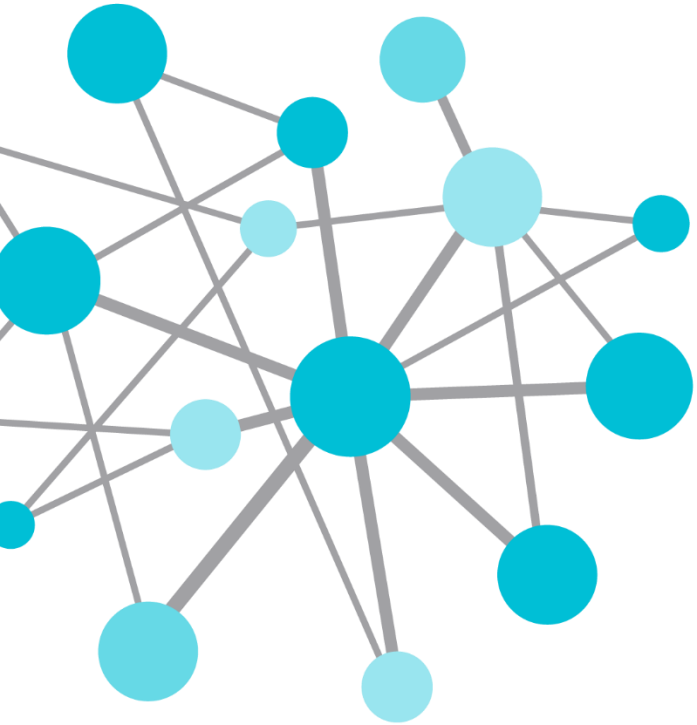


The Power of a Data Infrastructure: The PI System® Explained

Hans-Otto Weinhold

Senior Systems Engineer, OSIsoft EMEA

Why a Data Infrastructure

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

Challenges for Fossil Fuel Based Generation

Reliability and Availability

- Condition based maintenance
- Key Performance indicators
- Reducing forced outages
- Unit trips
- Life extension

Flexibility and ramping

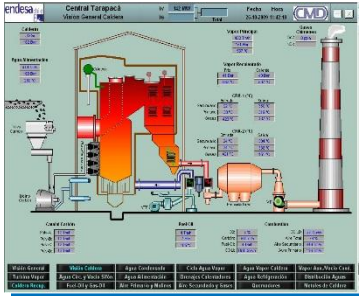
- Minimum load reduction
- Ramping
- Cycling
- Start up monitoring
- Temperature excursions

Fleet Optimization

- Economic dispatch
- Outage planning & scheduling
- Alternative fuel use
- Market bidding strategy
- Ancillary services

Regulatory Requirements

- Outage reporting
- Environmental regulations
- Best Available Control Tech
- Emissions monitoring
- Discharge water
- Reliability Regulations



Operations Performance

- Heat Rate and cycle efficiency
- Controllable Losses
- Turbine Efficiency
- Boiler efficiency
- Gas turbine performance

Challenges forTransmission and Distribution

Transmission Automation

Renewable energy, wholesale deregulation, and advanced monitoring from PMUs provide a wide range of new transmission challenges and opportunities

Distribution Automation

Substation Automation, Intelligent Electronic Devices, Smart Switches and advanced communications highlight new frontiers in utility operations

Automated Metering Infrastructure

AMI represents the #1 source of new, high volumes of data. Can you manage the inflow of information and make it work for you?

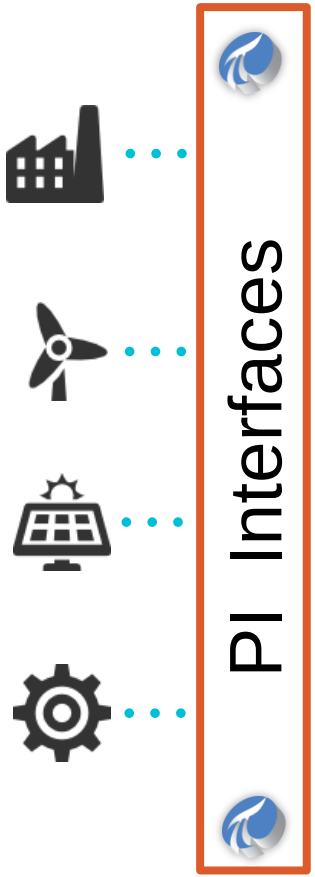
Smart Homes

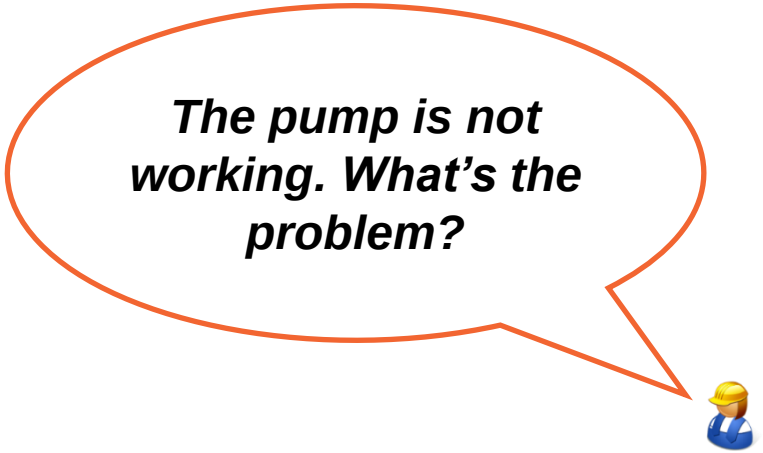
Home automation opens up new business opportunities for the creative utility. Services, home security, demand management all enable new operations

Distributed Generation

A paradigm shift in the utility business is being driven by low cost PV solar. Customers are becoming generation sources. How prepared is your utility to cope?

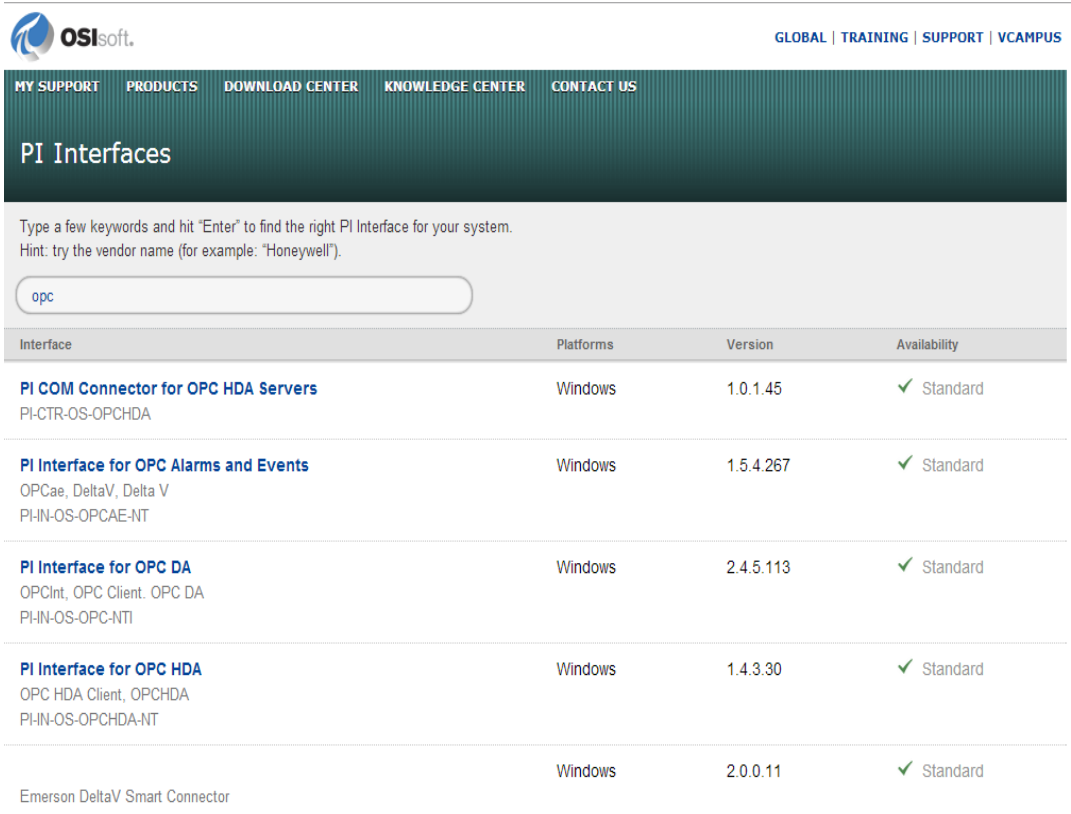
PI System Infrastructure



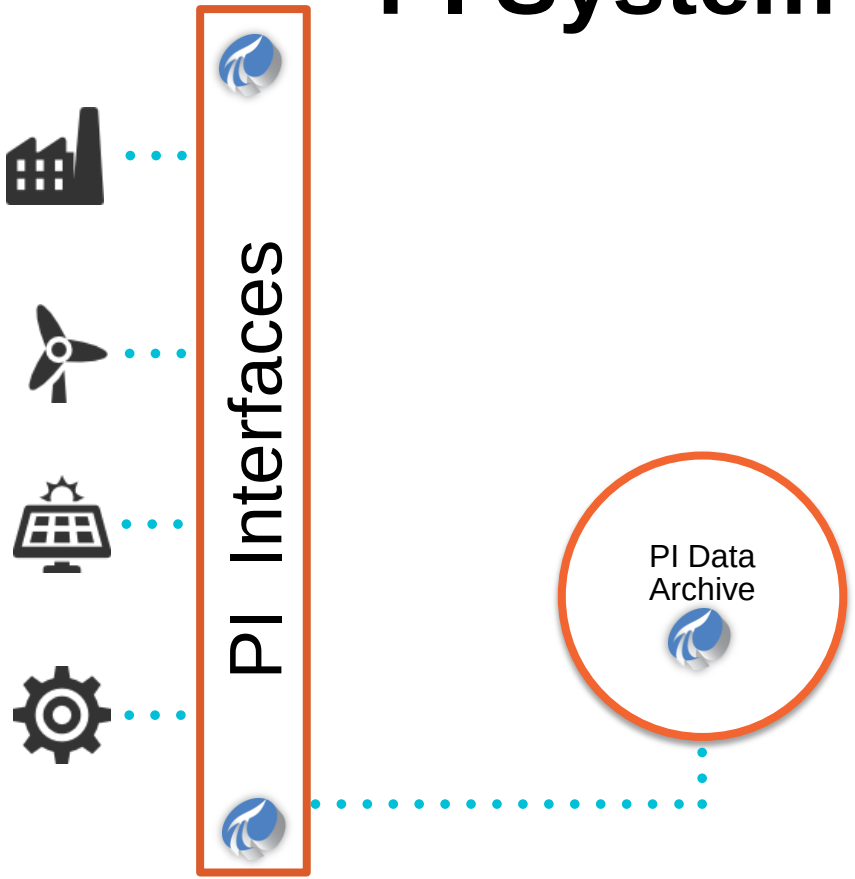


PI Interfaces

- More than **450** interfaces
- Support multiple **protocols** and **data sources**
  - OPC, Modbus, SNMP, Text File, ODBC
- Robust and reliable



PI System Infrastructure



PI Data Archive

- Optimized for **real time** data **streams** - TAGS

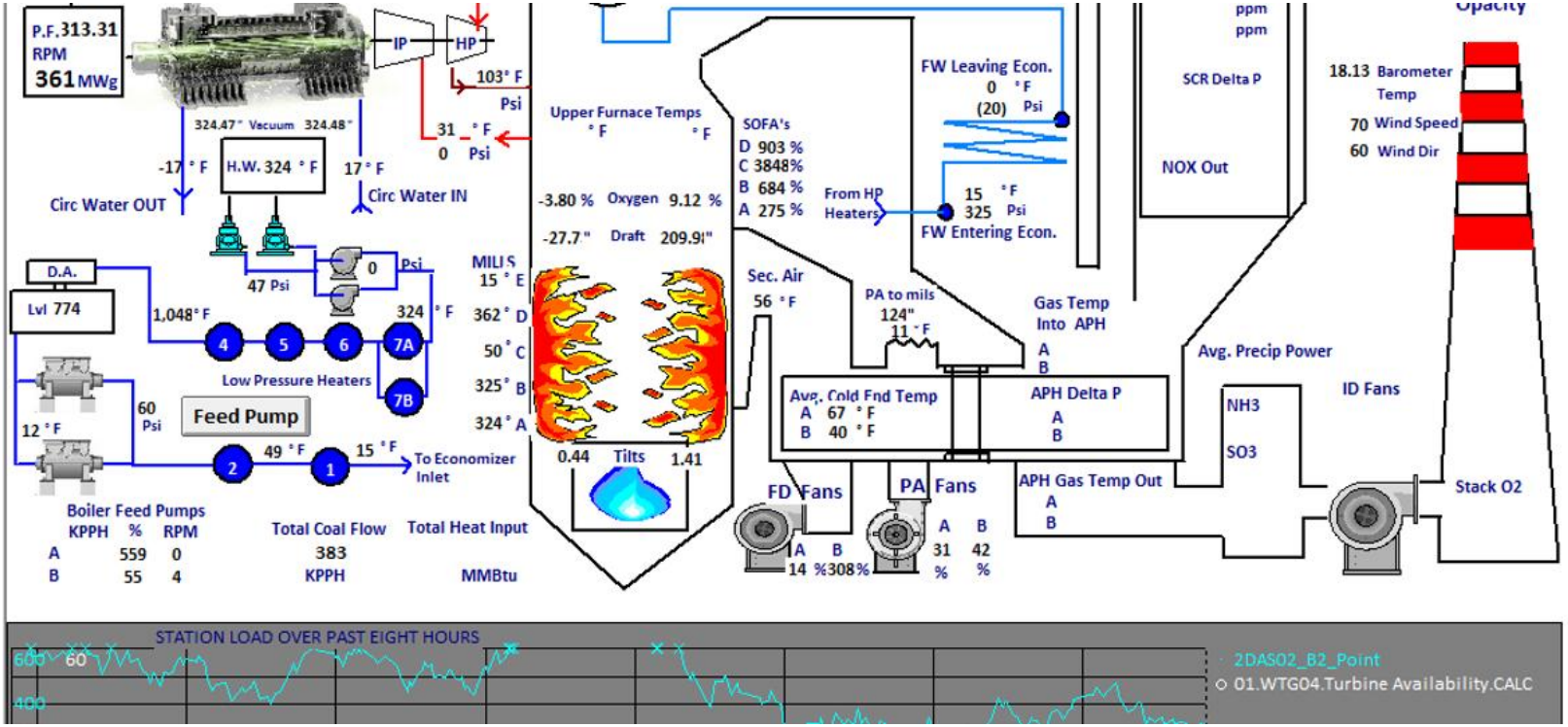
TAG	TIME	VALUE	STATUS
TIC1001.PV	23-MAY-08 11:01:02	12.3	GOOD
LIC30211.PV	23-MAY-08 11:01:03	198.4	GOOD
…	…	…	…

- Designed to archive data for **millions** of tags and **tens** of years

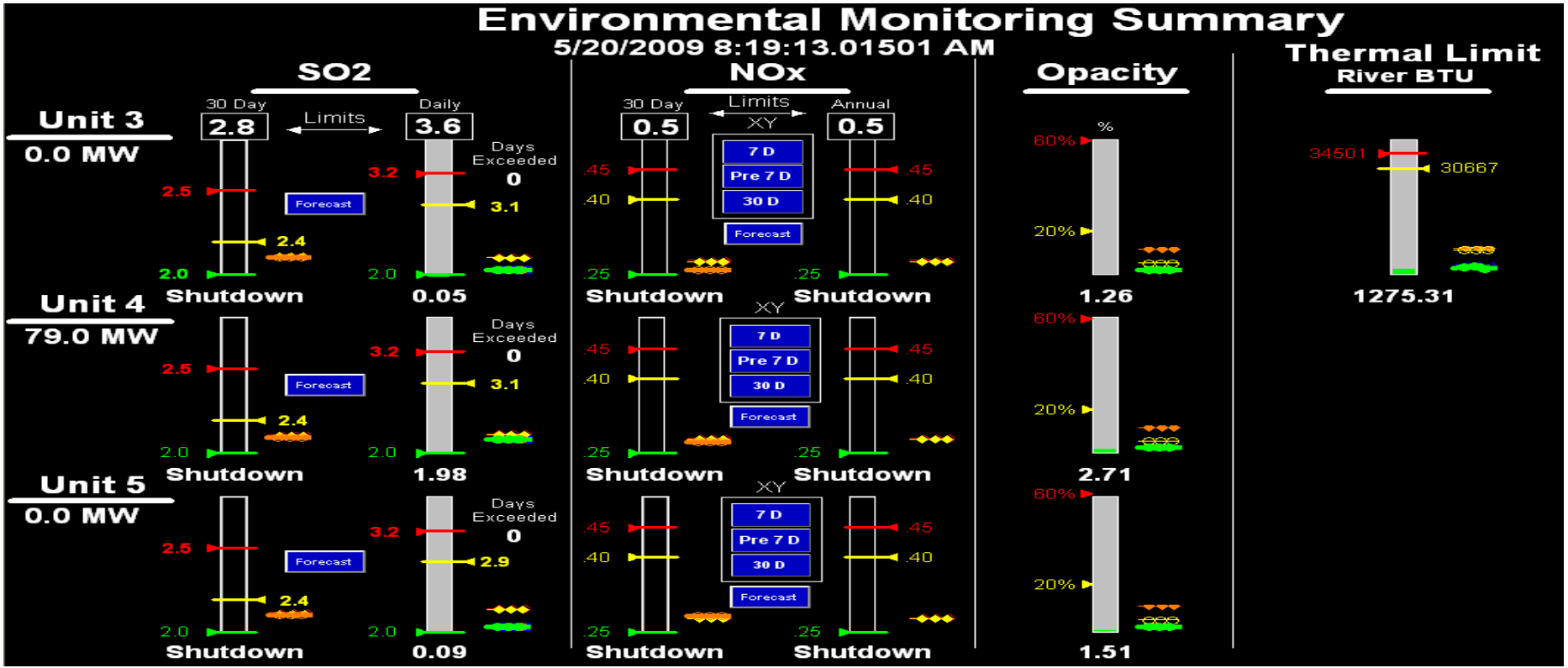
PI Data Archive 2012

	2010	2012	Delta
Max Point Count	2-3M	**20M+**	5-10x
Startup Time	>10 min/Mpts	<30 sec/Mpts	20x
Point Creation	<100 pt/sec	500-2K pt/sec	5-200x
Tag Searching	Variable, Non-Linear	Constant or Linear	N/A
Max Update Signups	<200K	**10M+**	50x
Update Signup Rate	<2K/sec	>100K/sec	50x
Data Out (Archive)	<1M ev/sec	**>10M ev/sec**	10-20x
Data In (Snapshot)	<200K ev/sec	>1M ev/sec	5-10x
Data In (Archive)	<100K ev/sec	**>500K ev/sec**	5-10x
Archive Shifts	>1 min/GB	<10 sec/GB	6-12x
Online Archives	<10K files	>50K files	5-10x
Backup Speed	>5 min/GB	<1 min/GB	5-10x
Offline Reprocessing	>15 min/GB	30 sec/GB	30x

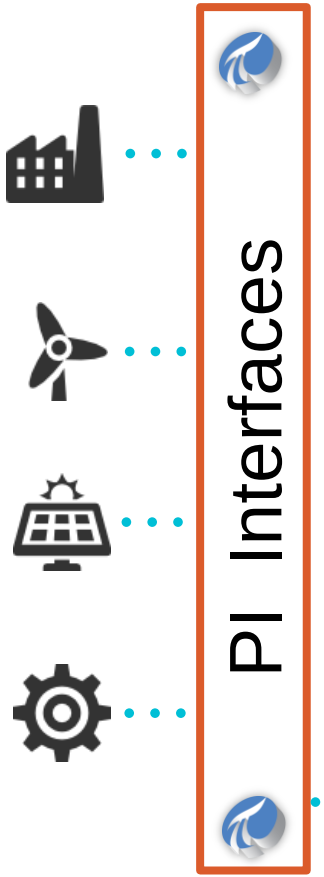
Plant Overview – Boiler and Turbine Cycle

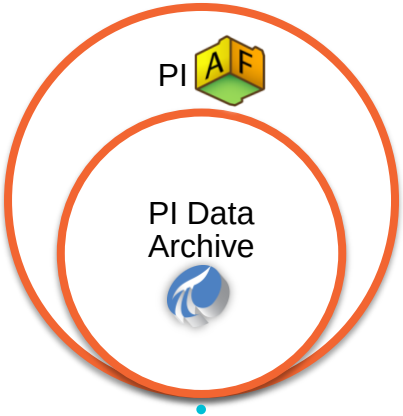


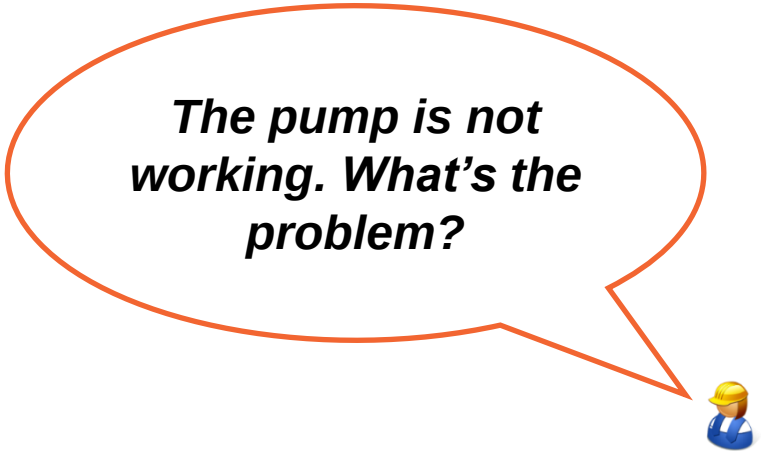
Environmental Parameters Monitoring



PI System Infrastructure

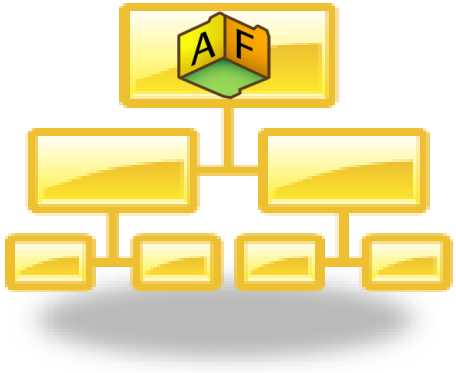






PI Asset Framework (PI AF)

- Organize your assets' data in a **hierarchical**, **scalable**, **secure**, and **extensible** database
- Model data from **different PI Servers**
- Relate **non time-series** data sources
- Integrate with tools **analyses** and **notifications** tools



The Big Picture

- 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

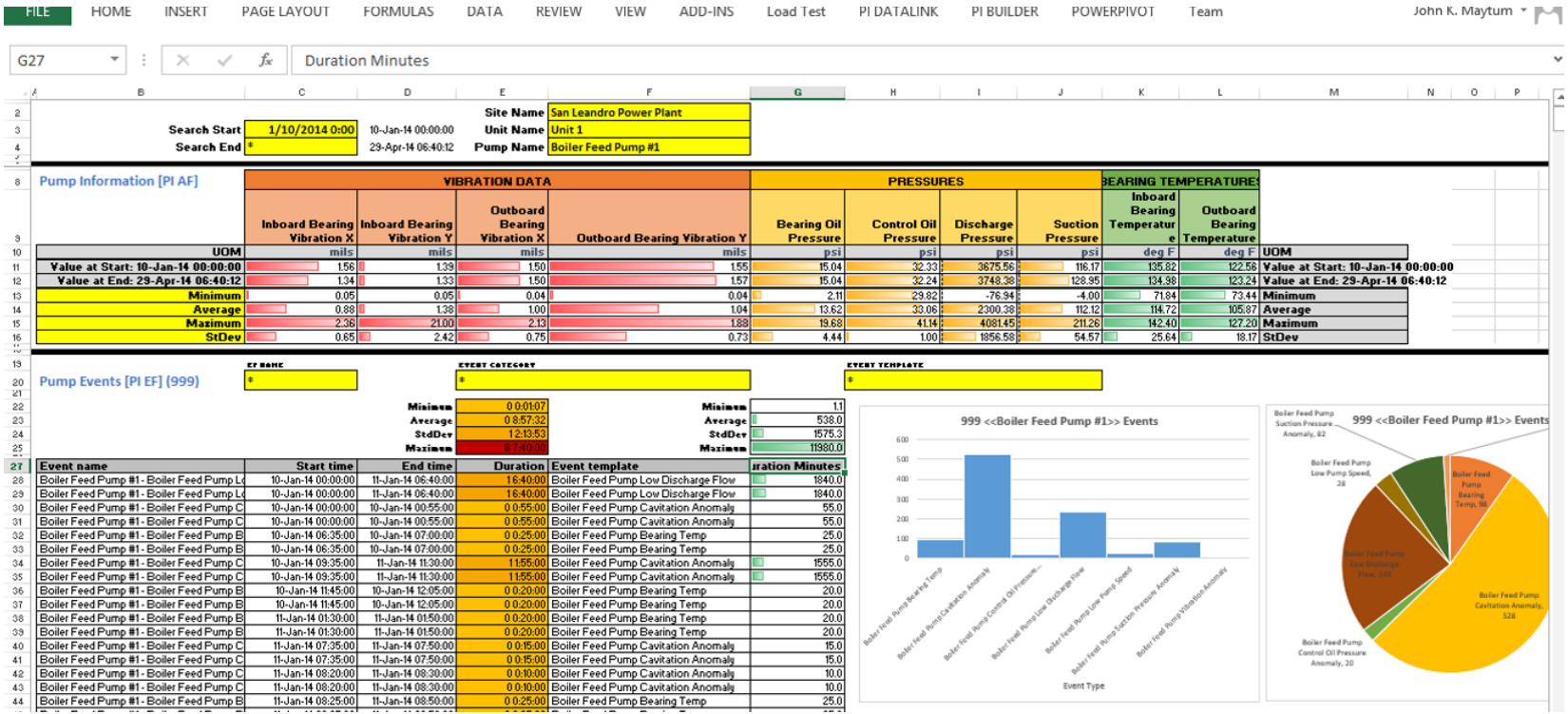
External data
- Performance curves
- Last maintenance date
- Design documents
- Best operating procedures

Distribution Circuit Breaker Monitoring

- Flexibility for user to configure
- Allows for simple (one click) navigation
- Easy searching circuits
- No need to remember display numbers

Pump Report

Asset Analysis using PI DataLink



FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ADD-INS Load Test PI DATALINK PI BUILDER POWERPIVOT Team John K. Maytum

G27 | Duration Minutes

Search Start	1/10/2014 0:00	10-Jan-14 00:00:00	Site Name	San Leandro Power Plant	
Search End	*	29-Apr-14 06:40:12	Unit Name	Unit 1	
			Pump Name	Boiler Feed Pump #1	

Pump Information [PI AF]

	VIBRATION DATA				PRESSURES				BEARING TEMPERATURES		
	Inboard Bearing Vibration X	Inboard Bearing Vibration Y	Outboard Bearing Vibration X	Outboard Bearing Vibration Y	Bearing Oil Pressure	Control Oil Pressure	Discharge Pressure	Suction Pressure	Inboard Bearing Temperature	Outboard Bearing Temperature	
UOM	mils	mils	mils	mils	psi	psi	psi	psi	deg F	deg F	UOM
Value at Start: 10-Jan-14 00:00:00	1.56	1.39	1.50	1.55	15.04	32.33	3675.56	116.17	135.82	122.58	Value at Start: 10-Jan-14 00:00:00
Value at End: 29-Apr-14 06:40:12	1.34	1.33	1.50	1.57	15.04	32.24	3748.38	128.95	134.38	123.24	Value at End: 29-Apr-14 06:40:12
Minimum	0.05	0.05	0.04	0.04	2.11	29.82	-76.94	-4.00	71.84	73.44	Minimum
Average	0.88	1.38	1.00	1.04	13.62	33.06	2300.38	112.12	114.72	105.87	Average
Maximum	2.36	21.00	2.13	1.88	19.68	41.14	4081.45	211.26	142.40	127.20	Maximum
StDev	0.65	2.42	0.75	0.73	4.44	1.00	1856.58	54.57	25.64	18.17	StDev

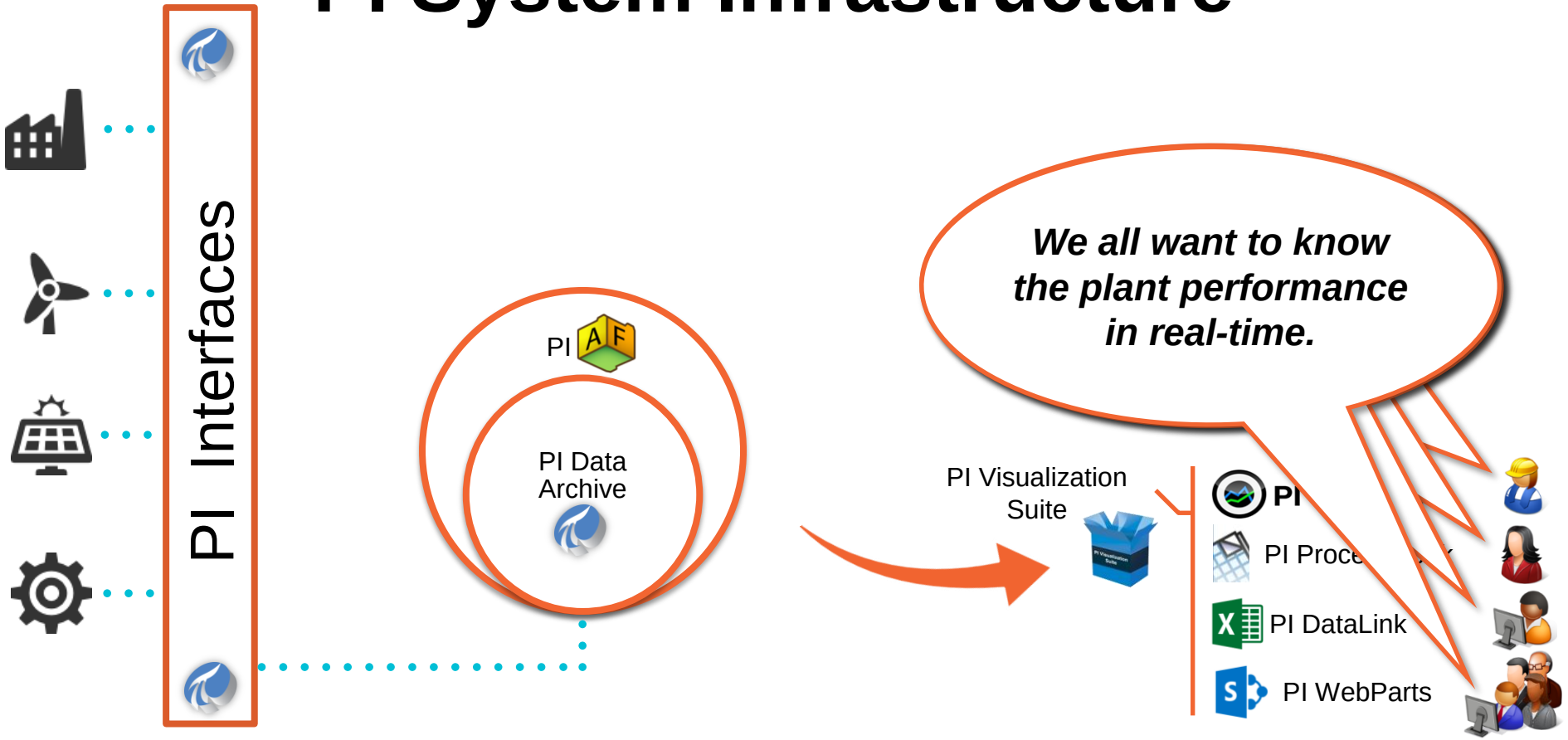
Pump Events [PI EF] (999)

EF Name: * Event Category: * Event Template: *

	Duration	Duration Minutes
Minimum	0 0:01:07	1.1
Average	0 8:57:32	538.0
StDev	1 2:13:53	1575.3
Maximum	8 7:40:00	11980.0

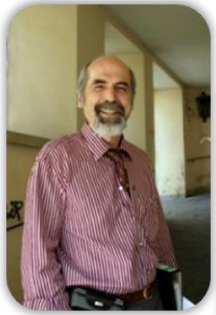
Event name	Start time	End time	Duration	Event template	Duration Minutes
Boiler Feed Pump #1 - Boiler Feed Pump Lo	10-Jan-14 00:00:00	11-Jan-14 06:40:00	16:40:00	Boiler Feed Pump Low Discharge Flow	1840.0
Boiler Feed Pump #1 - Boiler Feed Pump Lo	10-Jan-14 00:00:00	11-Jan-14 06:40:00	16:40:00	Boiler Feed Pump Low Discharge Flow	1840.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 00:00:00	10-Jan-14 00:55:00	0 0:55:00	Boiler Feed Pump Cavitation Anomaly	55.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 00:00:00	10-Jan-14 00:55:00	0 0:55:00	Boiler Feed Pump Cavitation Anomaly	55.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 06:35:00	10-Jan-14 07:00:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 06:35:00	10-Jan-14 07:00:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 09:35:00	11-Jan-14 11:30:00	1 1:55:00	Boiler Feed Pump Cavitation Anomaly	1555.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 09:35:00	11-Jan-14 11:30:00	1 1:55:00	Boiler Feed Pump Cavitation Anomaly	1555.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 11:45:00	10-Jan-14 12:05:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 11:45:00	10-Jan-14 12:05:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 01:30:00	11-Jan-14 01:50:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 01:30:00	11-Jan-14 01:50:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 07:35:00	11-Jan-14 07:50:00	0 0:15:00	Boiler Feed Pump Cavitation Anomaly	15.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 07:35:00	11-Jan-14 07:50:00	0 0:15:00	Boiler Feed Pump Cavitation Anomaly	15.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 08:20:00	11-Jan-14 08:30:00	0 0:10:00	Boiler Feed Pump Cavitation Anomaly	10.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 08:20:00	11-Jan-14 08:30:00	0 0:10:00	Boiler Feed Pump Cavitation Anomaly	10.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 08:25:00	11-Jan-14 08:50:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0

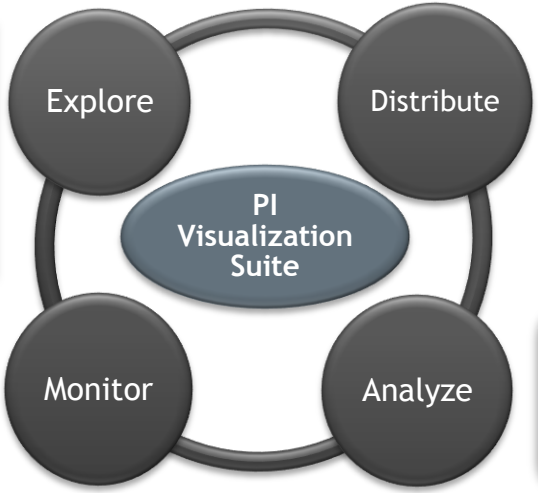
PI System Infrastructure



Visualization Landscape

PI Coresight
Collaboration and ad hoc analysis

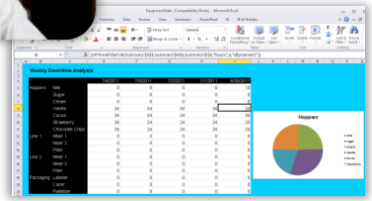




PI WebParts
Composite web applications

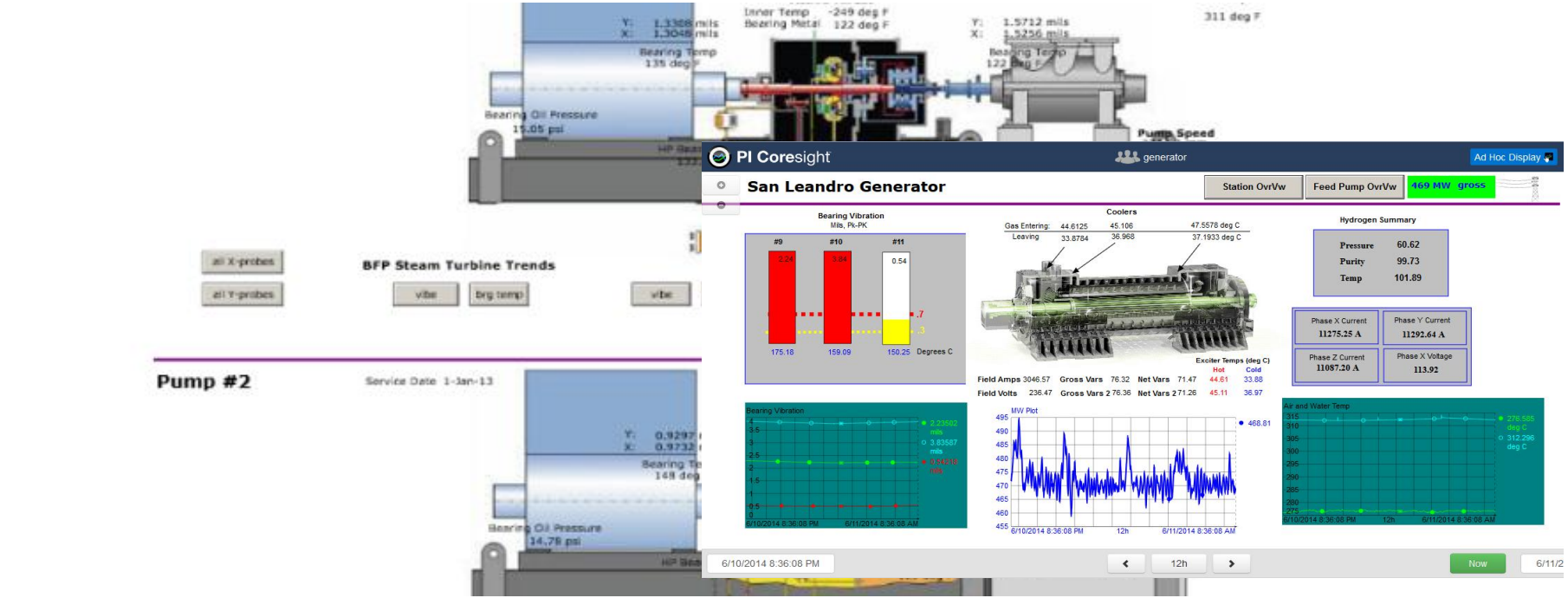
PI ProcessBook
Authoring tool for process displays and trends

PI DataLink
Reports and data analysis

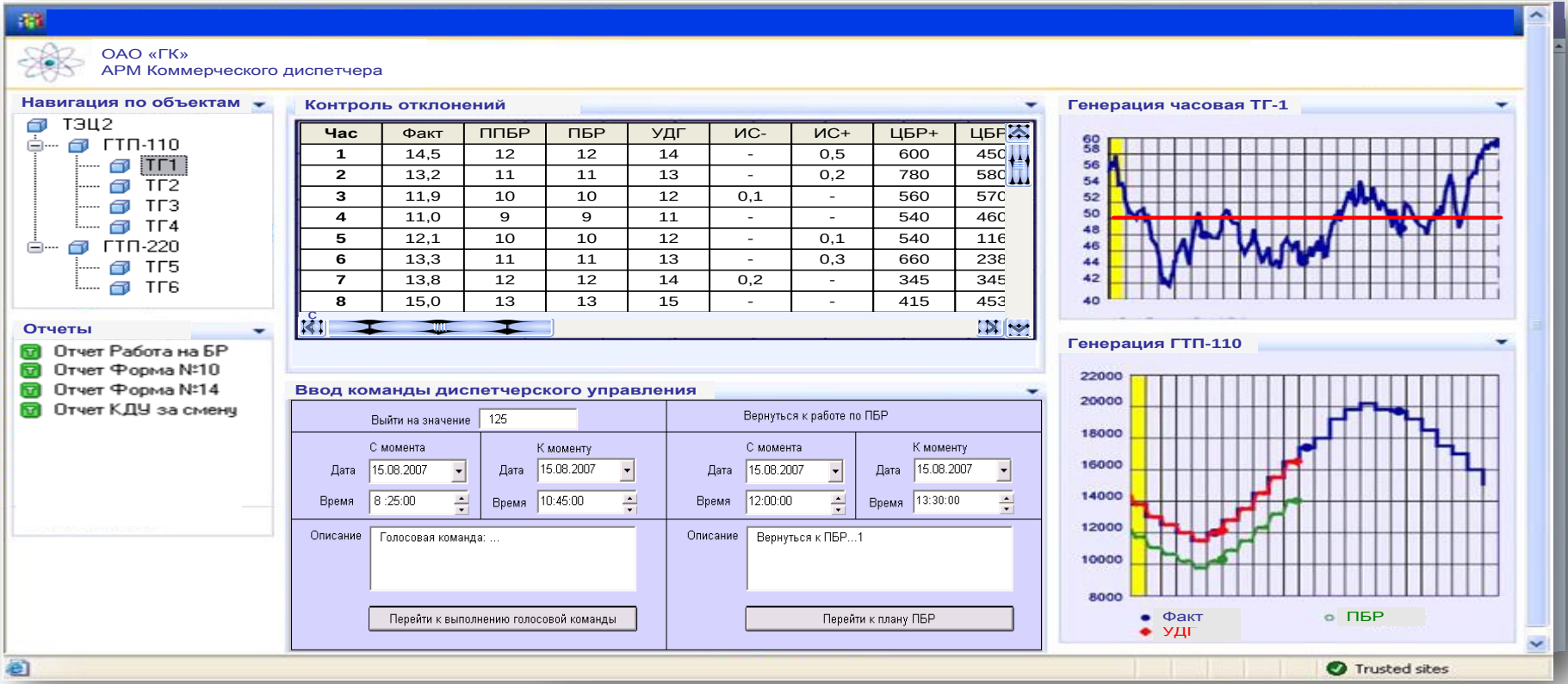


Web Based Operational Views

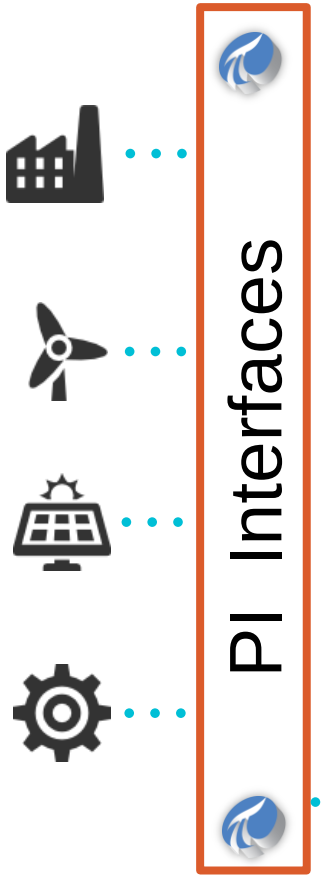
PI Coresight allows access to operational displays from any HTML5 compliant device

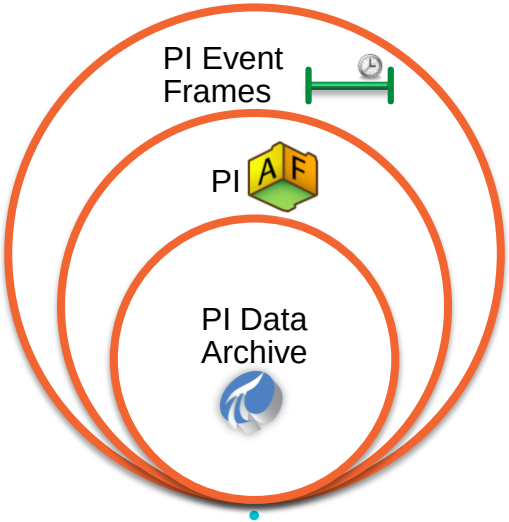


IEC Holding. Technological and commercial dispatching – Element relative Display

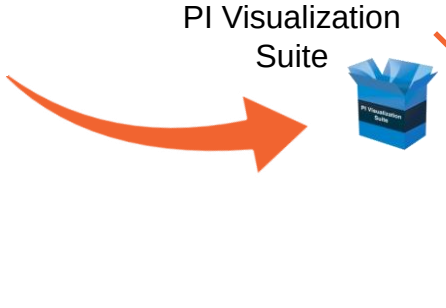


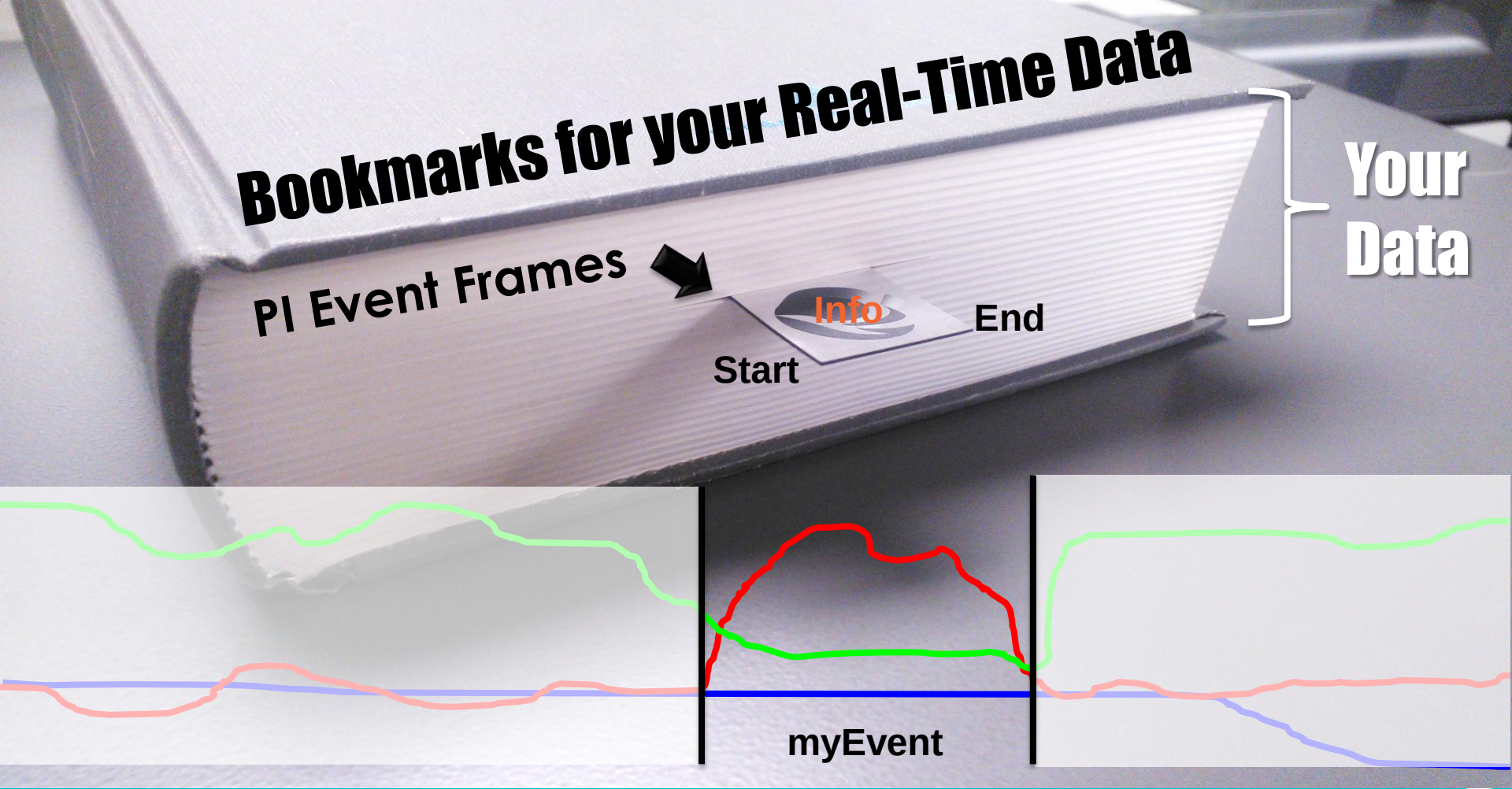
PI System Infrastructure



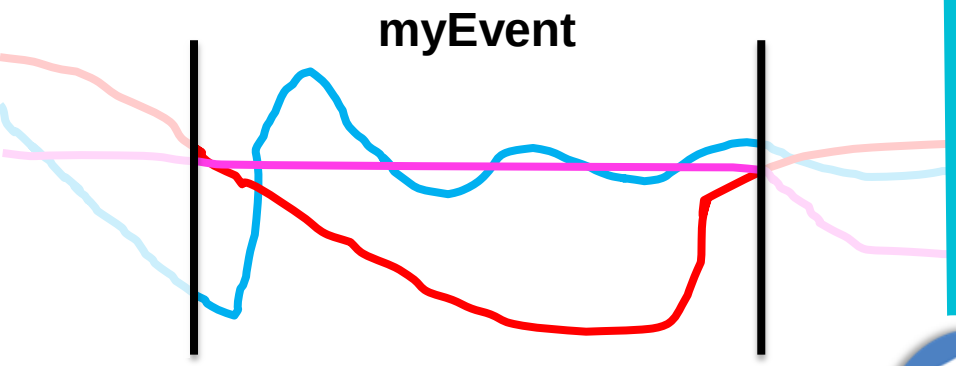


A specific recurring event might be affecting overall performance.

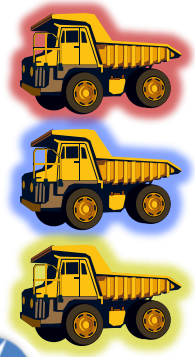


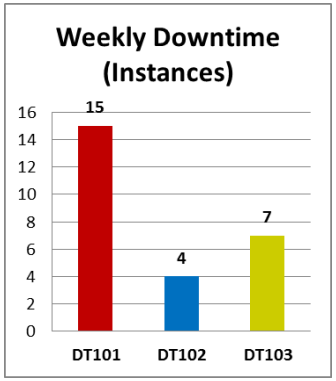


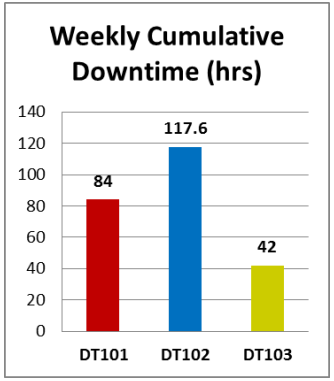
Simplify Data Analysis



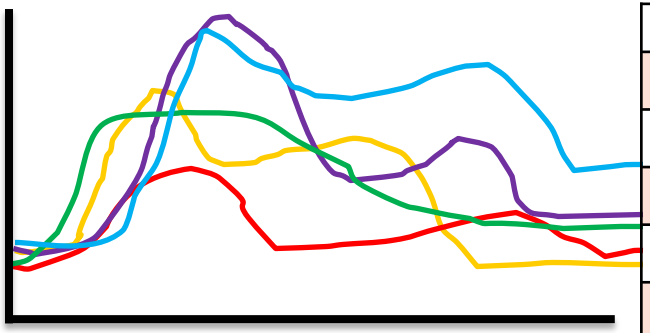
Perform Asset Comparisons







Event Overlay Trend (Temp.)

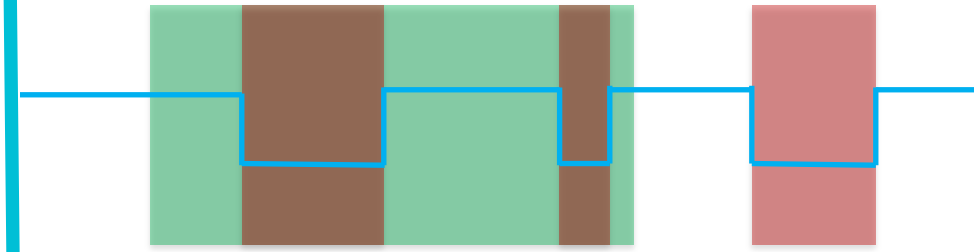


Name	Temp.Max
EF1	122.47
EF2	109.34
EF3	112.73
EF4	98.61
EF5	125.24

Downtime Events for Product XYZ

Product XYZ (1)

Downtime (2)

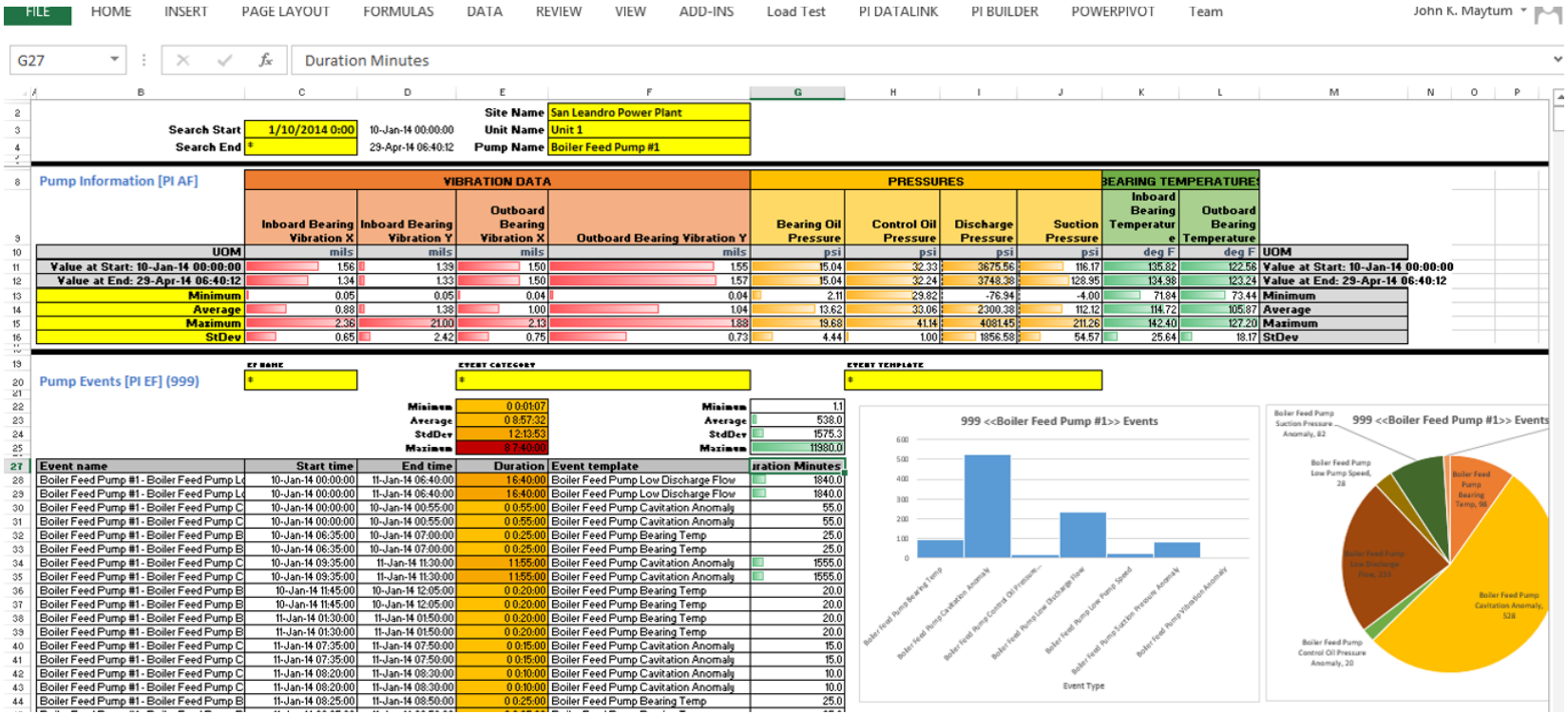


Perform Event Comparisons

Discover Event Interrelationships

Pump Report

Asset and Event Analysis using PI DataLink with AF and Event Frames



FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ADD-INS Load Test PI DATALINK PI BUILDER POWERPIVOT Team John K. Maytum

G27 | Duration Minutes

Search Start	1/10/2014 0:00	10-Jan-14 00:00:00	Site Name	San Leandro Power Plant	
Search End	*	29-Apr-14 06:40:12	Unit Name	Unit 1	
			Pump Name	Boiler Feed Pump #1	

Pump Information [PI AF]

	VIBRATION DATA				PRESSURES				BEARING TEMPERATURES		
	Inboard Bearing Vibration X	Inboard Bearing Vibration Y	Outboard Bearing Vibration X	Outboard Bearing Vibration Y	Bearing Oil Pressure	Control Oil Pressure	Discharge Pressure	Suction Pressure	Inboard Bearing Temperature	Outboard Bearing Temperature	
UOM	mils	mils	mils	mils	psi	psi	psi	psi	deg F	deg F	UOM
Value at Start: 10-Jan-14 00:00:00	1.56	1.39	1.50	1.55	15.04	32.33	3675.56	116.17	135.82	122.58	Value at Start: 10-Jan-14 00:00:00
Value at End: 29-Apr-14 06:40:12	1.34	1.33	1.50	1.57	15.04	32.24	3748.38	128.95	134.38	123.24	Value at End: 29-Apr-14 06:40:12
Minimum	0.05	0.05	0.04	0.04	2.11	29.82	-76.94	-4.00	71.84	73.44	Minimum
Average	0.88	1.38	1.00	1.04	13.62	33.06	2300.38	112.12	114.72	105.87	Average
Maximum	2.36	21.00	2.13	1.88	19.68	41.14	4081.45	211.26	142.40	127.20	Maximum
StDev	0.65	2.42	0.75	0.73	4.44	1.00	1856.58	54.57	25.64	18.17	StDev

Pump Events [PI EF] (999)

EF Name: * Event Category: * Event Template: *

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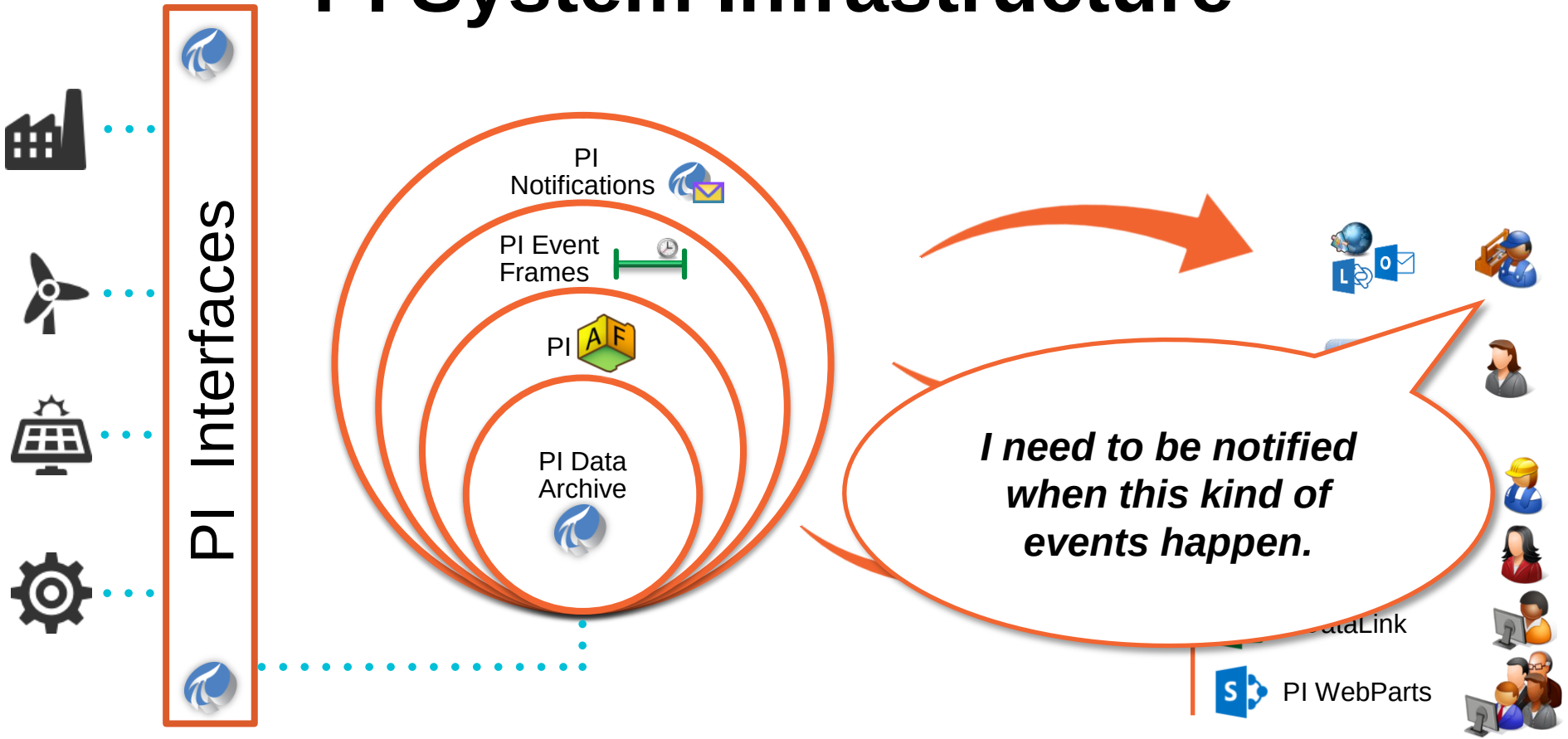
StdDev	1 2:13:53	1575.3
Maximum	8 7:40:00	11980.0

Event name	Start time	End time	Duration	Event template	Duration Minutes
Boiler Feed Pump #1 - Boiler Feed Pump Lo	10-Jan-14 00:00:00	11-Jan-14 06:40:00	16:40:00	Boiler Feed Pump Low Discharge Flow	1840.0
Boiler Feed Pump #1 - Boiler Feed Pump Lo	10-Jan-14 00:00:00	11-Jan-14 06:40:00	16:40:00	Boiler Feed Pump Low Discharge Flow	1840.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 00:00:00	10-Jan-14 00:55:00	0 0:55:00	Boiler Feed Pump Cavitation Anomaly	55.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 00:00:00	10-Jan-14 00:55:00	0 0:55:00	Boiler Feed Pump Cavitation Anomaly	55.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 06:35:00	10-Jan-14 07:00:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 06:35:00	10-Jan-14 07:00:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 09:35:00	11-Jan-14 11:30:00	1 1:55:00	Boiler Feed Pump Cavitation Anomaly	1555.0
Boiler Feed Pump #1 - Boiler Feed Pump C	10-Jan-14 09:35:00	11-Jan-14 11:30:00	1 1:55:00	Boiler Feed Pump Cavitation Anomaly	1555.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 11:45:00	10-Jan-14 12:05:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	10-Jan-14 11:45:00	10-Jan-14 12:05:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 01:30:00	11-Jan-14 01:50:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 01:30:00	11-Jan-14 01:50:00	0 0:20:00	Boiler Feed Pump Bearing Temp	20.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 07:35:00	11-Jan-14 07:50:00	0 0:15:00	Boiler Feed Pump Cavitation Anomaly	15.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 07:35:00	11-Jan-14 07:50:00	0 0:15:00	Boiler Feed Pump Cavitation Anomaly	15.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 08:20:00	11-Jan-14 08:30:00	0 0:10:00	Boiler Feed Pump Cavitation Anomaly	10.0
Boiler Feed Pump #1 - Boiler Feed Pump C	11-Jan-14 08:20:00	11-Jan-14 08:30:00	0 0:10:00	Boiler Feed Pump Cavitation Anomaly	10.0
Boiler Feed Pump #1 - Boiler Feed Pump B	11-Jan-14 08:25:00	11-Jan-14 08:50:00	0 0:25:00	Boiler Feed Pump Bearing Temp	25.0

Boiler Feed Pump Adhoc Analysis

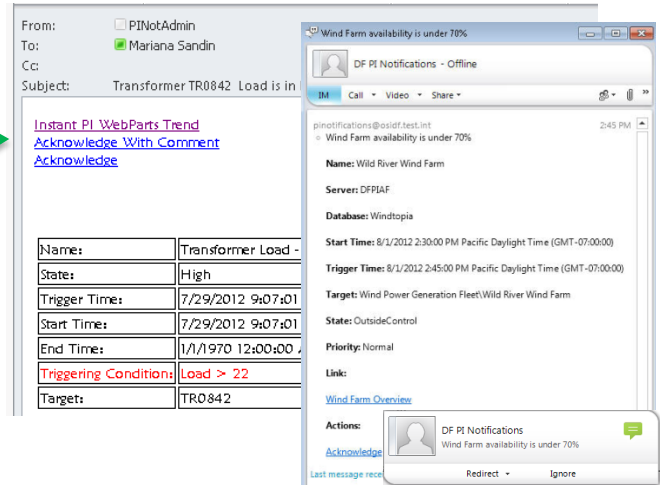
Adhoc Asset and event based analysis in PI Coresight

PI System Infrastructure



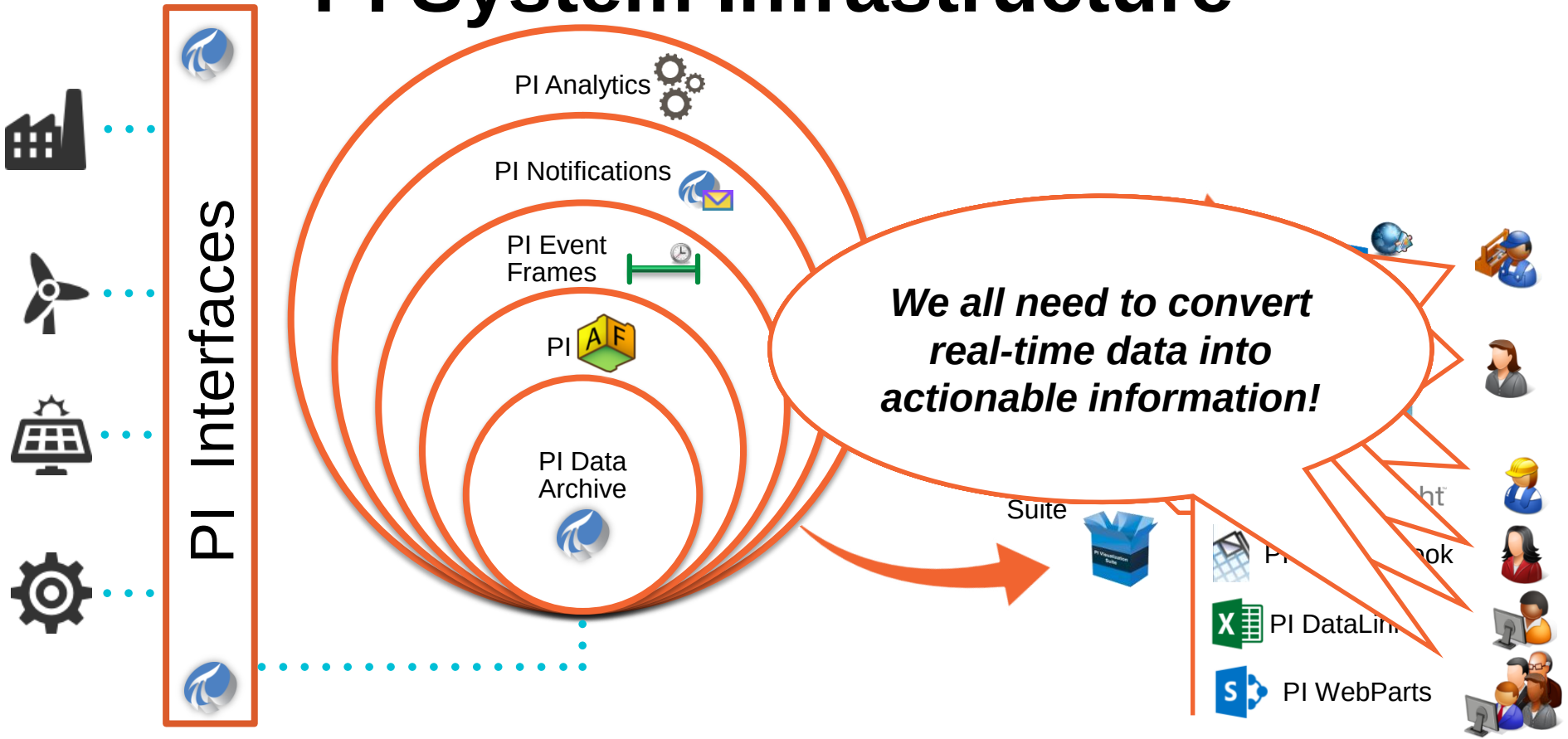
PI Notifications Keeps You Informed

DELIVER



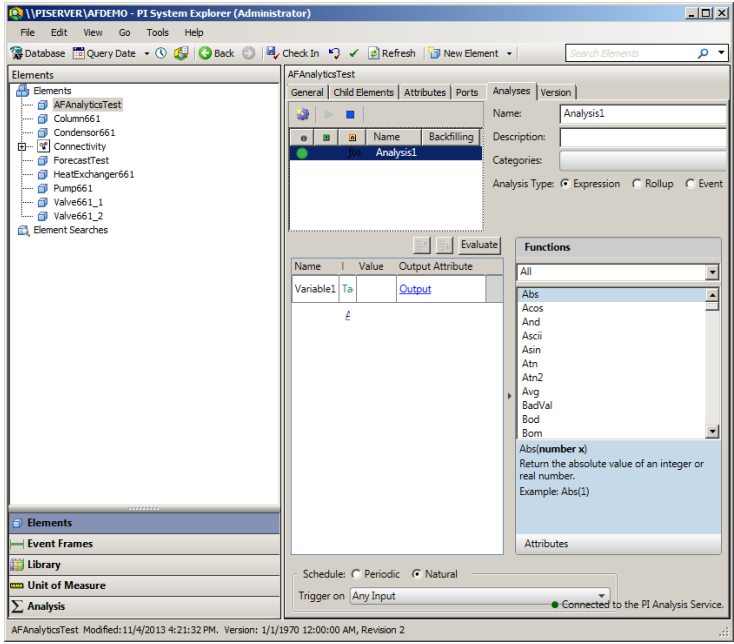
Web Service

PI System Infrastructure



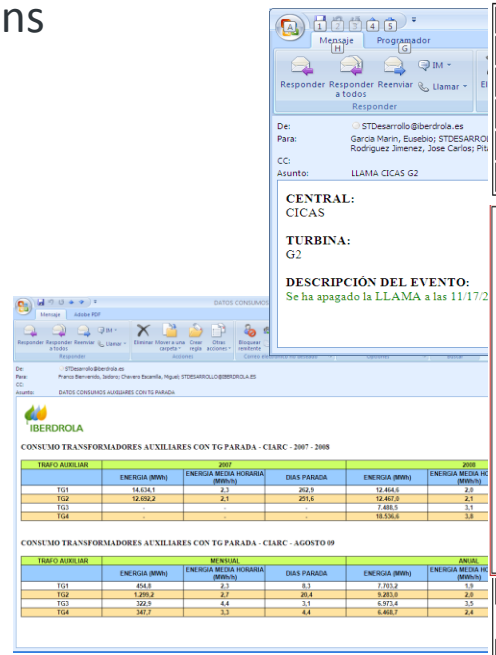
PI Analytics

- Transforms operational data into **actionable information**
- The analyses are:
  - Created by configuration or programming
  - Triggered periodically or on events
  - Consulted on-demand or historized



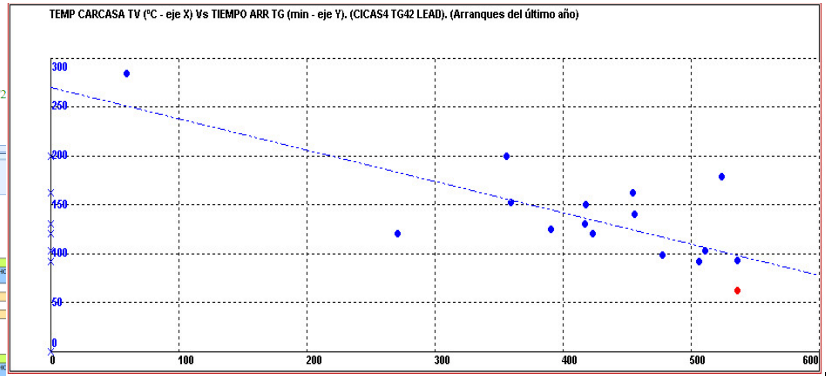
Advanced Equipment Monitoring

Plant Notifications



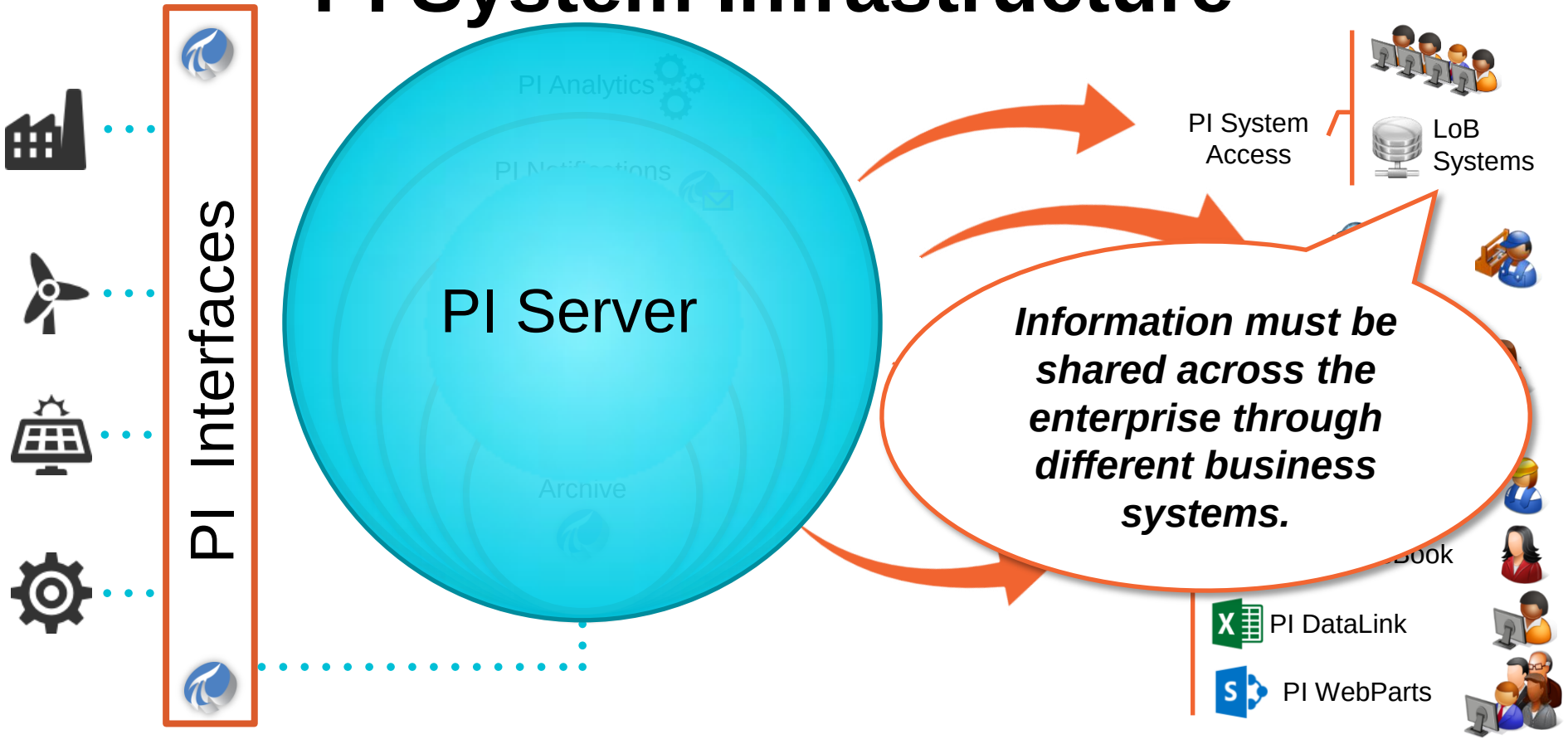
ARRANQUE TG42 LEAD CICAS4	
Número Arranque	190
Tiempo en FSNL (min)	2
Cierre del Int. Generación	06/12/2010 07:14
Tiempo desde Ignición hasta Premix (min)	62.7
Tiempo en cerrar bypass AP desde FSNL TG42 (min)	45.3

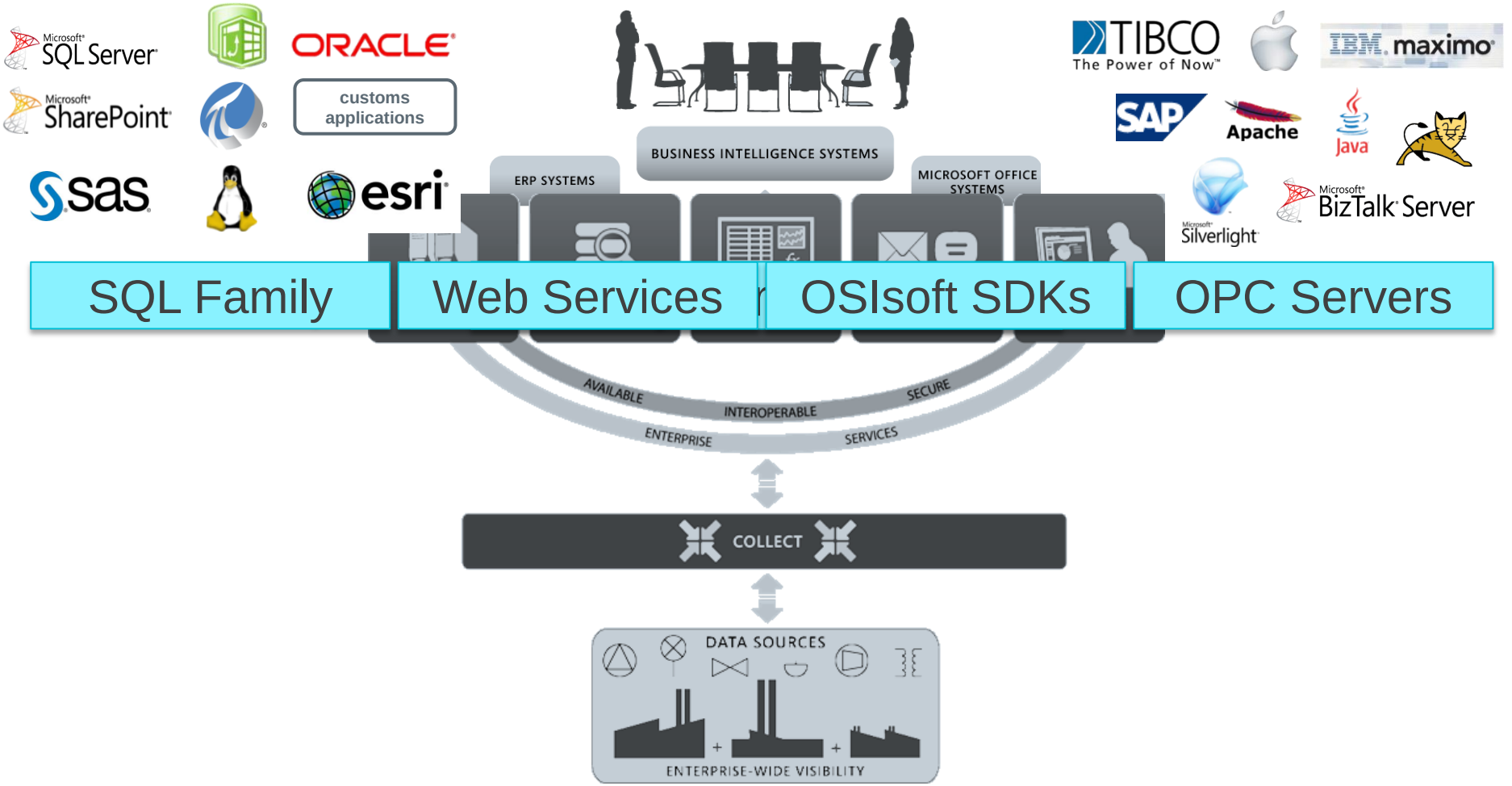
ARRANQUE TV CICAS4	
Inicio rodaje	06/12/2010 07:33
Tiempo en FSNL (min)	1.3
Cierre del Int. Generación	06/12/2010 07:45
Temp TV (ºC) - Tipo Arranque	536 - CALIENTE
Stress Máximo/Permitido	-2.1 / Bajo



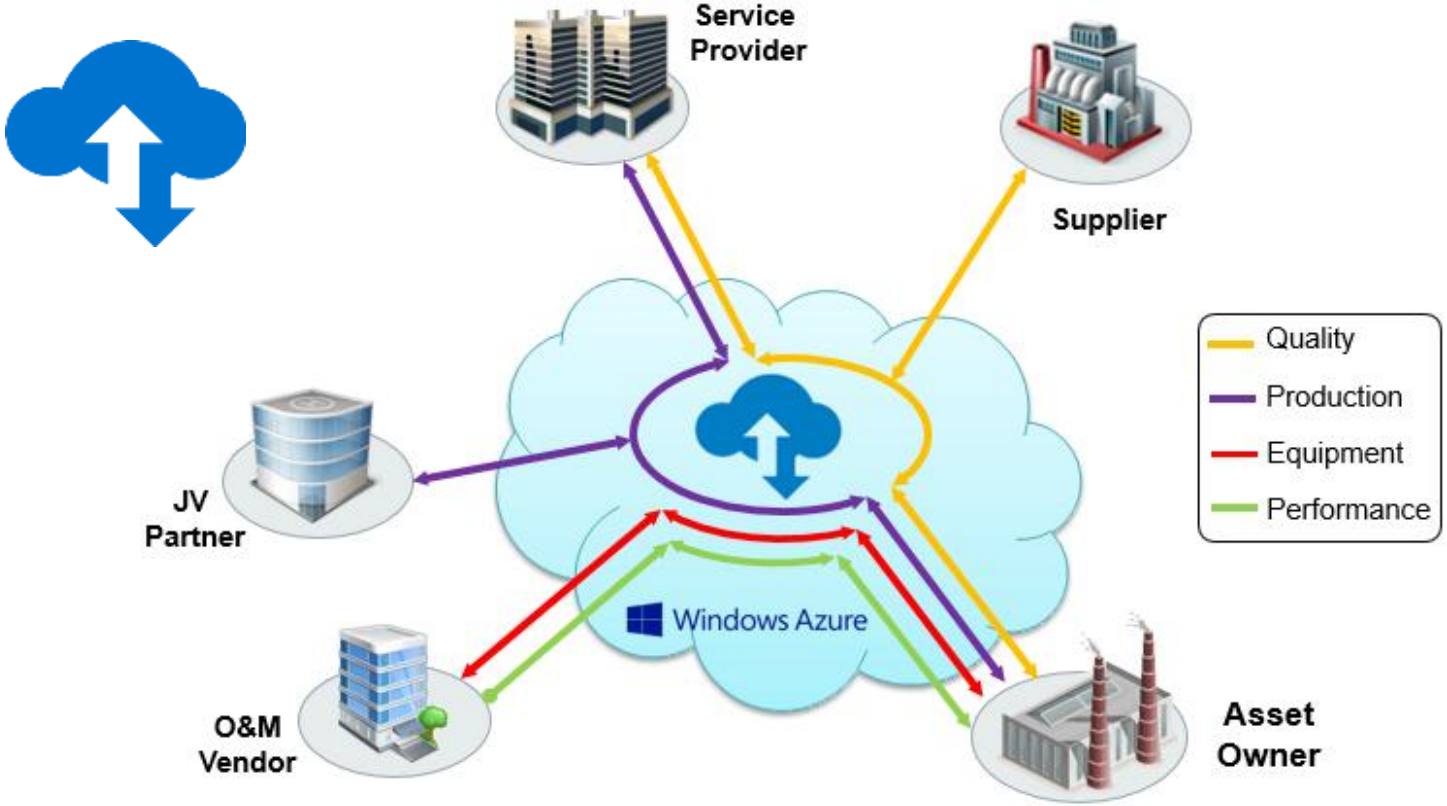
ENERGIA (MWh) POR BLOQUES DE HORAS DESDE EL ARRANQUE CICAS4						
	7:00	8:00	9:00	10:00	11:00	12:00
CASADA DCG	35	120	-	-	-	-
REAL	35	198	-	-	-	-

PI System Infrastructure





PI System Data Sharing – PI Cloud Connect



- ESRI is the maker of **ArcGIS**, the leading product of Geographical Information Systems **(GIS).**

- Rely on the PI System infrastructure to **combine GIS** data with **real-time** information

Contact Information

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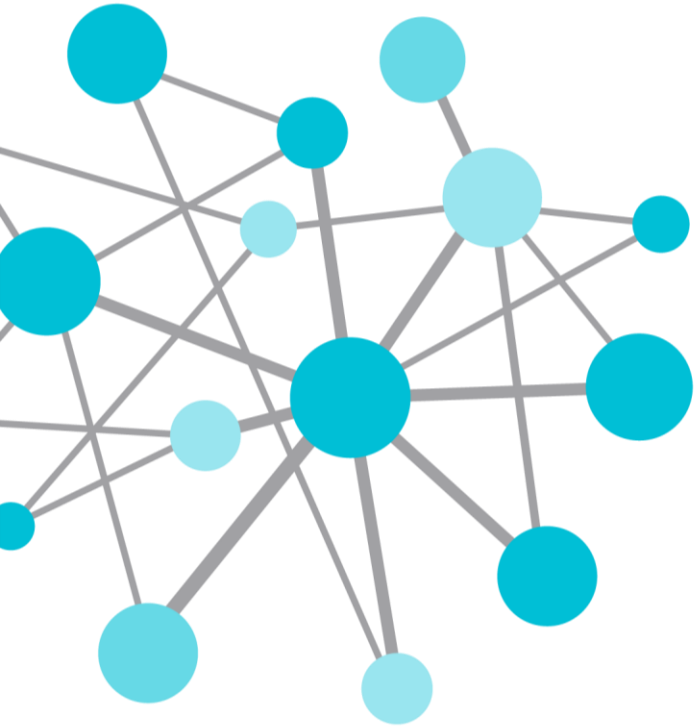

THANK YOU

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