Monitoring of the ITAIPU dam using PI System

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ITAIPU BINACIONAL

ITAIPU Binacional:
Dam Monitoring

Company and goals

Located on the Paraná river at the border between Brazil and Paraguay

Installed Capacity
14.000 MW
20 x GU (700MW)
Reservoir: 1.350km^2
Production Index:
10,4 KW / km^2

World leader in clean and renewable energy production
2.5 billions MWh
since 1984

2016: World record of energy production
103.1 millions MWh

PI System in ITAIPU Timeline

2002

SCADA

2006

SIRI

PI-SIRI

2015

OSIsoft EA

- Expansion of the PI System infrastructure;
- Training and capacity development;
- Development of new applications: PI AF, PI Coresight, PI ML;
- Support to the Technological Update Plan: Architecture, Security

2018

Technological update plan

SCADA - Supervision Control And Data Acquisition
SIRI - Integrated Industrial Networks System

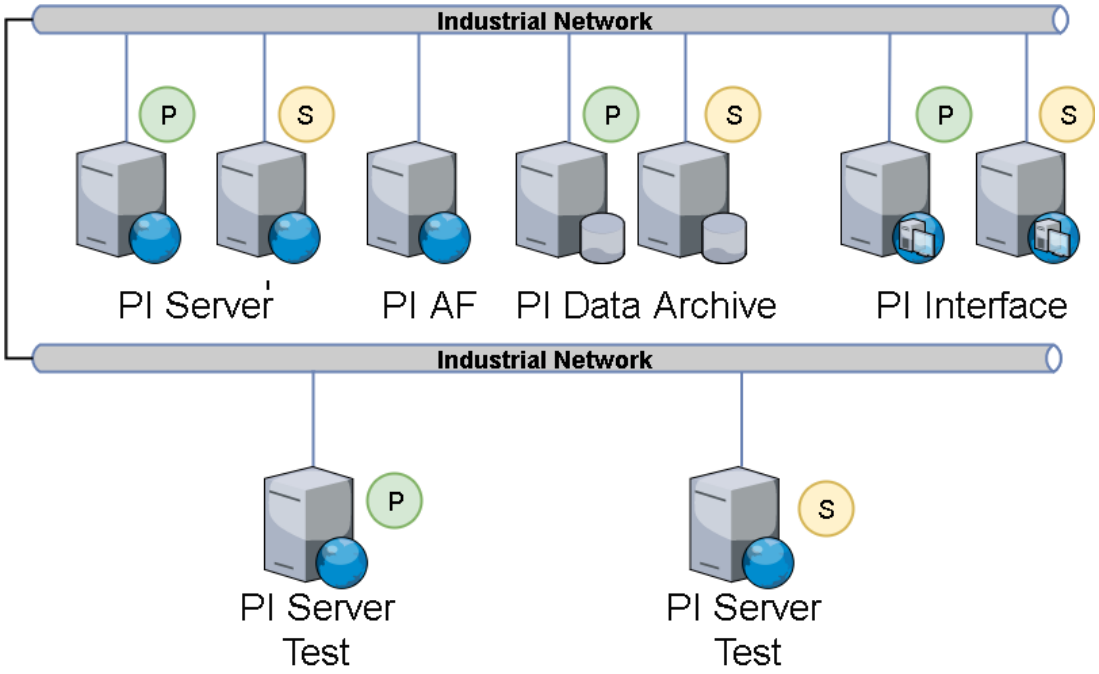
PI System Architecture: Infrastructure in ITAIPU

Production Environment

- Data Archive (HA)
- Asset Frameworks
- PI Interfaces: PI to PI, RDBMS, UFL
- PI Notification
- PI Vision
- Asset Analytics

Test Environment

- Full Virtualized PI System



Usage of PI System in ITAIPU

SCADA/EMS

- Power plant Supervision and Control (30,000 TAGs)

STH

- Hydrometeorological Data (1,000 TAGs)

MATRIX

- Condition Monitoring System(CBM)
- System designed to collect temperature, vibration and partial discharges (8,000 TAGs)

Others

- SMG - GIS Monitoring System
- SMT - Transformer Monitoring System
- RPMF - Oscilograph & Phasor Measurement
- ADAS - Automatic Data Auscultation System

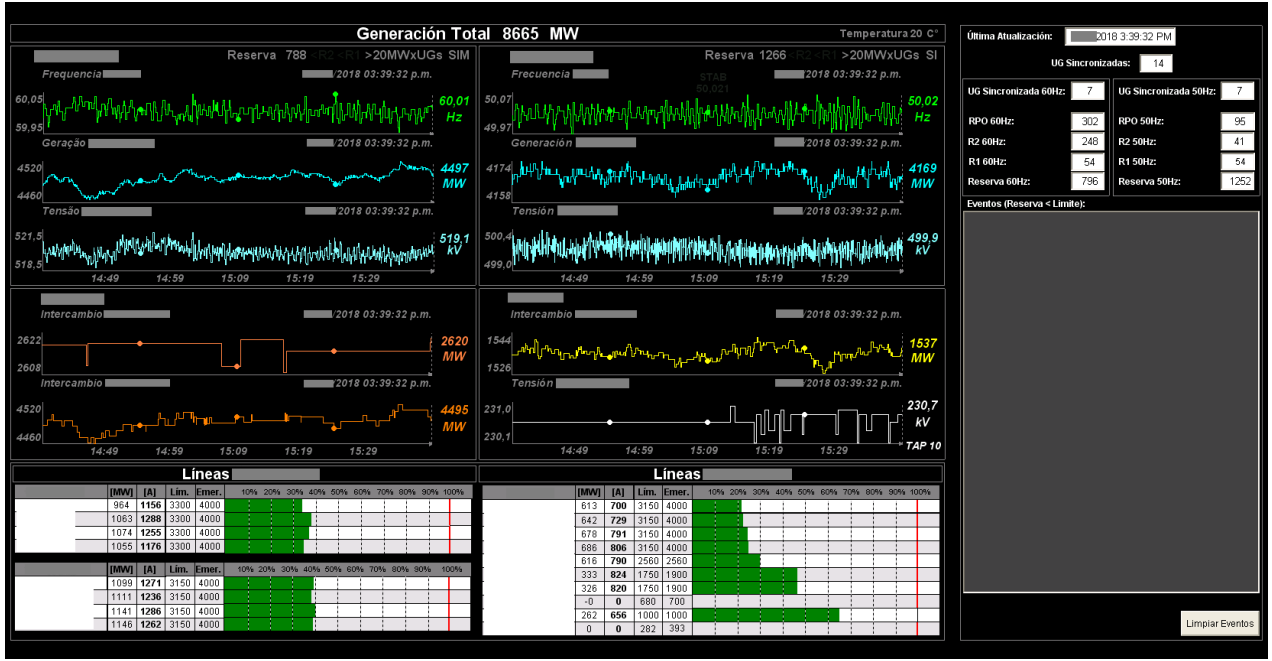
Example of applications that uses PI Systems in ITAIPU

Operação Online

SGW

Example of applications that uses PI Systems in ITAIPU

SCADA - ProcessBook



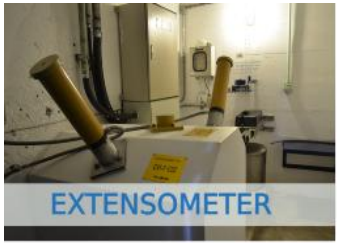
Dam monitoring: Instruments used

Currently in the dam there are 24 UARs (Remote Acquisition Unit). These units centralize the acquisition of data in which 10% of the instruments have automated acquisition.

The automated instruments include:

- Piezometers;
- Flow Meters;
- Tri-orthogonal Meters;
- Pendulum;
- Inverted Pendulum;
- Extensometers.

Instrumentation at the dam



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ITAIPU Technological Park (PTI)

Motivation: Currently applied solution

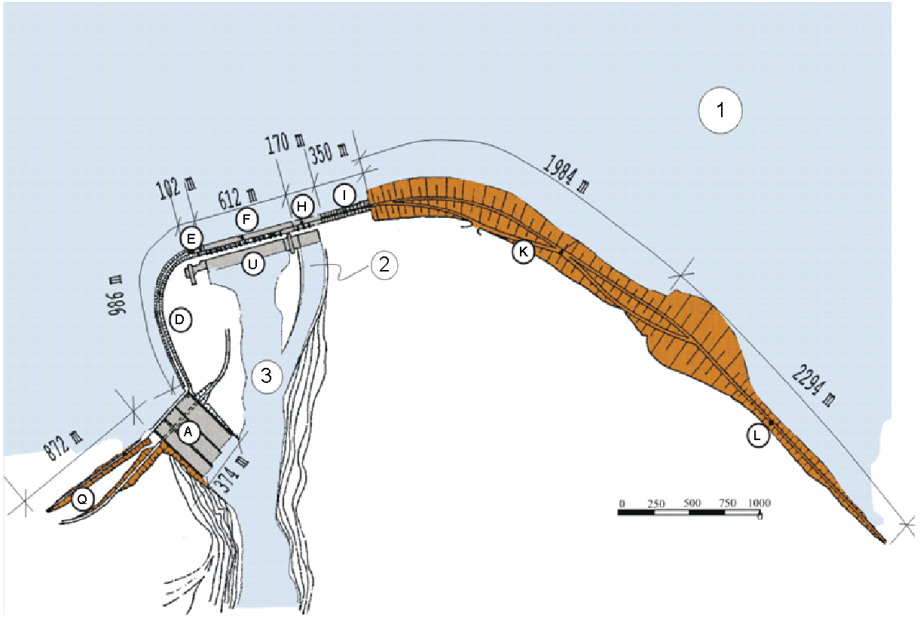
ADAS – Automatic Data Auscultation System

ADAS is responsible for acquiring information regarding the monitoring instruments of inside ITAIPU civil structure;

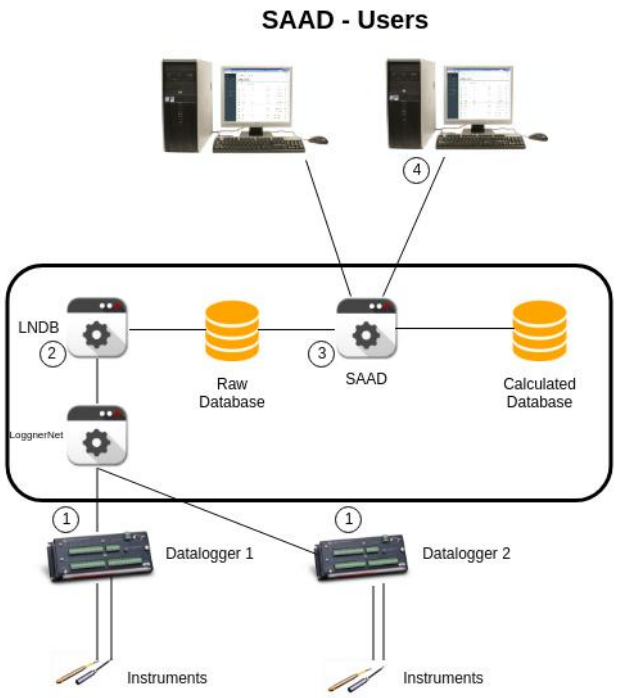
This customized software solution was developed by PTI. Requires a high level of specialization (change of source code - "Black Box") in case of any maintenance, such as:

- Add new types of instruments;
- Instruments calibration (eg parameter change in flow equations);
- Inclusion and editing of mathematical models.

Civil Structure of the Dam



ADAS – Application Architecture



1. *Datalogger/LoggerNet*: Datalogger is the equipment responsible for communicating with the sensors every 30 minutes and stores the data collected in an internal memory. LoggerNet is a Campbell application that performs data collection from Dataloggers;

2. *LNDB*: The datalogger does not send the information automatically and a Campbell application named LNDB connects to LoggerNet, searching for the collected data and inserting it into a relational database (SQL Server);

3. *SAAD*: It is an application developed by PTI where it performs the transformation and calculations of the measurements. It is also responsible for providing a web interface with users for viewing;

4. *Users*: They access the information calculated in SAAD to follow the alerts and trends.

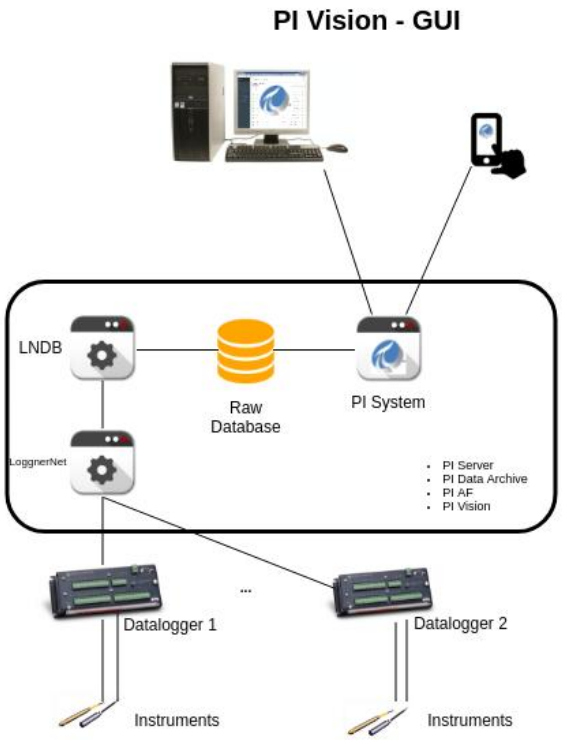
Solution based on PI System

The PI System Platform is evaluated as an alternative to the current SAAD solution through a PoV (Proof of Value)

Visualization: The web visualization interface is PI Vision. In this interface the user can monitor all the alerts, analyze the measurements in real time or historically through trends. System maintenance is simpler and does not require any coding;

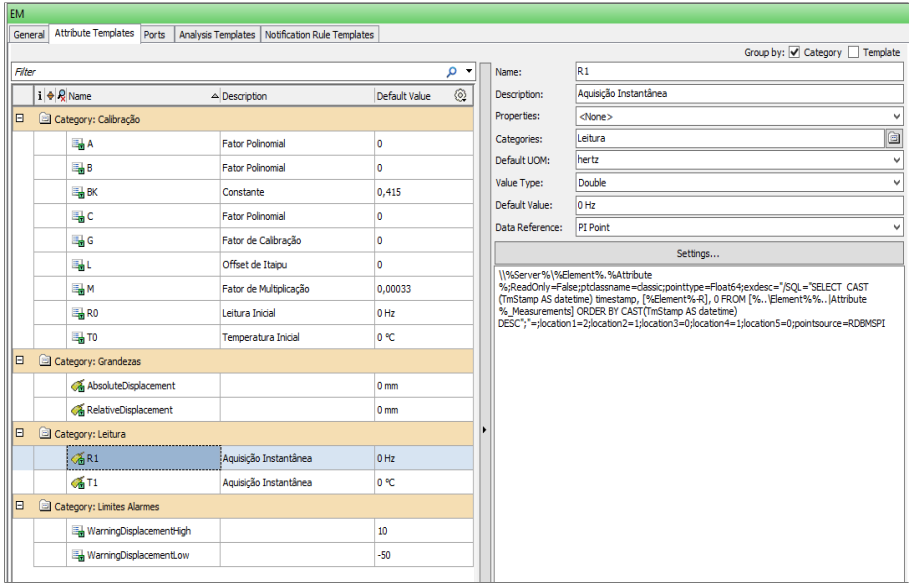
Contextualization and Analytics: The collected data is stored in PI Points and organized hierarchically in the Asset Framework (AF) PI. Measurement calculations are performed in Analytics, alerts are treated as Event Frames, and alerts are sent through Notifications automatically. Calculation results are stored in PI Points;

PI Interface for RDBMS: Using a native OSIsoft interface for reading relational databases, we collect the raw data stored temporarily in the LNDB (SQL Server).



The modeling of the instruments was performed in PI AF through templates automating the data acquisition (PI Points)

System modeling in PI AF (Asset Framework)



PI Element Templates: The correct use of templates allowed the solution to be easily scaled because the standardization of the structure by type of instrument and dramatically facilitates the addition of new instruments;

Categories: Using categories to organize information in a user-friendly way;

Automatic PI Point (tags) creation: Data acquisition is automatic, just by creating a new element based on the various templates available.

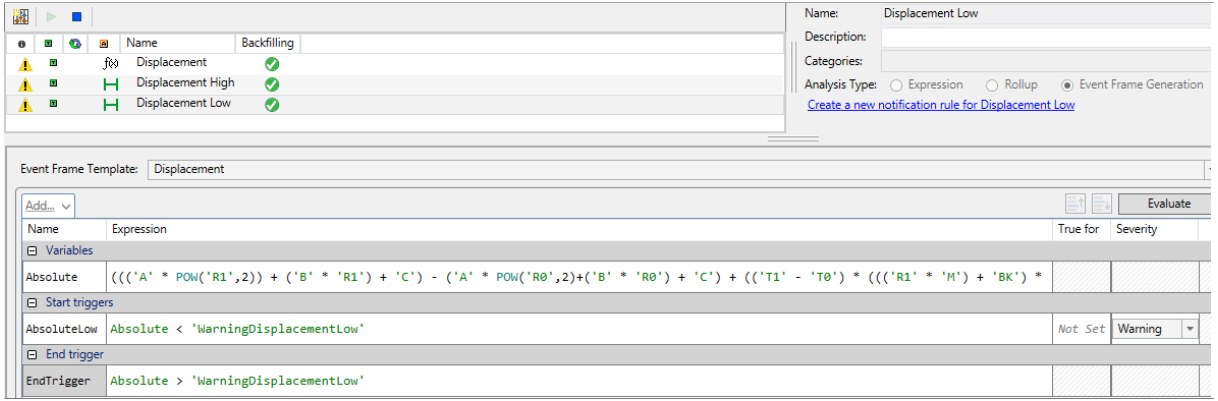
4 templates and 26 elements were created.

Each template corresponds to either an instrument or datalogger.

Creation of analysis: Complex calculations executed as data is acquired

Calculated Quantities:

- Water level (mm)
- Flow (l/s)
- Absolute displacement (mm)
- Relative displacement (mm)



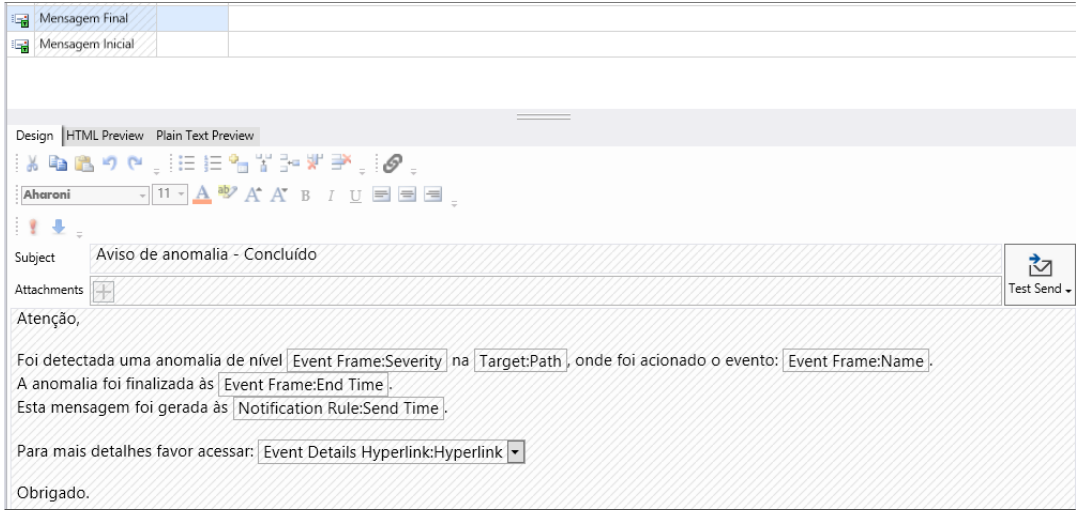
Asset Analytics & Event Frame

- Calculations made on each reading (~30min);
- Parameters are easily configurable;
- Events are created as soon as the thresholds are exceeded, generating alerts.

Notifications are generated automatically as soon as operational limits are reached

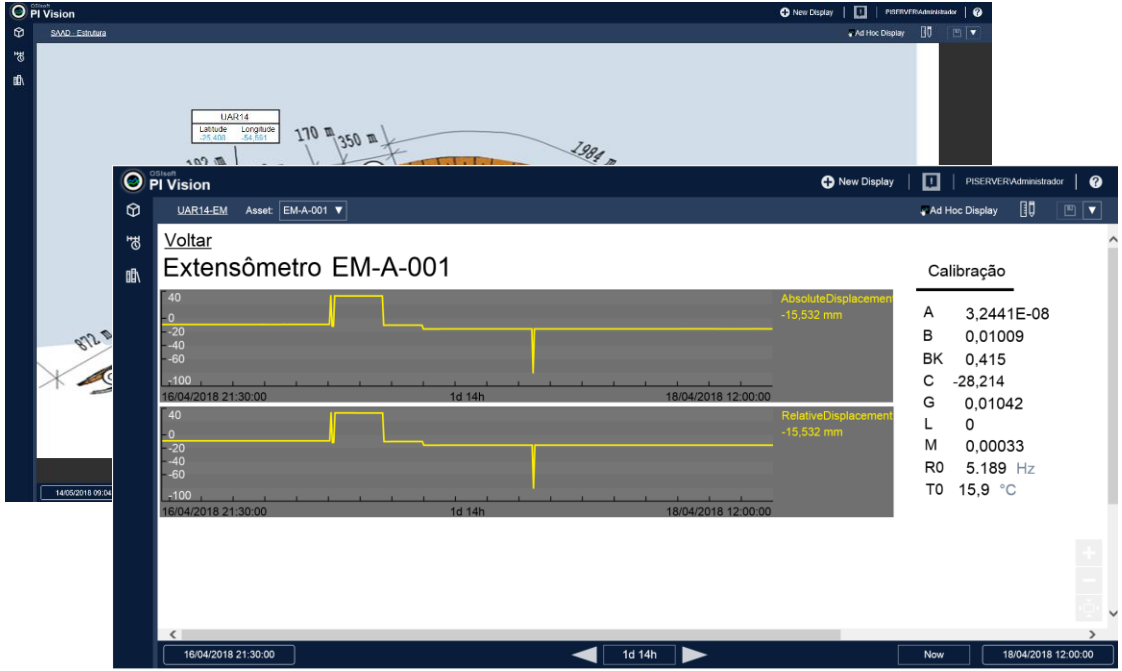
Notifications

- Customized message according to alert;
- Scheduling for management if no action is taken;
- Active real-time monitoring of anomalies;
- Easy maintenance and implementation.



An event is generated whenever a threshold established in the instrument configuration is exceeded, thus generating one or more notification emails.

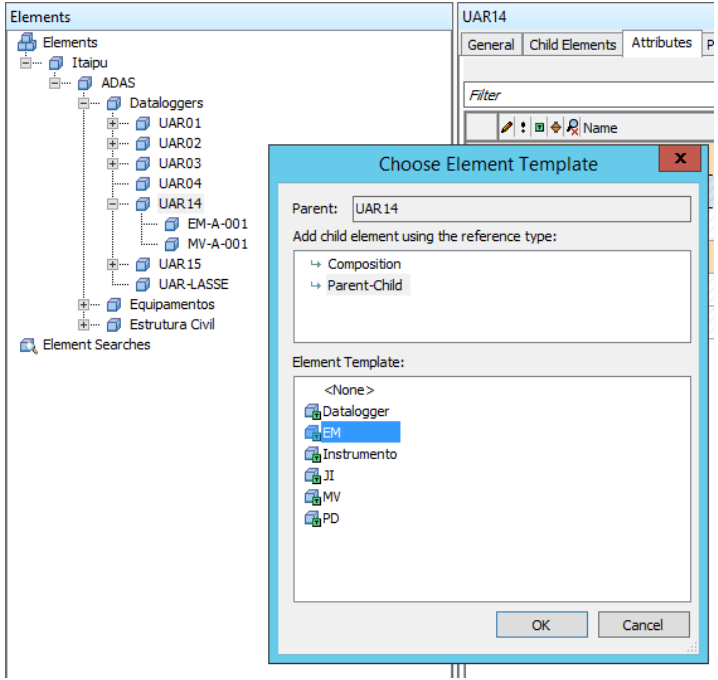
The graphic visualization proposal is made through PI Vision in a friendly, intuitive and multiplatform way



PI Vision

- Native support for mobile;
- Intuitive solution and well aligned with user expectations;
- Easy to use and secure;
- Friendly single interface widely used among users.

The graphic visualization proposal is made through PI Vision in a friendly, intuitive and multiplatform way



Adding new instruments

- All settings are inherited from the template;
- The only work required is instrument calibration;
- Enables change of instruments without affecting the template.

Use of a wide range of PI System modules for better maintenance, scalability and governance

Data Sources

- SQL Server
- Datalogger
- No change in data acquired from equipments

Data Acquisition

- Native integration
- Using the OSIsoft standard interface (PI RDBMS)
- Easy configuration
- Quick implementation

Processing

- Configurable parameters
- Contextualization
- Extensible calculations
- Traceable events
- Automatic notifications

Presentation

- Ease of use
- Quick implementation
- Fully mobile-friendly

ITAIPU Binacional

Monitoring of the ITAIPU dam using PI System

CHALLENGE

Monitor the instruments of 24 UARs

- Model the entire structure of UARs and instruments;
- Simplify application configuration and maintenance;
- Automate and facilitate the process of reading, calculations and analysis.

SOLUTION

Use the PI System to implement the entire process: from acquisition to presentation of data

- Utilization of AF, PI Interface, PI System Explorer, PI Notifications, Event Frames, PI Vision, and others;
- Team composed of engineers and systems analysts;
- All the calculations and analysis inside the PI System.

RESULTS

Solution with potential to be validated by users and replace ADAS

- Decrease in development costs;
- Decreased time spent with development efforts;
- Mitigate errors and impacts of changes made to configurations;
- Improve the process of adding and manipulating instruments.

SAAD Roadmap - ITAIPU ⟺ OSIsoft EA

✔	Architecture	• Defined and created with the help of OSIsoft Center of Excellence
✔	Proof of Value	• 15 tickets open in OSIsoft support • Quick generation of licenses for the virtualized environment
✔	PI-Test Server	• Work in progress
✘	Product Environment	
✘	Mobile App	

Future steps to be taken

- Configuration of all instruments within the PI System;
- Survey of new indicators through the analysis of trends;
- Use of PI DataLink to facilitate the calibration process.

Speakers

- Luís Eugênio Espinosa Aranha
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- Luiz Fernando Lima
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Questions?

Please wait for the **microphone**

State your **name & company**

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