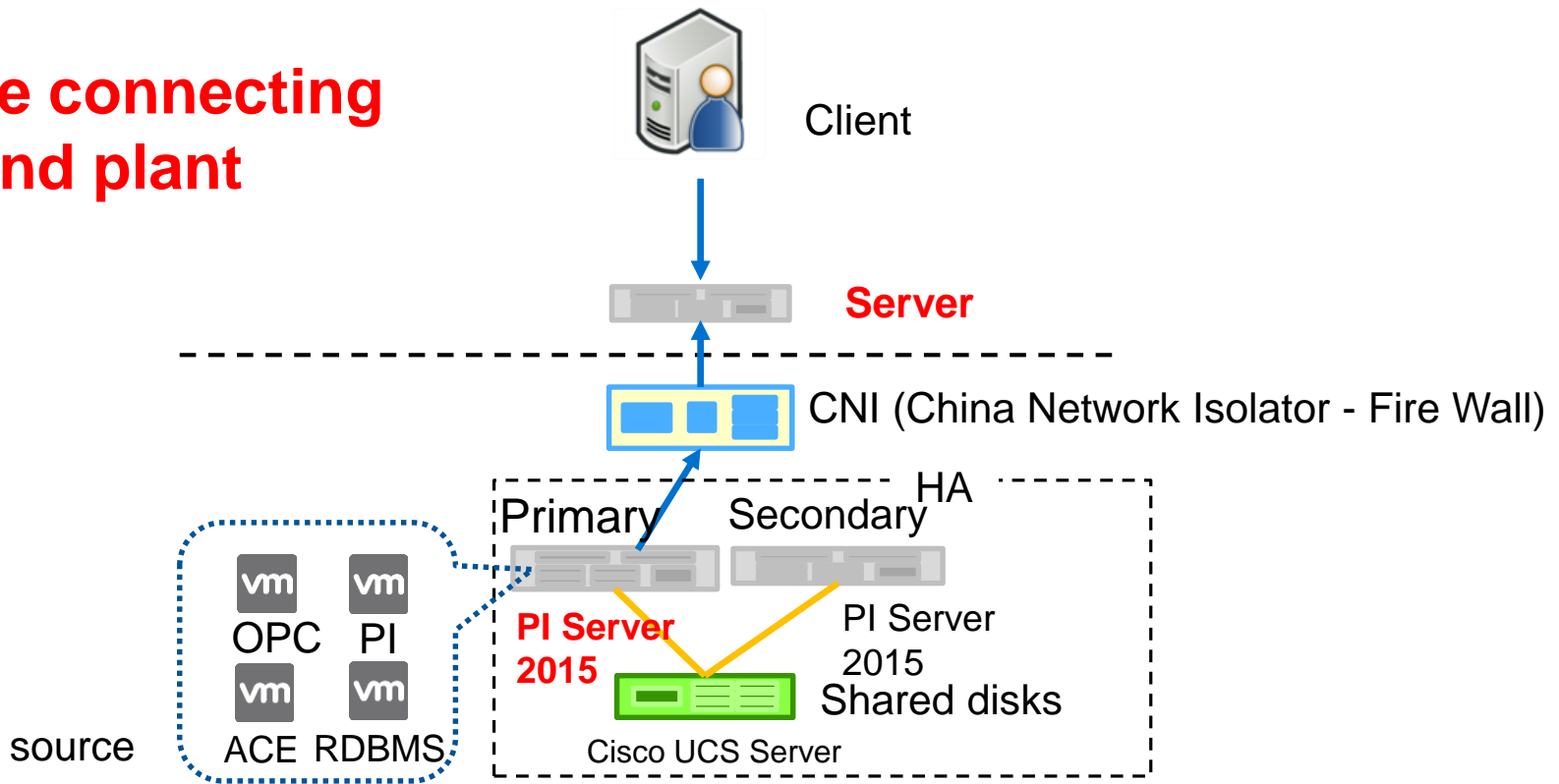- Product: Hot-rolled coils, Flat, H beams and Billets

PI System @ CSC

10+ Years Data in PI

**1K Tags
PI ProcessBook
PI DataLink**

2007.1

**20K Tags
PI ActiveView**

2008.5

**100K Tags
AF
PI WebParts**

2012.5

**150K Tags
Event Frames
Future Data
PI Coresight**

**DSC
Joined**

2015.12

PI System Architecture @ DSC

A bridge connecting office and plant

Client

Server

CNI (China Network Isolator - Fire Wall)

HA

Primary   Secondary

PI Server 2015   PI Server 2015

Shared disks

Cisco UCS Server

OPC   PI

ACE   RDBMS

source

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Business Requirements

Process PC (DCS, PLC) → Data collection — **Hand writing, key in, rework and low efficiency**

LEVEL 1

→ Trend Monitoring — **Hard to execute**

→ Integration of Platforms — **Hard to execute**
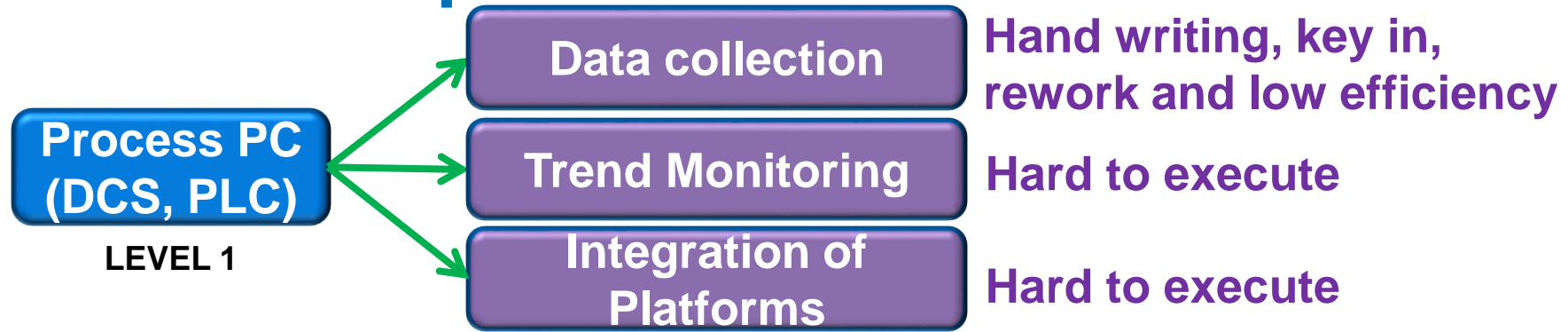
⬇ **Requirements**

PI (Plant Information) System

- **Collecting plant information efficiently**
- **Integrating data from different sources and platforms and providing a uniformed user-interface to all users**
- **Building Big Data applications on top for intelligent manufacturing and better effectiveness**

Requirements

Industry 4.0 Plant…
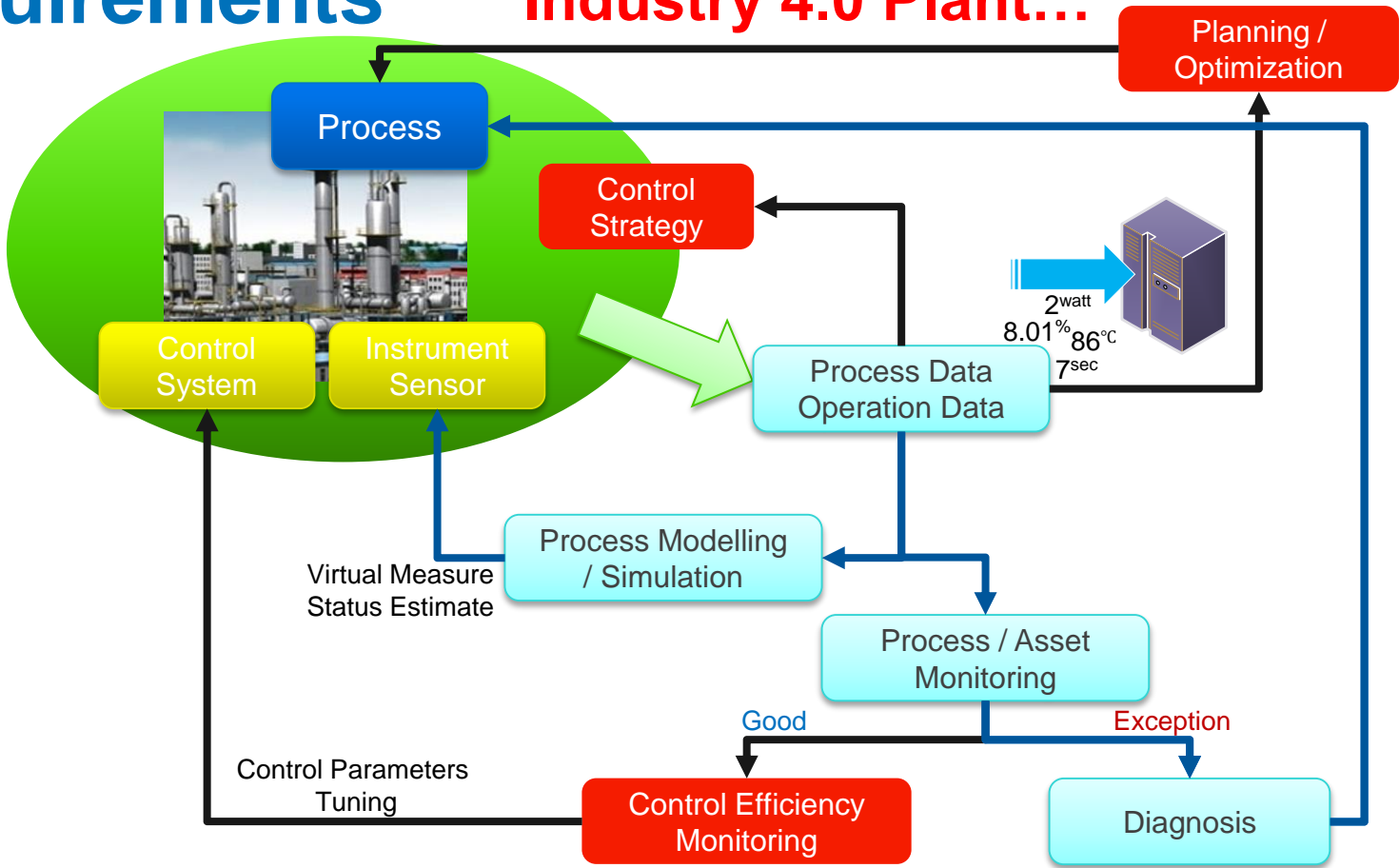
Requirements

Why Do We Need the OSIsoft PI System?

A tool for

- **Data Collecting**

Saving and Earning Money $$$

- **Problem Solving and Analysis**

- **Management (Processes, Power and Resources, etc.)**

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ASU: Oxygen Load Forecasting System
Function of Oxygen

O_2

ASU

Limestone — Sinter Plant - Sinter

Iron Ore

Coal

Coke Ovens - Coke

Recycled Steel - Scrap

Secondary Steelmaking

Basic Oxygen Converter

Blast Furnace - Molten Iron

Electric Arc Furnace

Molten Steel

Click this button to go to the next page

Offcuts from various processes & scrap

1. For oxygen enriched combustion in BF
2. Convert iron to steel in **B**asic **O**xygen **C**onverter、EAF

ROLLING   PRODUCTS

Oxygen Supply in DSC

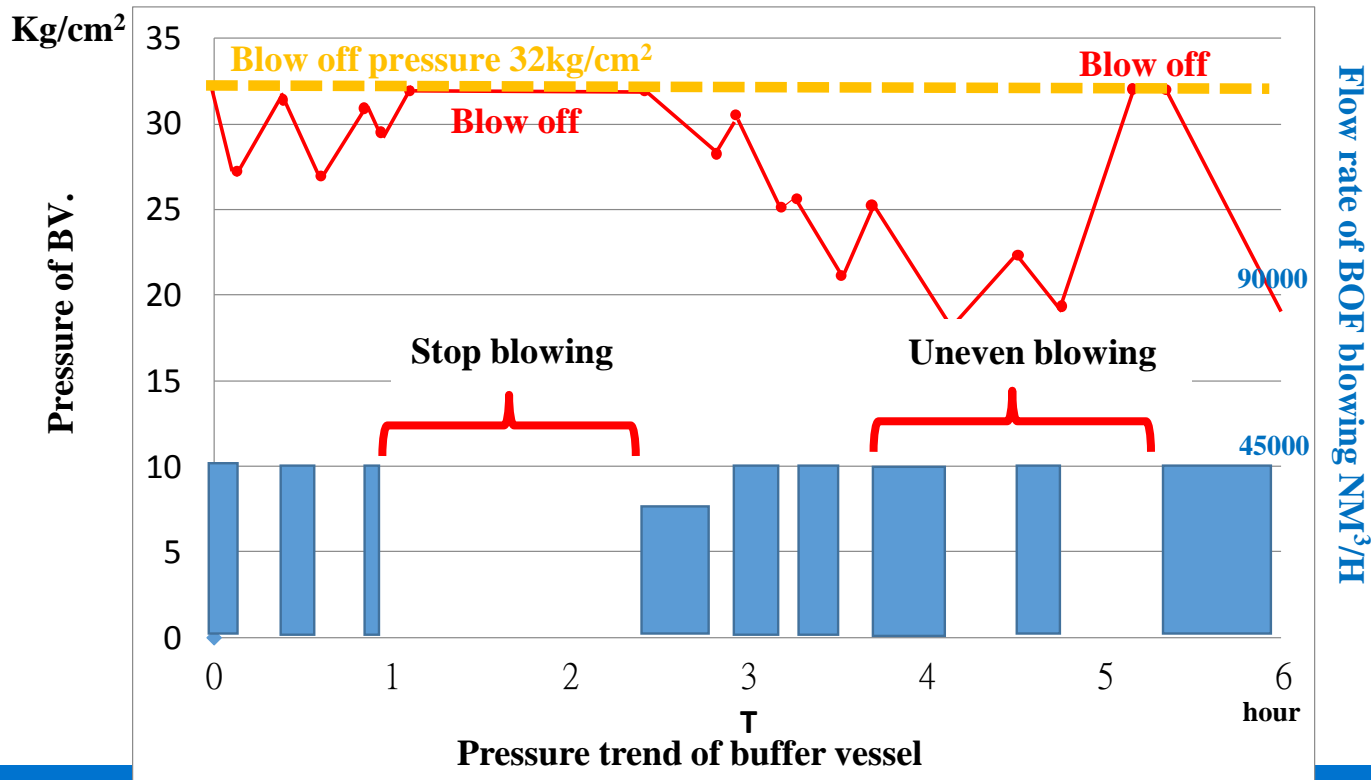# Problem 1: LOX Consumption

Even though <u>oxygen's supply met demand,</u> LOX consumption still could not be avoided when BOC operated unstably.

Kg/cm²

Set P

Pressure of BV reduce to set P (about 19~20kg/cm²), LOX consume

Double BOF 90000

Single BOF 45000

Flow of blowing   (NM³/H)

T
Pressure of buffer vessel

time: H

Problem 2: Blow Off

Due to the nature of BOC's batch processing, when BOC stopped or uneven blowing also makes oxygen blow off.

Pressure trend of buffer vessel

Oxygen Load Forecasting System

Applying Forecasting System (Before)

Applying Forecasting System (After)

Reduce LOX Consumption and Blow Off

Monthly Average LOX Consumption

Before Forecast Sys.
816.8T
Blow off 3-7%

After Forecast Sys.
443.4T
Blow off <3%

Reduce **45.7%** LOX Consumption
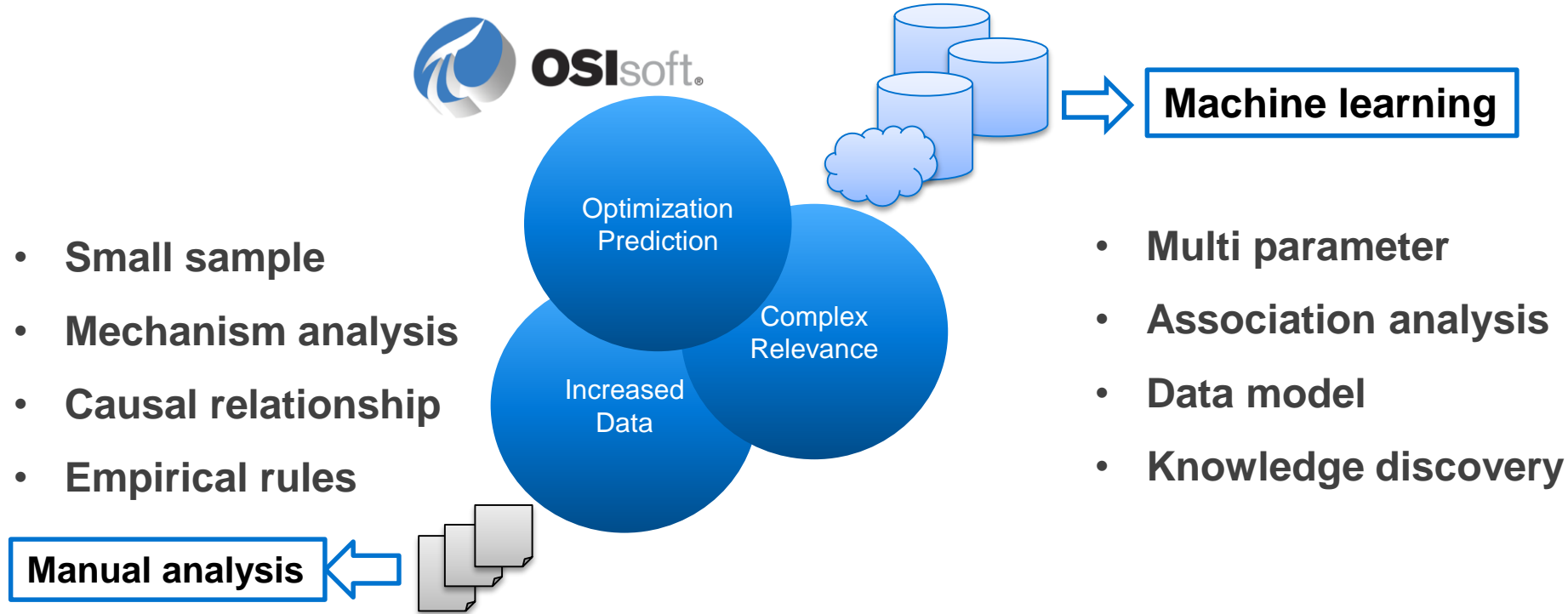
9/M Forecast Sys. Test Run

2014

SUM

2015

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Evolution of PI System Analysis Methods

- **Small sample**
- **Mechanism analysis**
- **Causal relationship**
- **Empirical rules**

Manual analysis

Optimization Prediction

Complex Relevance

Increased Data

Machine learning

- **Multi parameter**
- **Association analysis**
- **Data model**
- **Knowledge discovery**

Why Do We Need Big Data Analysis?

Most PI Server Data is Sleeping…

Apps

3+ Year Data 0 Apps

1+ Year Data Less 1% Apps

1 Year Data 5% Apps

3 Months Data 30% Apps

3 Weeks Data 95% Apps

PI-DA & AF

What is iEM?

Raw PI Server Data   **Refined Data**   **IBD Model**

Data Cleaner

IBD Modeling
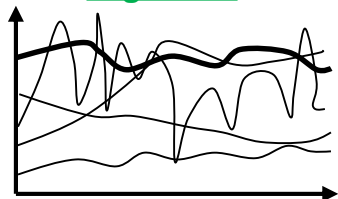**Hypersphere Model**

PI Server   +   iEM

intelligent Engine for Machine-learning

PI System Based Industrial Big Data Apps
IBD - Hypersphere Modeling

Tag Trend
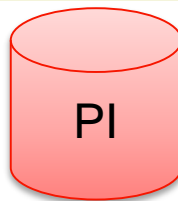
Process/Equipment

Years+ Data in PI

$$\begin{bmatrix} v_{11} & v_{12} & v_{13} & v_{14} & v_{15} & v_{16} \\ v_{21} & v_{22} & v_{23} & v_{24} & v_{25} & v_{26} \\ v_{31} & v_{32} & v_{33} & v_{34} & v_{35} & v_{36} \\ v_{41} & v_{42} & v_{43} & v_{44} & v_{45} & v_{46} \\ v_{51} & v_{52} & v_{53} & v_{54} & v_{55} & v_{56} \end{bmatrix}$$
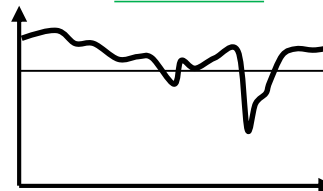
$$H_v = 80\%$$

Hyp-Evaluating

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \end{bmatrix}$$

Hyp-Modeling

PI

HPI Trend

$$\begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{bmatrix}$$
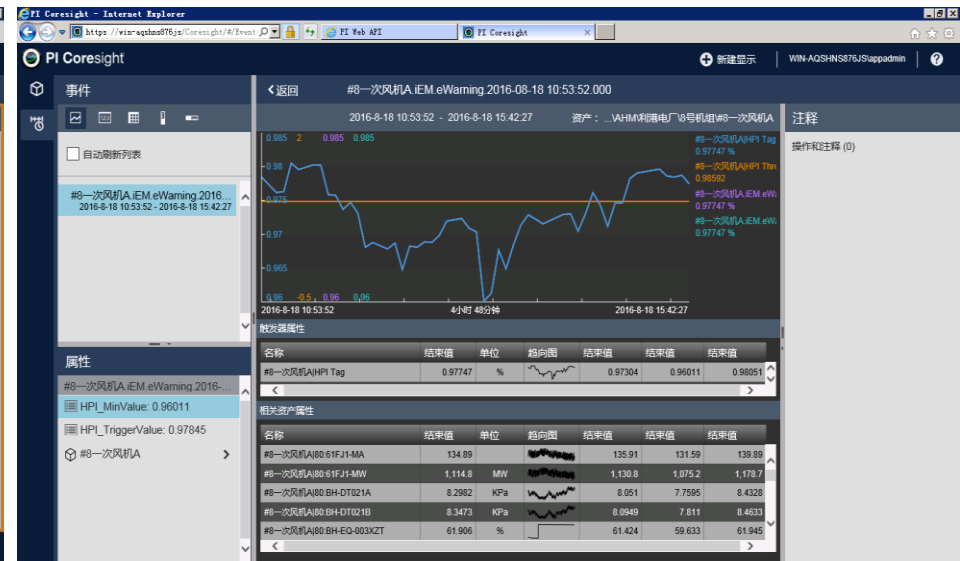
$$H_{th} = 97\%$$

IBD Model

$$\begin{bmatrix} v_{11} & v_{13} & v_{14} \\ v_{21} & v_{23} & v_{24} \\ v_{31} & v_{33} & v_{34} \\ v_{41} & v_{43} & v_{44} \\ v_{51} & v_{53} & v_{54} \end{bmatrix}$$
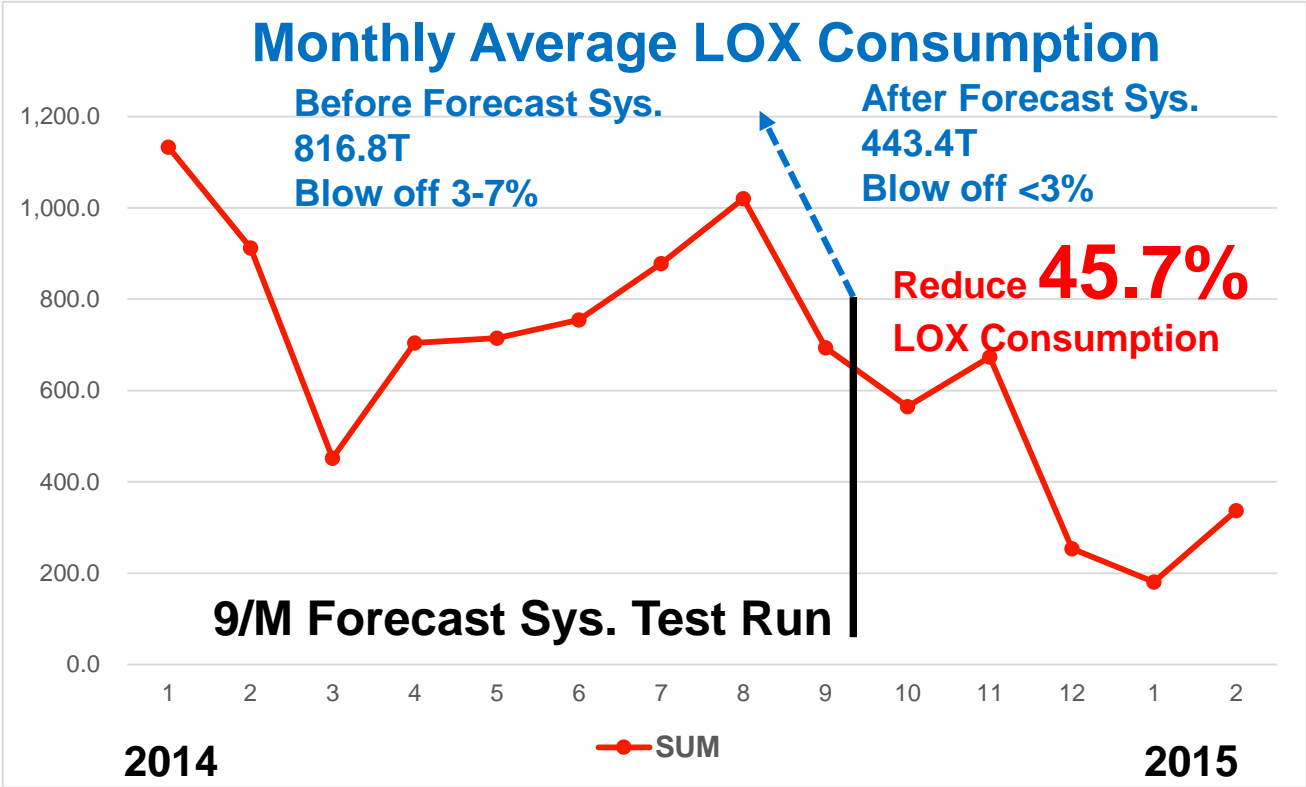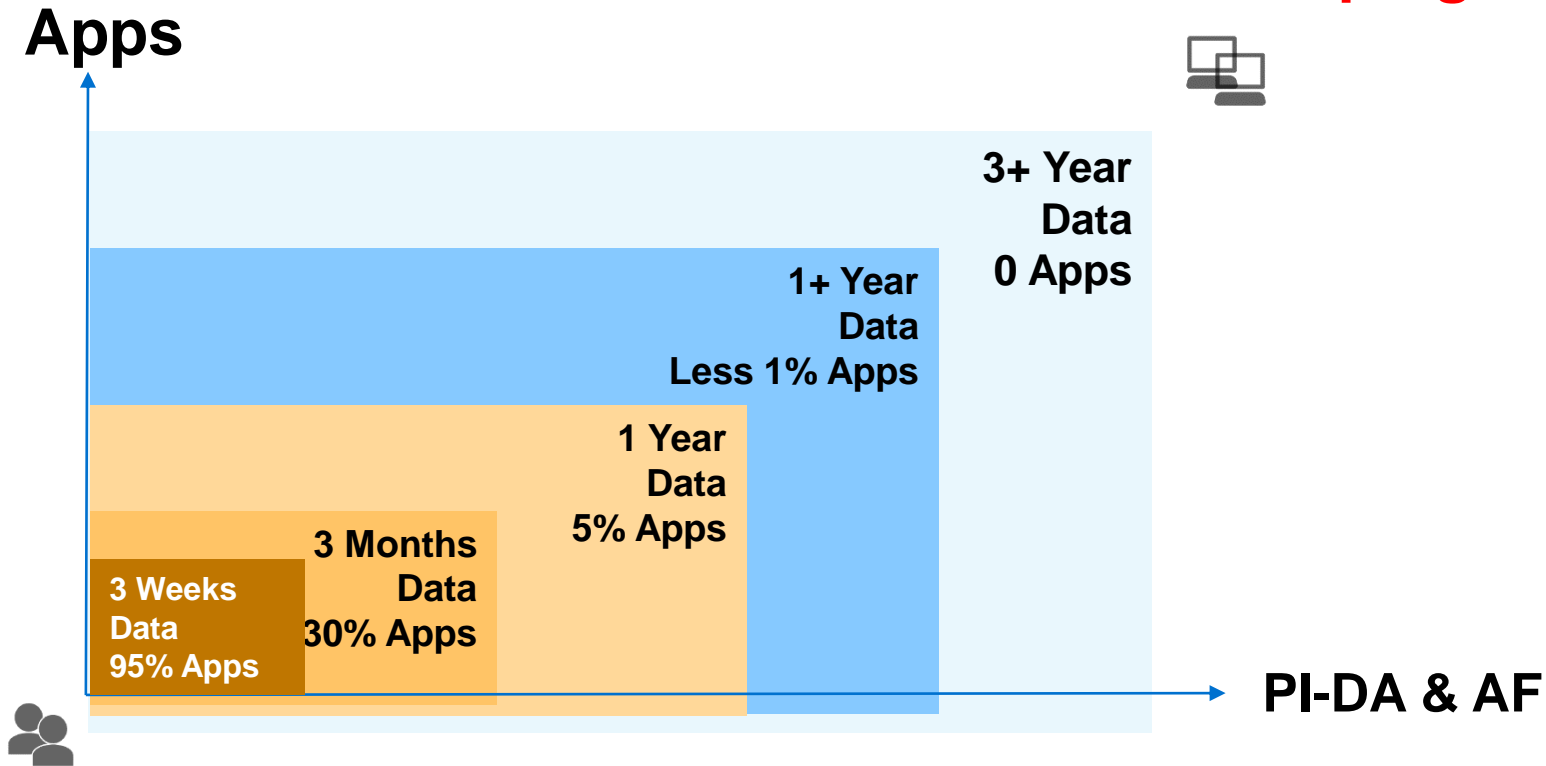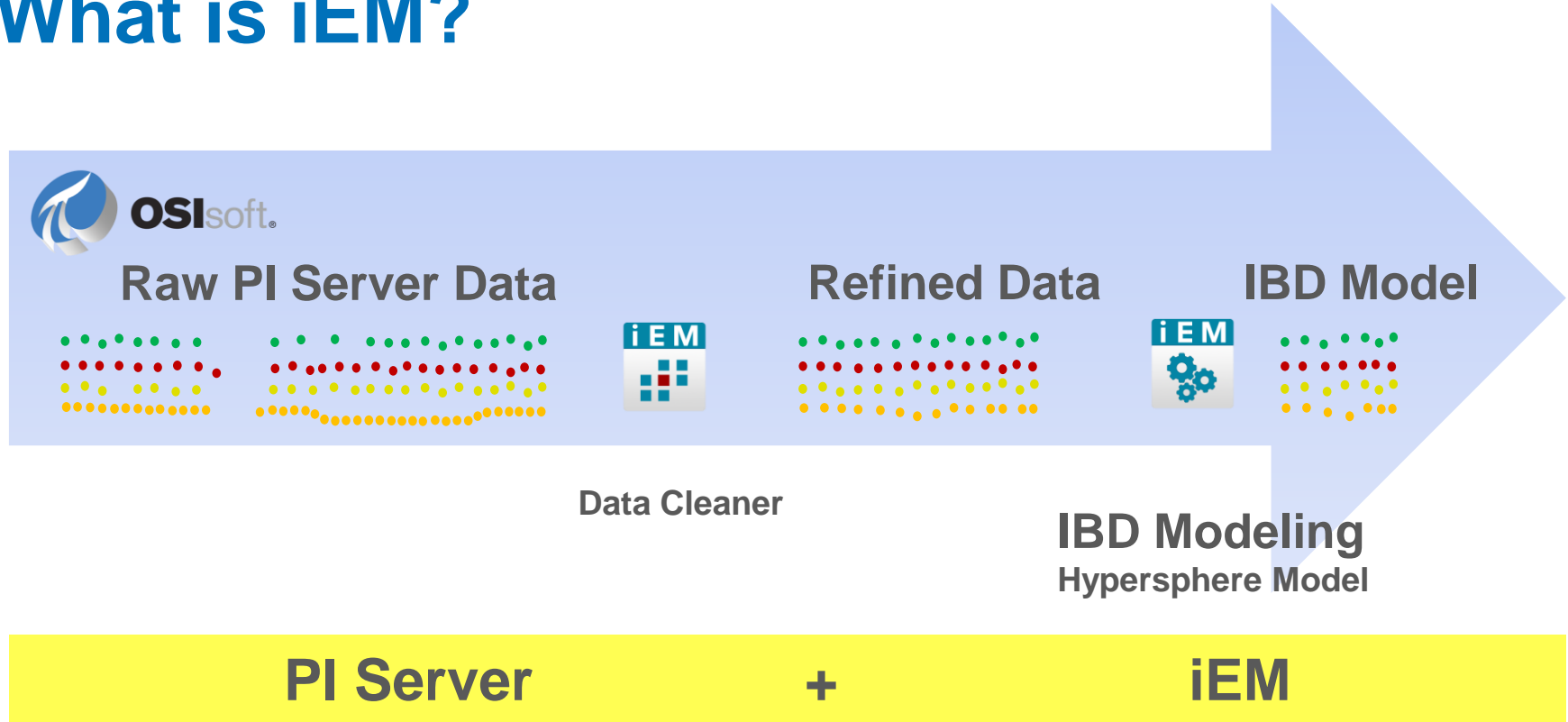
IBD View

PI System Based Industrial Big Data Apps
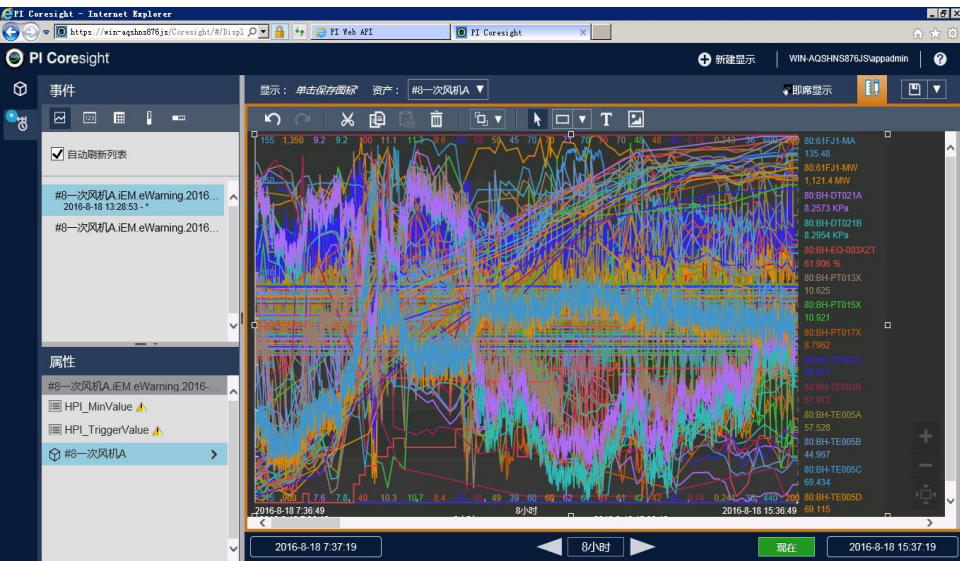
IBD - Hypersphere Model

PI System Based Industrial Big Data Apps

- **PI AF**
- **PI EF**
- **PI ProcessBook**
- **PI Coresight**

- **iEM Manager**
- **iEM Explorer**
- **iEM Monitor**
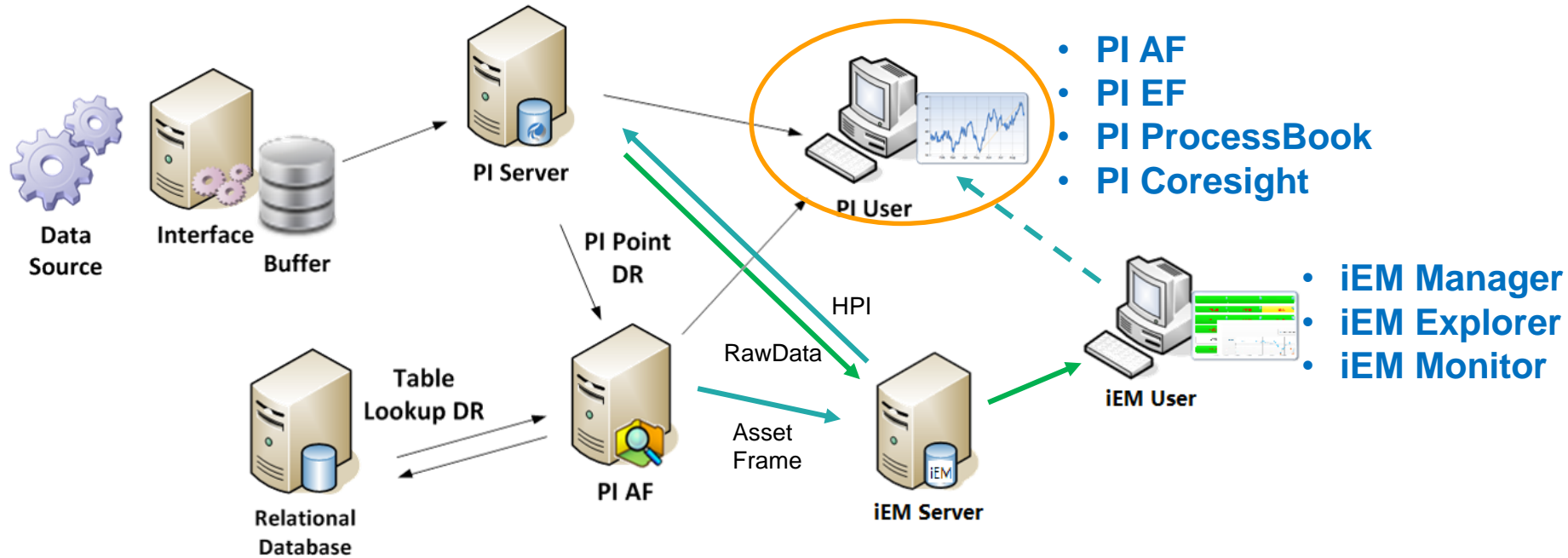
PI System Based Industrial Big Data Apps

Multi-Year Data

Manager

Modeler

Explorer

PI Server

IBD Server Hypersphere

Report

PI AF

Monitor

iEM

InsightOne

Miner

Solutions	IBD Applications
AHM Asset Health Management	**Asset Health Management on Sintering & Iron-Making**
MES+ Equipment E-warning & Prognosis	**Equipment Early Warning & Prognosis on Pumps & Fans**
TDM+ Remote Rotating System Diagnosis	**Electric Power Generator Remote Diagnosis**
DCS+ Process Health Monitoring	**Process Health & Performance Optimization on Air Separation**
EMS+ Energy Efficiency Online Analysis	**Energy Efficiency Online Monitoring & Analysis**

PI Server + iEM

Solutions

IBD Applications

PI Server/IBD Model + Asset Framework   + PI Coresight

With Big Data Apps

Most PI Server Data is Awakening...

Apps

- 3+ Year Data Apps
- 1+ Year Data Apps
- 1 Year Data Apps
- 3 Months Data 30% Apps
- 3 Weeks Data 95% Apps

PI Tags
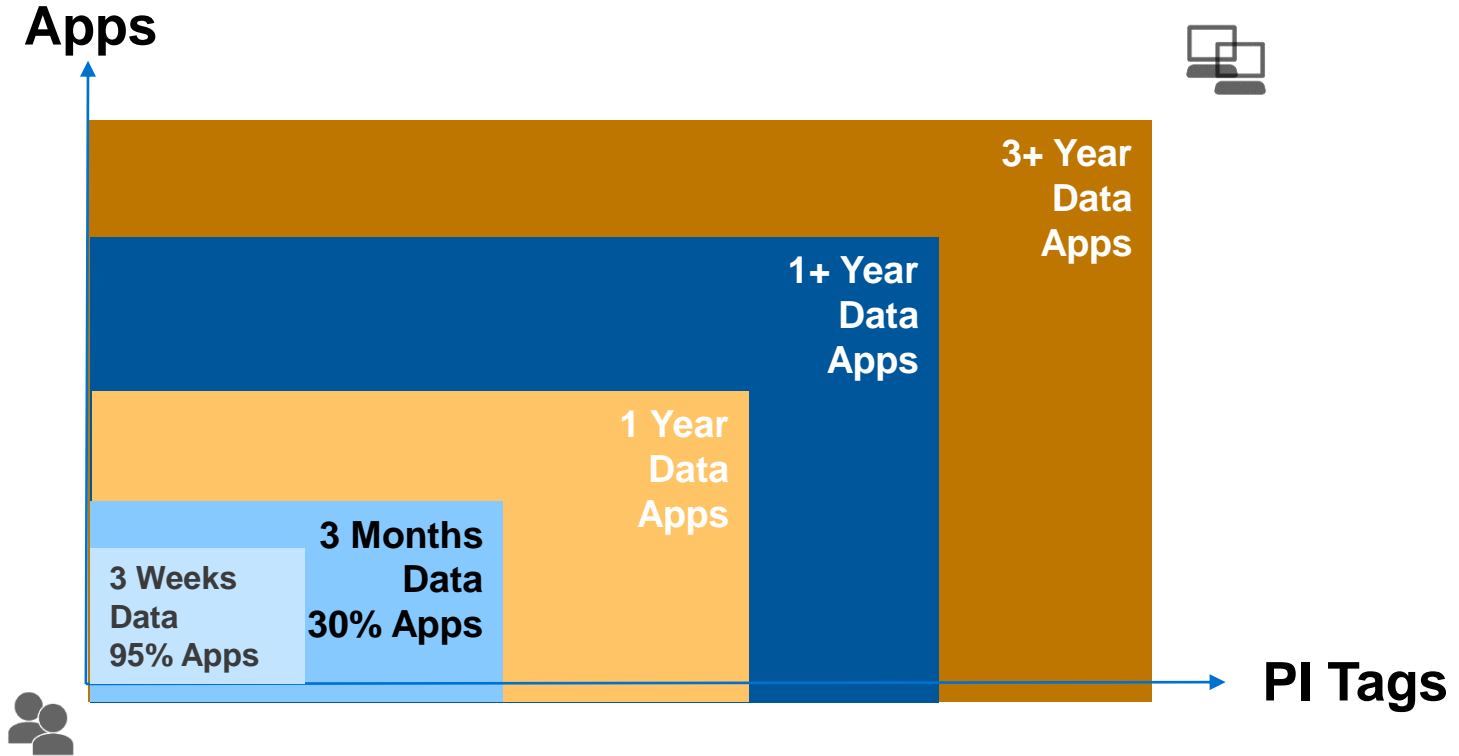
Intelligent Monitoring
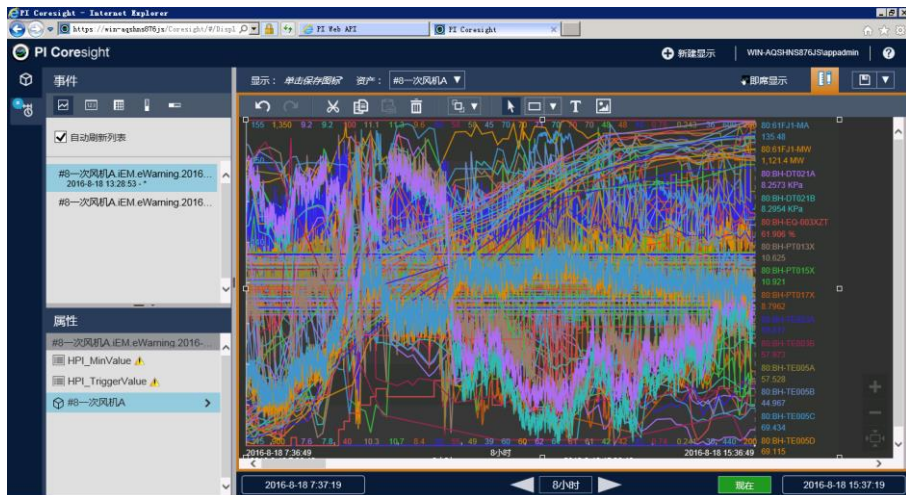
At least 5 ~ 10 times of efficiency improvement

Benefits

- 360° 24 / 7 Monitoring
  - Promote equipment efficiency > 50%
- Early-Warning
  - Save maintenance cost > 10%
  - Improve equipment reliability > 20%
  - Reduce the number of accidents/losses
- Operations Optimization
  - Identify equipment and process optimization operation key points
  - Real-Time optimization prediction
  - Guide optimal operations
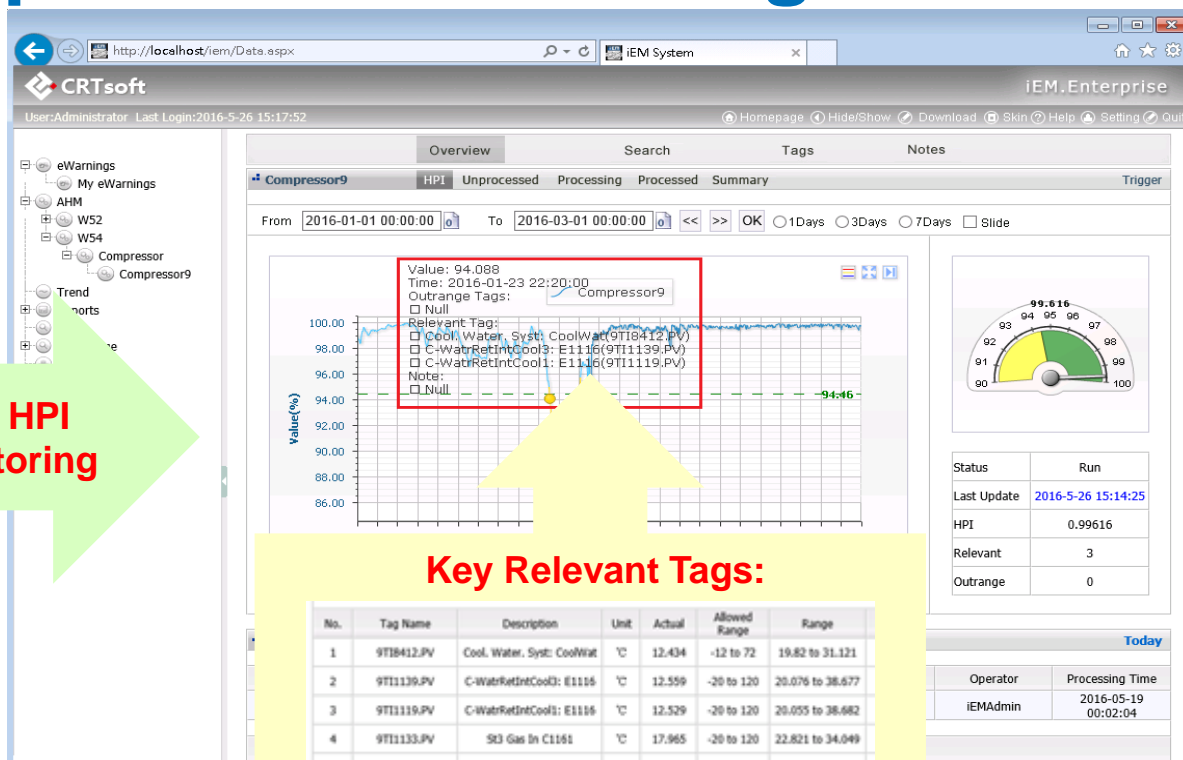 - Improve production rate and equipment energy efficiency > 5%

Equipment Efficiency and Process Health and Process Index Optimization sensing percentage and perception quantitative curve
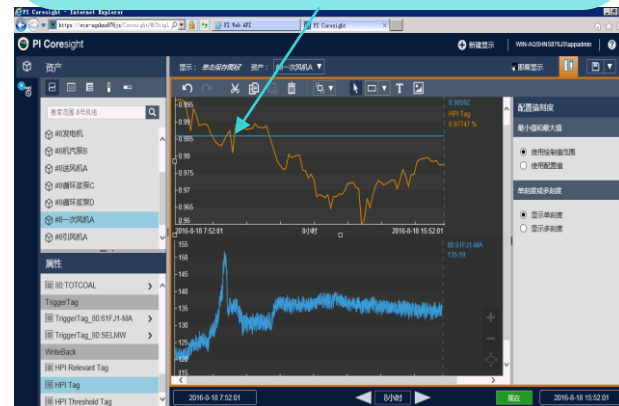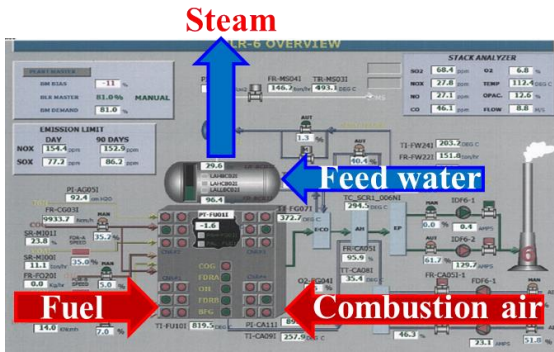
Case 1: Air Compressor Online Diagnosis

IBD HPI Monitoring

Key Relevant Tags:

Root Cause:
Cooling water temperature too low

Case 2: Boiler System Online Diagnosis

IBD HPI Monitoring
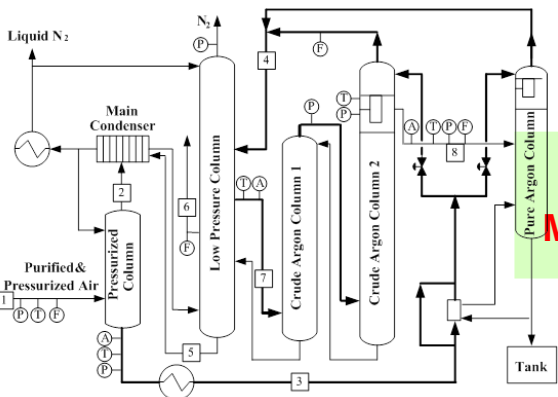
Steam

Feed water

Fuel

Combustion air

Root Cause:
Feed water flow error / Pump stopped
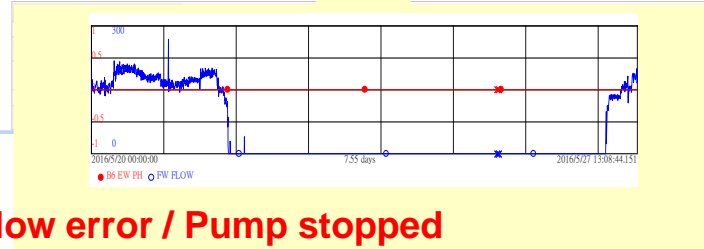
Case 3: Air Separating Process Online Diagnosis

IBD HPI Monitoring

Root Cause:
Tower temperature too low

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Summary

COMPANY and GOAL

China Steel Group aims to increase cashflow with a better data integration platform for problems solving and analysis, and better management of processes, power and resources, etc.

CHALLENGE

Various data sources, a lot of manual work, difficult to achieve Industry 4.0 objectives

- Need a unified data integration platform
- Need a uniformed user-interface
- Need to utilize data to achieve intelligent manufacturing for better effectiveness

SOLUTION

Implemented PI System for data integration; with iEM for Big Data analytics

- Use PI System as the bridge between office and plant
- Use Future Data for Forecasting
- Use iEM for Big Data analytics and prediction

RESULTS

Intelligent manufacturing and better effectiveness

- 5-10 times efficiency improvement
- Increase equipment efficiency > 50%
- Early warning to save maintenance cost > 10%
- Reduce accidents and losses, improve equipment reliability > 20%
- Improve production rate and equipment energy efficiency > 5%

Conclusion

Best Decision – PI System!!

Contact Information

CHINASTEEL
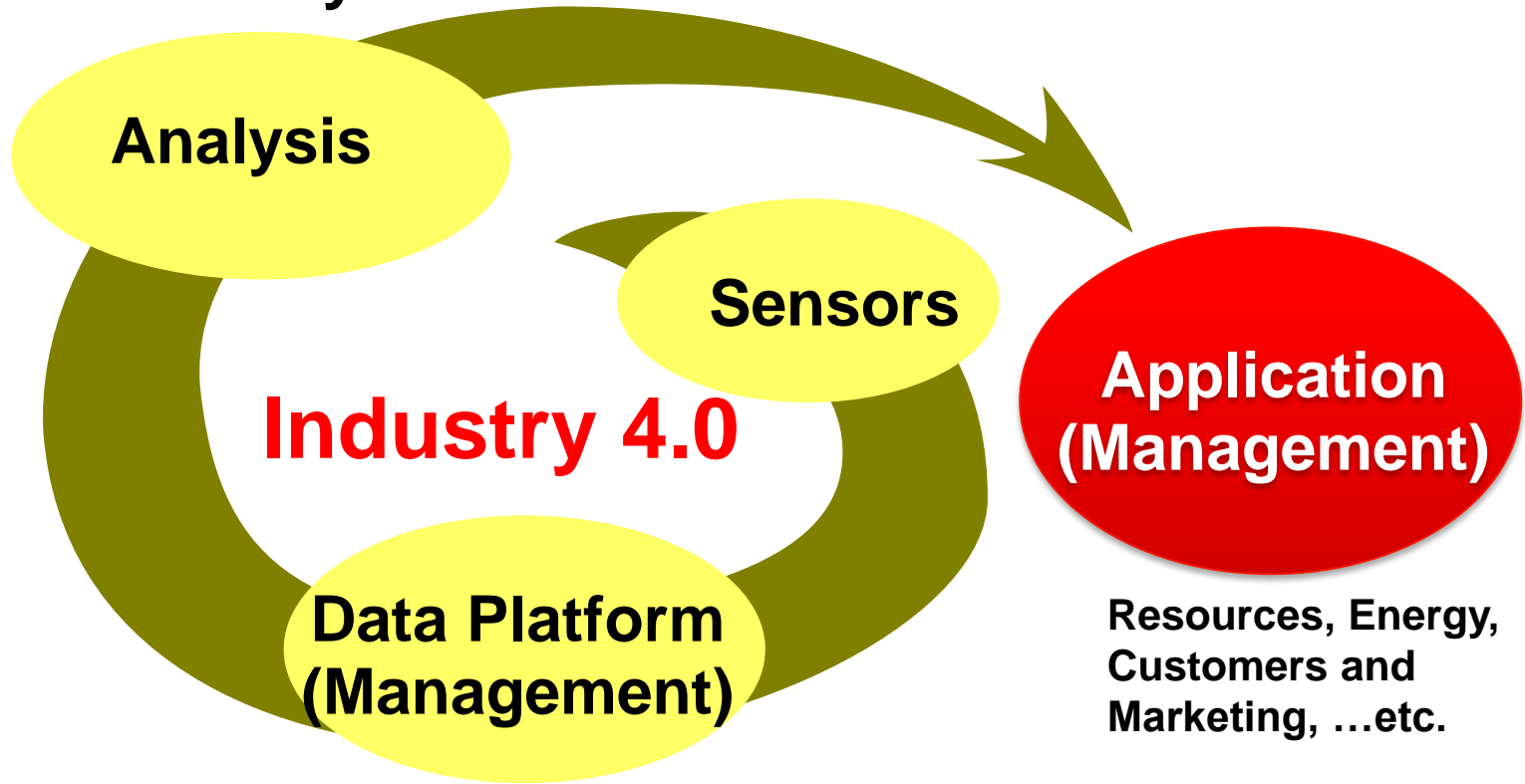
Dragon Steel Co.

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General Foreman

Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado