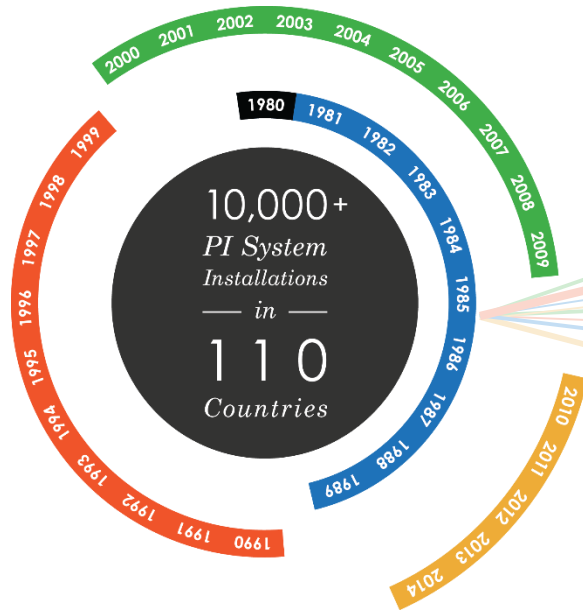**IF**

The Power of a Data Infrastructure: An Overview of The PI System®

Frank Batke
Global Solutions Architect
OSIsoft Europe GmbH

A Unique and Proven Vision

For over 30 years OSIsoft has:

- Infrastructure for consolidation and centralization of sensor based data
- Open infrastructure to support best of breed ecosystems
- Scalability from small deployments to enterprise deployments
- Infrastructure for change
- Infrastructure for empowering people

Engaging with Personas

Executive Level Persona =

Mid-Level Manager Persona =

Operational / Technical Persona =

Our Customers Gain Value

Safety & Security

Energy Utilization

Process Efficiency

Asset Health

Quality

Regulatory Performance

Our Customer's Challenge:

What is the forecast of productivity?

Engineer

COO

The turbine is not working – what's the problem?

I need to combine data from 3 sources

Maintenance Technician

Plant Manager

I need to know the moment it goes out of tune

Why a Data Infrastructure

Electrical Power	Water Systems	Transportation	Communication	Data
Sustainable	**Reliable**	**Accessible**	**Enabling**	**Organized**

Today's PI System

Silos to Standards / Complexity to Simplicity

PLC1 → SCADA 1
PLC2 → SCADA 2
IPC 1
IPC 2
Instrument → PAT 1
Instrument → PAT 2
Controller

Historian
Asset Reliability
Excel
ERP
CAPA
Planning and Scheduling
Learning Mgmt.
CBM
EMS
LIMS

Traditional Strategy

Silos to Standards / Complexity to Simplicity

PLC1 → SCADA 1
PLC2 → SCADA 2
IPC 1
IPC 2
Instrument → PAT 1
Instrument → PAT 2
Controllers

Collect
Enhance
Deliver

ERP
Asset Reliability
Learning Mgmt.
LIMS
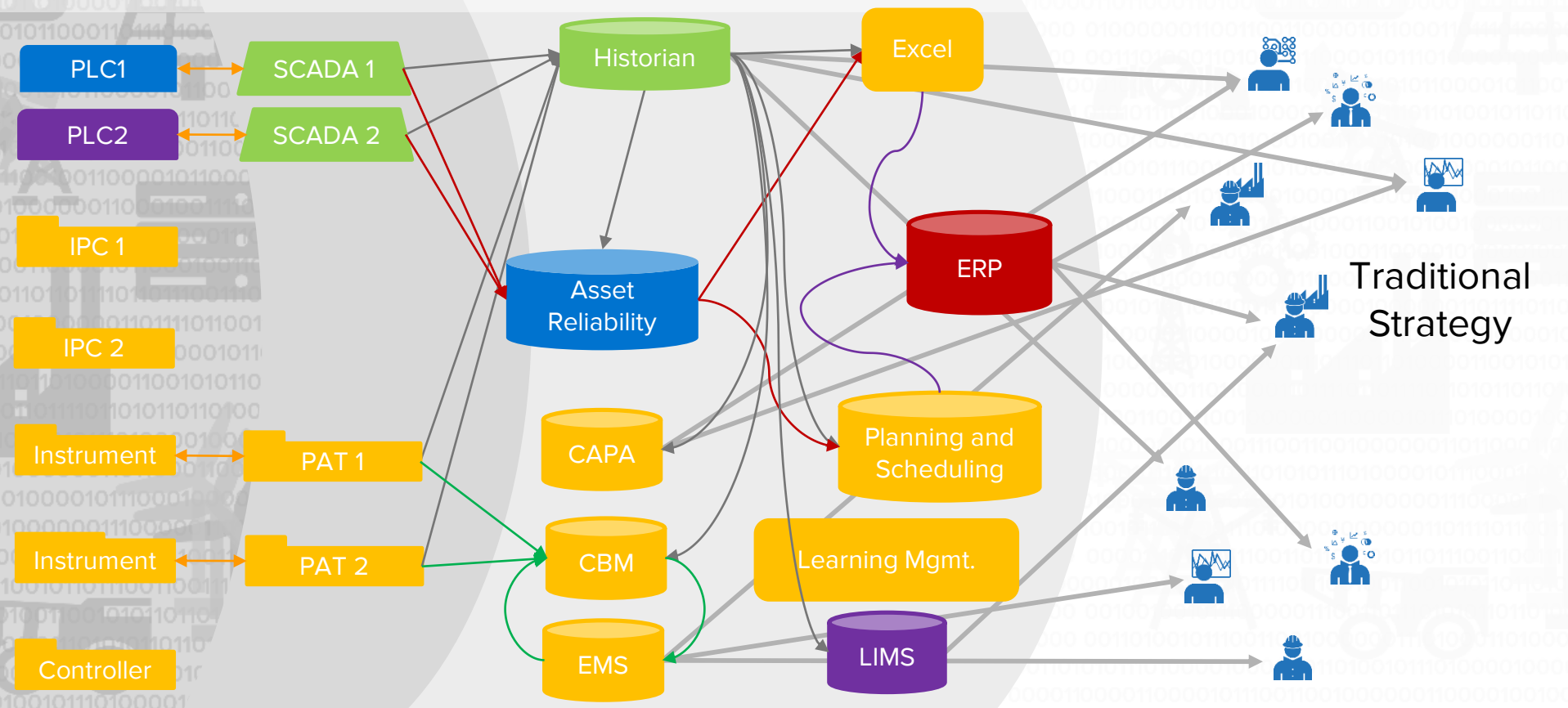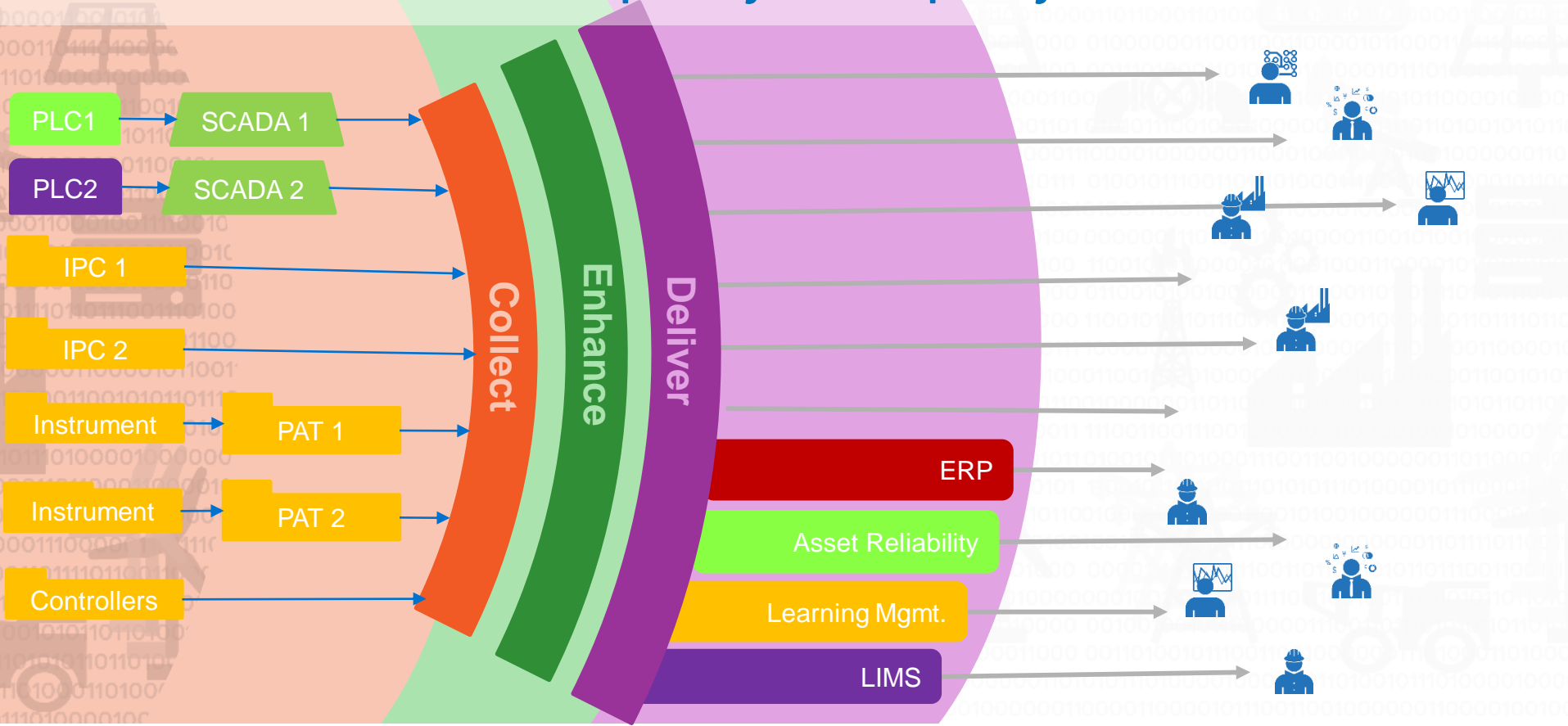
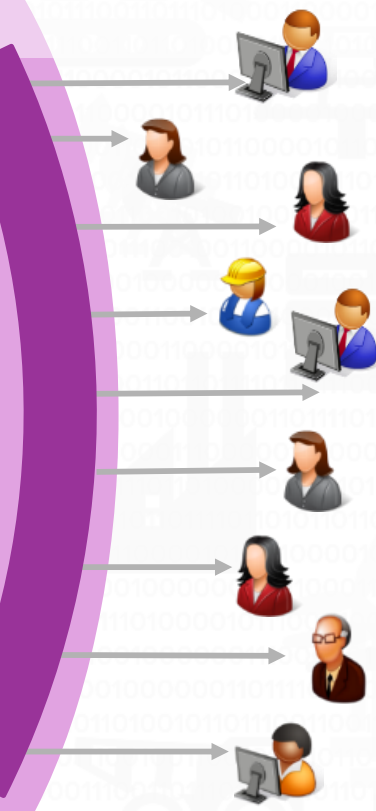# The PI System has 3 Layers

Collect

Manage
Enhance

Deliver

PI Interfaces

PI Server

PI Tools

OSIsoft Product List

Connections

PI COM Connector

PI Connectors (some examples below)
- PI Connector for Cygnet
- PI Connector for IPMI
- PI Connector for EtherNet/IP
- PI Connector for Kongsberg

PI Manual Logger (PI ML)

PI Interfaces (some examples below)
- PI Interface OPC DA
- PI Interface for Modbus Ethernet
- PI Interface for Fast Fourier Transform (FFT) Data
- PI Interface for Universal File and Stream
- PI IT Monitor
- PI to PI Interface
- …and many more

PI Integrators
- PI Integrator for Esri ArcGIS

Server

PI Server
- Event Frames
- Notifications
- Asset Calculations
- Asset Framework (AF) Server
- Data Archive Server

PI System Mgmt. Tools (PI SMT)
PI Tag Configurator
PI Collective
PI OPC DA/HDA Server
PI AutoPointSync (PI APS)
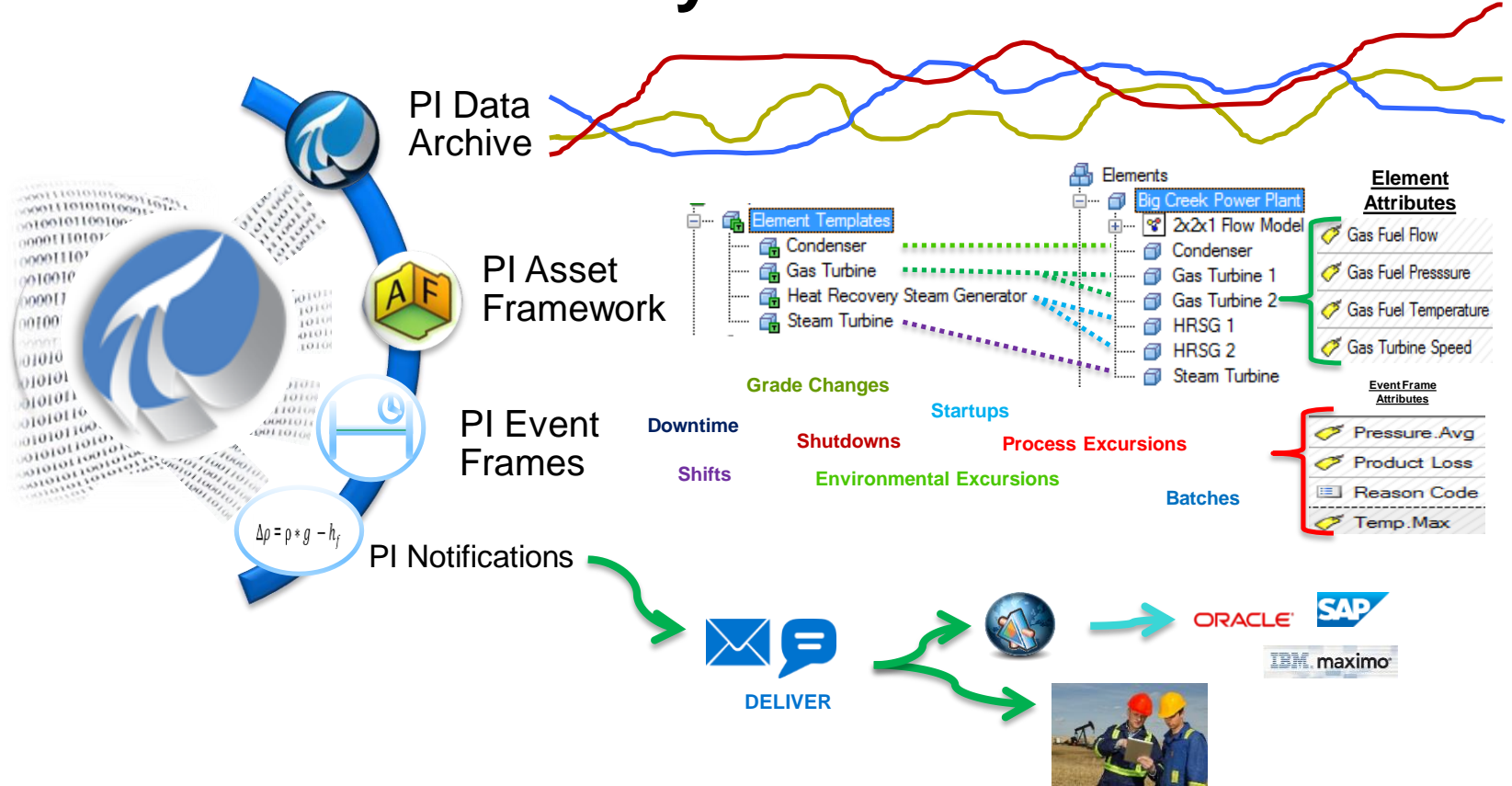**PI Batch**
PI Cloud Connect

Tools

PI DataLink
PI Coresight
PI ProcessBook
PI WebParts
PI Visualization Suite (All above products are included)

PI DataLink for SharePoint
PI Profile View
PI Compliance Reporting
PI SQC
PI Profile View
PI BatchView
PI ActiveView
PI AlarmView

PI Data Access
- PI ODBC
- PI OLEDB Enterprise
- PI OLEDB Provider
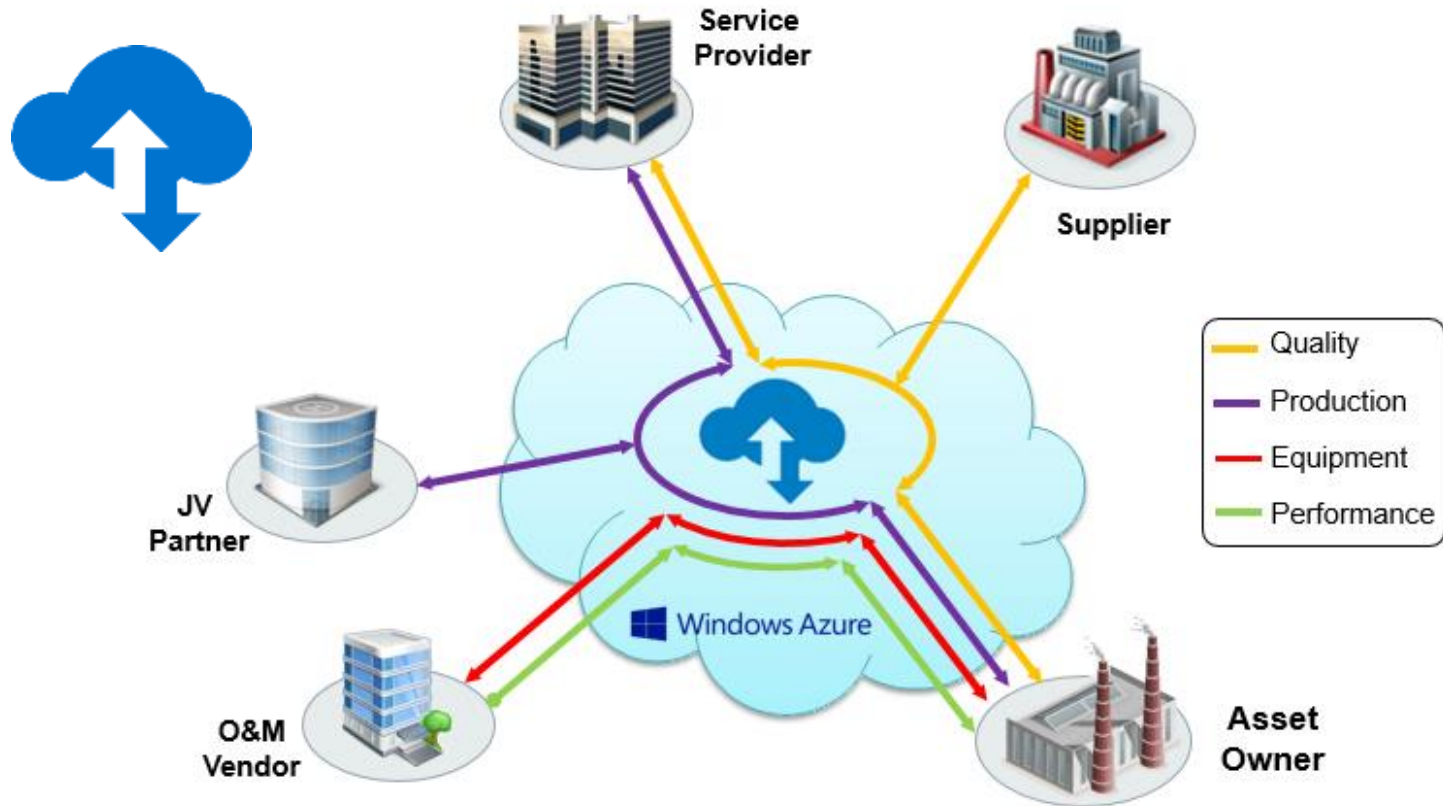- PI JDBC Driver
- PI Web Services

Key Elements of the PI System Infrastructure

PI Data Archive

PI Asset Framework

PI Event Frames

PI Notifications

$\Delta p = \rho * g - h_f$

Elements
Big Creek Power Plant
- 2x2x1 Flow Model
- Condenser
- Gas Turbine 1
- Gas Turbine 2
- HRSG 1
- HRSG 2
- Steam Turbine

Element Templates
- Condenser
- Gas Turbine
- Heat Recovery Steam Generator
- Steam Turbine

Element Attributes
- Gas Fuel Flow
- Gas Fuel Presssure
- Gas Fuel Temperature
- Gas Turbine Speed

Event Frame Attributes
- Pressure.Avg
- Product Loss
- Reason Code
- Temp.Max

Grade Changes
Startups
Downtime
Shutdowns
Process Excursions
Shifts
Environmental Excursions
Batches

DELIVER

ORACLE
SAP
IBM maximo

PI System Access

SAP NetWeaver™

Microsoft BizTalk Server

Microsoft SQL Server Analysis/Reporting Services

CERTIFIED FOR COMPLIANCE OPC FOUNDATION

MathWorks®

IBM maximo®

ORACLE®

SAP MII

Java

OData

Microsoft SharePoint®

Linux

TIBCO The Power of Now™

Microsoft Silverlight®

PI JDBC	PI Web Services (SOAP)	PI WebAPI With OData (REST)	PI ODBC	PI OLEDB Enterprise	PI OPC DA/HDA Server	OSIsoft SDKs

AF — **Asset Information / Metadata**

Notifications

Analytics

Relational / Non Time Series Data

PI Data Archive

PI Data Archive Collective

Time Series Data

PI System Data Sharing – PI Cloud Connect

An Infrastructure Connects the Enterprise

Safety & Security · Energy Utilization · Process Efficiency · Asset Health · Quality · Regulatory Performance

Enterprise Infrastructure

Assets · Assets · Assets · Assets · Assets · Assets
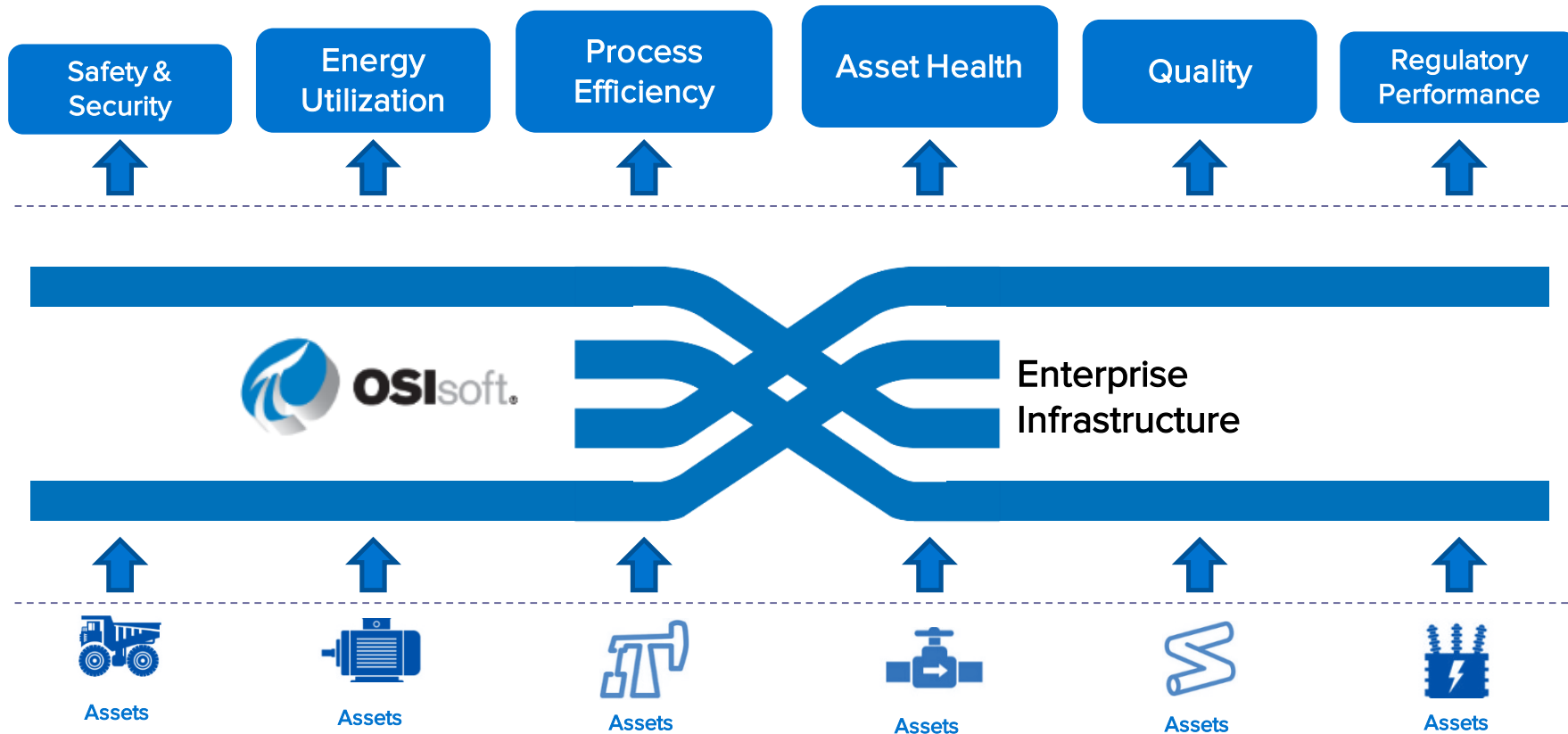
An Infrastructure helps data drive results across the enterprise

Safety & Security	Energy Utilization	Process Efficiency	Asset Health	Quality	Regulatory Performance
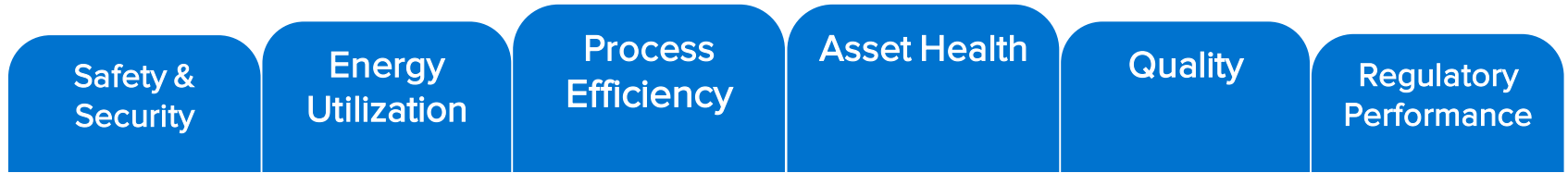
Operators
Craftsmen
Supervisors

- ✓ Achieve daily targets
- ✓ Resolve immediate issues
- ✓ Maintain schedule/plan
- ✓ Safe operations

Process Engineers
Production Superintendents
CoE experts

- ✓ Detect excursions
- ✓ Maintain process stability
- ✓ Improve productivity
- ✓ Improve quality

Location Managers
Regional/Global Ops
Business leadership

- ✓ Understand/grade perf.
- ✓ Adjust expectations
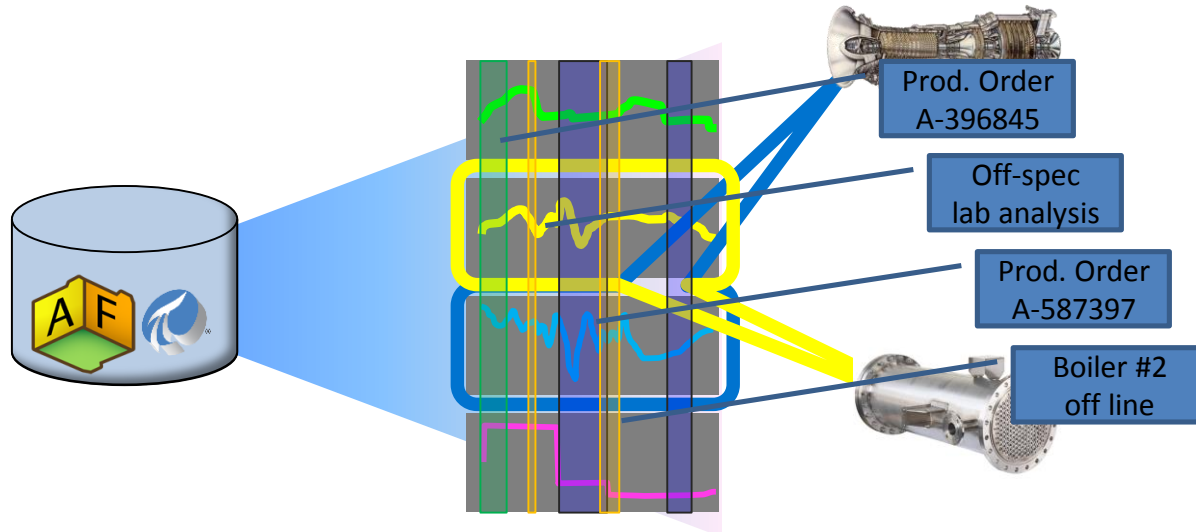- ✓ Establish plans
- ✓ Calculate forecasts

Principles

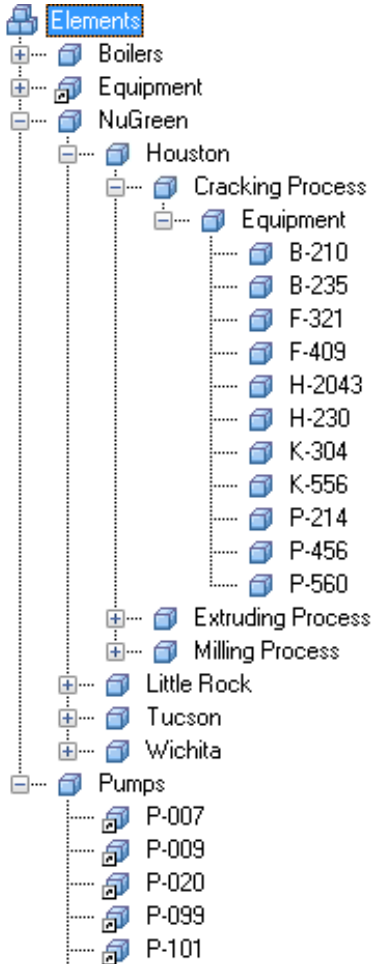# Collect and historize - Data and Structure

PI Archive – time series data (tags)

PI Asset Framework - structure data linking (Elements)

PI Event Frames - framing the time

Prod. Order
A-396845

Off-spec
lab analysis

Prod. Order
A-587397

Boiler #2
off line

The Big Picture

Element tree:
- Elements
  - Boilers
  - Equipment
  - NuGreen
    - Houston
      - Cracking Process
        - Equipment
          - B-210
          - B-235
          - F-321
          - F-409
          - H-2043
          - H-230
          - K-304
          - K-556
          - P-214
          - P-456
          - P-560
      - Extruding Process
      - Milling Process
    - Little Rock
    - Tucson
    - Wichita
  - Pumps
    - P-007
    - P-009
    - P-020
    - P-099
    - P-101

Analyses
- Efficiency analysis
- Key Performance Indicators (KPI)

Time-series
- In-Flow
- Pressure
- Vibration data

Events
- Downtime
- Startup
- Failure

Asset details
- Name
- Model
- Manufacturer

Notifications
- High speed
- Rotor failure
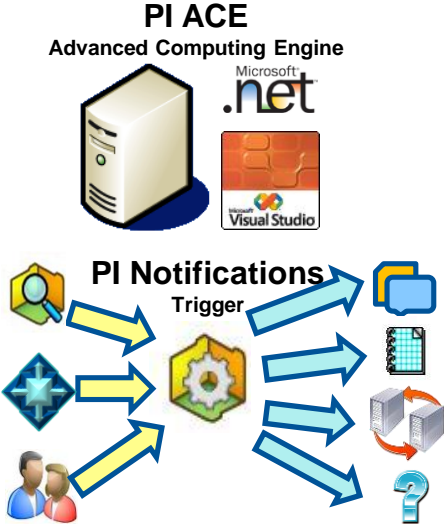- Low pressure

External data
- Performance curves
- Last maintenance date
- Design documents
- Best operating procedures

Find , Analyze, Deliver

PI ACE
Advanced Computing Engine

PI SQC
Statistical Quality Control

Microsoft Azure

PI Cloud Connect
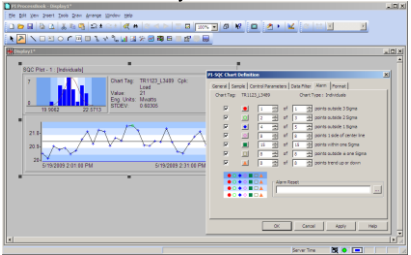
PI Notifications
Trigger

PI System Access –PSA
- PI SDK
- AF SDK (includes AN/EF SDK)
- PI OLEDB / PI OLEDB Enterprise
- PI JDBC
- PI ODBC
- PI OPC DA/HDA Server
- PI WebServices – SOAP
- PI WebAPI - REST
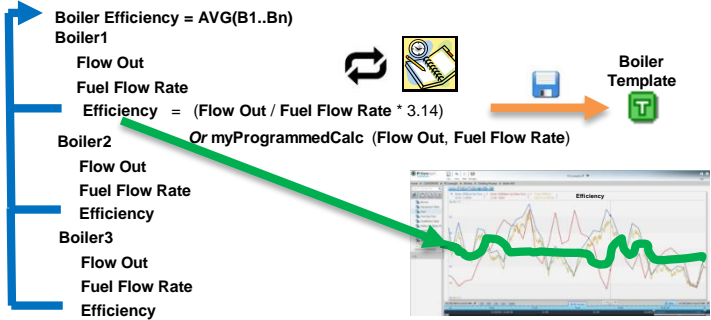- PI API (Runtime, no Development)

Asset Based Analytics

Boiler Efficiency = AVG(B1..Bn)
Boiler1
  Flow Out
  Fuel Flow Rate
  Efficiency = (Flow Out / Fuel Flow Rate * 3.14)
  Or **myProgrammedCalc (Flow Out, Fuel Flow Rate)**
Boiler2
  Flow Out
  Fuel Flow Rate
  Efficiency
Boiler3
  Flow Out
  Fuel Flow Rate
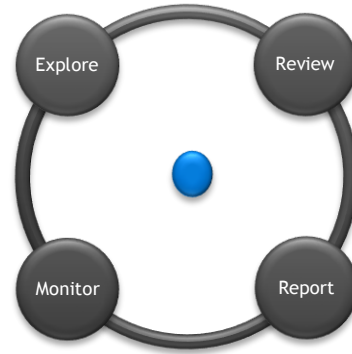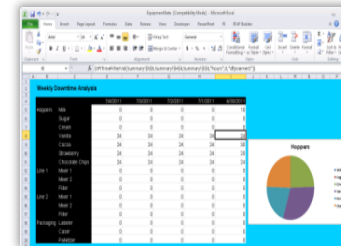 **Efficiency**

Boiler Template

Visualize

PI Coresight:
*Ad Hoc Analysis &
Collaboration
Going mobile*

PI ProcessBook:
Display authoring and Process
monitoring

PI WebParts:
Composite Apps, Shared broadly
Integration into Portal

PI DataLink:
Reporting using Microsoft
Excel as front end

Explore — Review — Monitor — Report

Lessons learned

- The infrastructure is open to integrate using standards other analytics, data sources and visualizations. This supports (legal) constraints like usage of special visualizations and algorithms.

- Introduction of an infrastructure is an evolution , allows you to keep the existing knowledge and investments and grow step by step.

- Keep the functionality in the layer it belongs to

- Typical errors you later pay for :

  - ➢ Keep data outside of data layer
  - ➢ Start without defining goal and workflow
  - ➢ Absence of responsibility for data maintenance
  - ➢ Mix raw and validated data to save space
  - ➢ Implicit rules like to save for a short time space
  - ➢ Put calculations into visualization
  - ➢ Give infrastructure access only to a few special gurus
  - ➢ Try to replace things by exactly the same

What people have done

Sample Application powered by PI (I)

Alarm Management
Analyzer Performance
Automated Generation Control
Automated Reports
Balanced Scorecards
Baseline Best Practices
Batch Quality Monitor
Certificate Of Analysis
Compliance Documentation
Condition Based Maintenance (CBM)
Continuous Emissions Monitor (CEM)
Control Loop Monitor
Corporate Data Warehouse
Customer Load Management
Data Reconciliation
Down-hole Systems In O&G Production
Downtime Monitoring
E-Commerce
Energy Management System
Environmental Compliance Monitor
General Ops Docn And Equipment Specs
Hazardous Waste Tracking
Hierarchical Process Data Views

Hydrogen Manufacturing And Distribution
Incident Investigations
Inventory Management
IT / Systems Monitoring
Key Performance Indicators (Kpi)
Lab Quality Data Integration
LNG Terminal Operating Assistance
LNG Terminal Operations Reports
Maintenance History Or Status
Maintenance Lockout Procedures
Manual Data Recording
Manufacturing Intelligence Data
Material Balance
Material Usage Tracking
Multi-Plant Equipment Performance Monitor
O&G Production Remote Monitoring By Non
Operating Partners And Customers
O&G Production Well Testing
Operating Envelope Data
Operations Data Warehouse
Operations Desktop
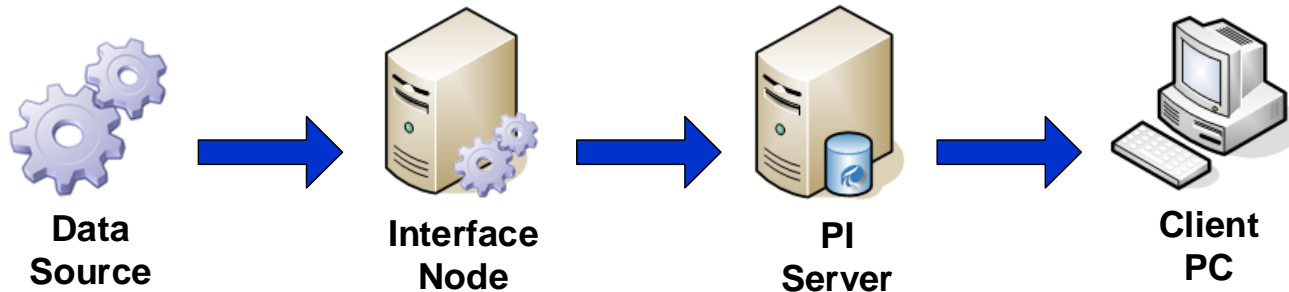Operator Handover
Operator Training

Sample Application powered by PI (II)

Paper Machine Felt Monitoring
Paper Machine Grade Management
Paper Machine Lost Opportunity Module
Paper Machine Performance Monitor
Pipeline Equipment Remote Monitor
Pipeline Leak Detection Support
Pipeline Operations Planning
Pipeline Pigging Schedule For Paraffin Removal
Pipeline Solar Turbine Efficiency Remote Monitor
Plant Performance Overviews
Power Delivery Capability For Gas Turbines
Power Generation Fleet Outage Management
Power Generation Supplier Scheduling
Power Turbine Trip Monitor
Process Monitoring
Process Performance Analysis
Product Compliance Reporting
Product Development Trials
Product Pricing
Product Separation In Multi-Product Pipelines
Production Analysis
Production Data Integration To ERP
Production Plan Versus Target Data
Production Plan Versus Actual Data
Pulp And Paper Mill Steam Energy Monitor
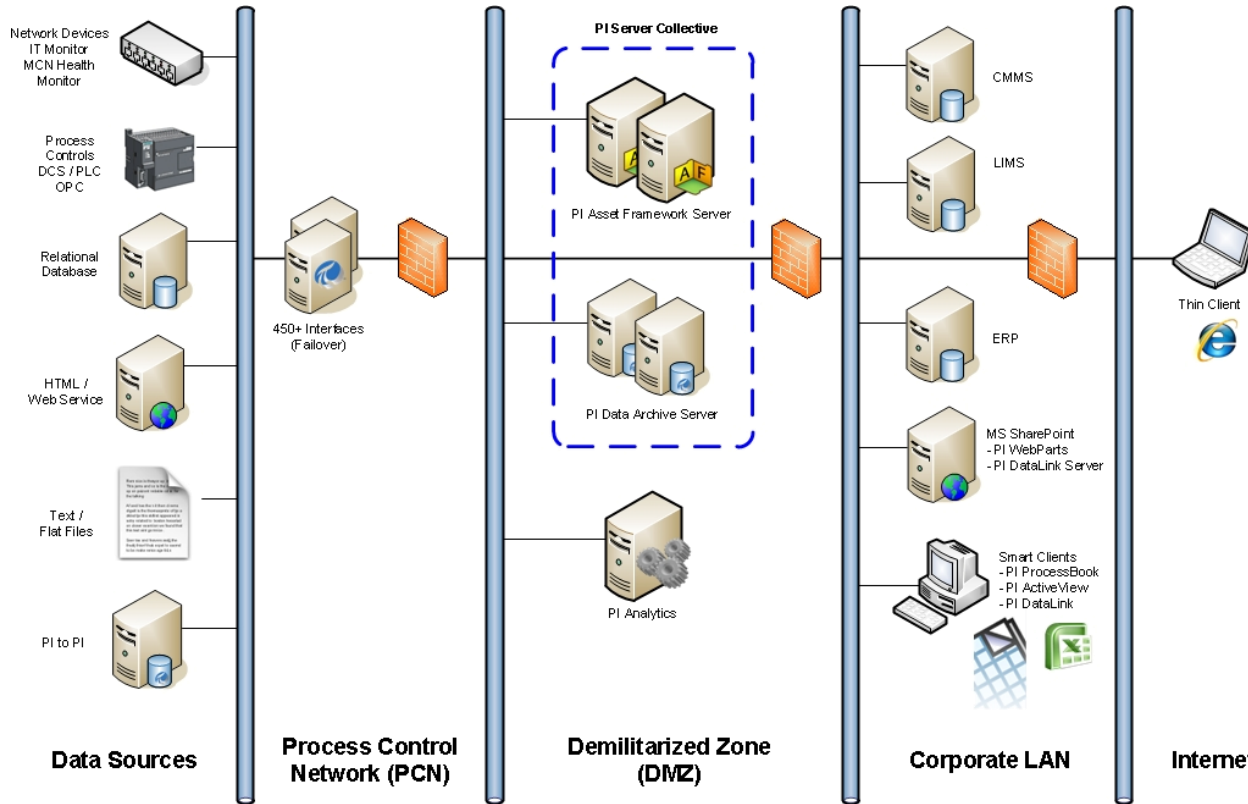Pulp Mill Tracking

Quality Monitoring/Analysis
Reliability Centered Maintenance Support
Reservoir Control And Production Operations
Root-Cause Analysis
Shared Inventory Management Service
Shift Production Monitor
Six Sigma
SPC/SQC Production Quality Control
Steam Turbine Performance Analysis
Substation Load Monitoring
Substation Transformer Asset Management
Supply Chain Management
T&D Network System Load Forecasts
T&D Network System Load Planning
T&D Substation Equipment Monitoring
Tanker Fleet Current/Past Locations
Total Effective Equipment Productivity
Transmission Line Capacity Planning
Transmission Network Diagrams
Transmission Network Frequency Monitor
Troubleshooting Equipment Startups
Utilities Management
Virtual On-Line Analyzer In Refining
Waste Treatment Monitor
Weather Data Import

Logical Architecture

Architecture example of a PI System

Data Source → Interface Node → PI Server → Client PC

Architecture example for a PI System

Network Devices
IT Monitor
MCN Health
Monitor

Process
Controls
DCS / PLC
OPC

Relational
Database

HTML /
Web Service

Text /
Flat Files

PI to PI

Data Sources

450+ Interfaces
(Failover)

**Process Control
Network (PCN)**

PI Server Collective

PI Asset Framework Server

PI Data Archive Server

PI Analytics

**Demilitarized Zone
(DMZ)**

CMMS

LIMS

ERP

MS SharePoint
- PI WebParts
- PI DataLink Server

Smart Clients
- PI ProcessBook
- PI ActiveView
- PI DataLink

Corporate LAN

Thin Client

Internet

THANK YOU

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