Alarm System for Structural Monitoring of the ITAIPU Dam Employing the tools of the PI System

Presented by **Airton Bordin Junior**

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Agenda

- About us
- Business Challenge
- PI System in ITAIPU
- The Solution
- PI System Tools
- Next Steps
- Results
- Conclusion

About us

ITAIPU Binacional

- Largest generator of electric energy in the world
- Installed capacity 14,000 MWs – 20 generator units of 700 MW each
- 2013 Record: 98,630,035 megawatts-hour

ITAIPU Binacional

75.2% of the Paraguayan consumption

16.8% of the Brazilian consumption

PTI – ITAIPU Technological Park

ÁREA DE INFLUÊNCIA - PARQUE TECNOLÓGICO ITAIPU
ÁREA DE ABRANGÊNCIA - BACIA DO PARANÁ III (BR)
ÁREA DE INTERESSE - MISIONES (ARG) E MUNICÍPIOS LINDEIROS (PY)

- Since 2003
- 420 direct jobs
- Innovator space that congregates projects and programmes addressing
  - Social insertion
  - Jobs and income creation
  - Distribution of knowledge
  - Transfer of technology
- Incubated firms
- 3 universities

PTI - ITAIPU Technological Park

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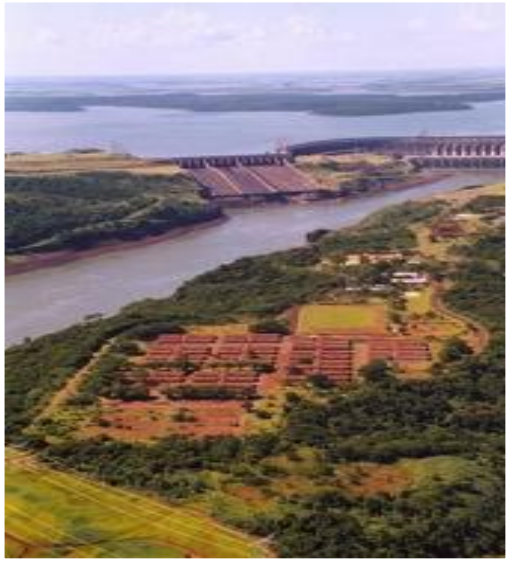
1979



2003

2013

Total Area: ***75,54 hectares*** | Constructed Area: ***49,521 m²***

ITAIPU/PTI and OSISoft

- ITAIPU utilizes PI System since 2002
- Specification and acquisition of EA – 2015 to 2019

R&D CEASB

CEASB

CEASB
Centro de Estudos Avançados em Segurança de Barragens

- Centre of Advanced Studies on Dam Safety
- Programme of the ITAIPU Technological Park
- Develops research and development projects in the area of dam safety
- 9 research areas
- Database: projects utilising PI System
  - 6 graduation fellowships
  - 2 volunteers

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Business Challenge

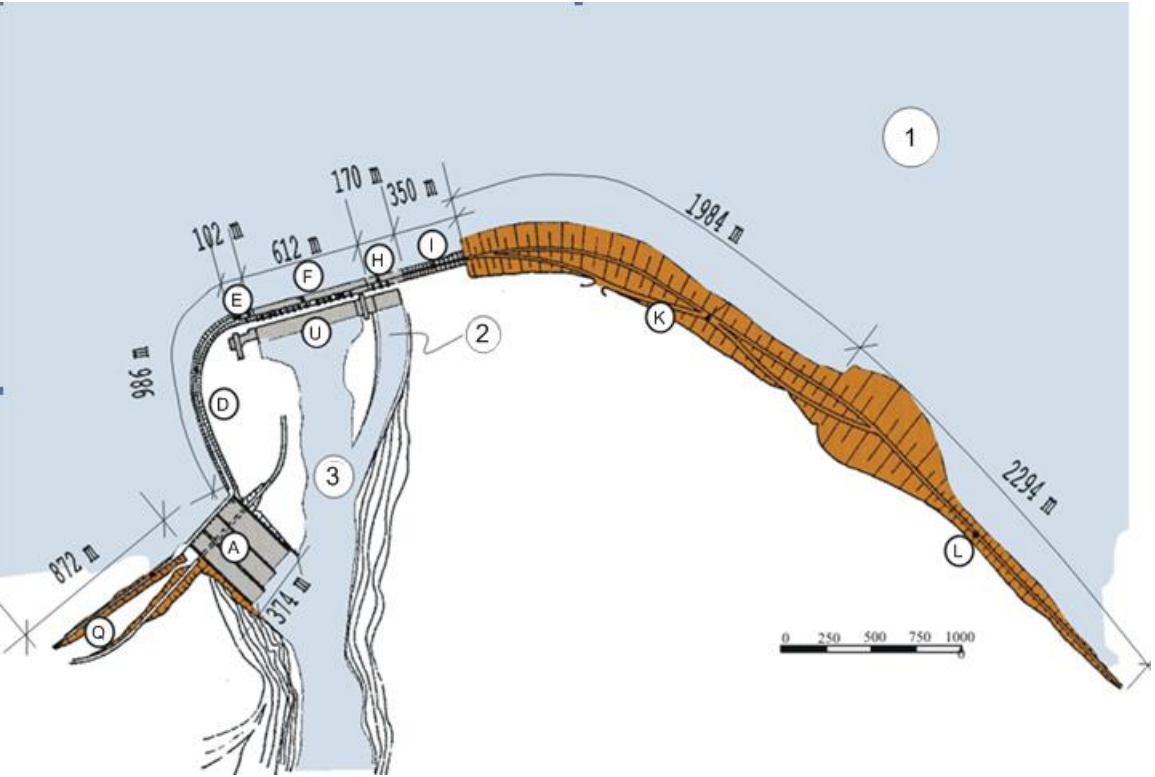
Business Challenge

- Monitor a dam 8km long, 185m high with 2,700 instruments in real time;
- Identify possible abnormal behaviour of the structure;
- Automatically correlate between the instrumentation;

Business Challenge

- Identify possible faults in the structure;
- Alert those responsible for the dam at the exact moment an event occurs;
- Assist those responsible in reaching a decision.

ITAIPU power plant civil structure



1 – Reservoir

2 – Diversion Channel

3 – Downstream

Q – Right Earthfill Dam

A – Spillway

D – Left Lateral Dam

E – Right Wing Dam

F – Main Dam

H – Diversion Structure

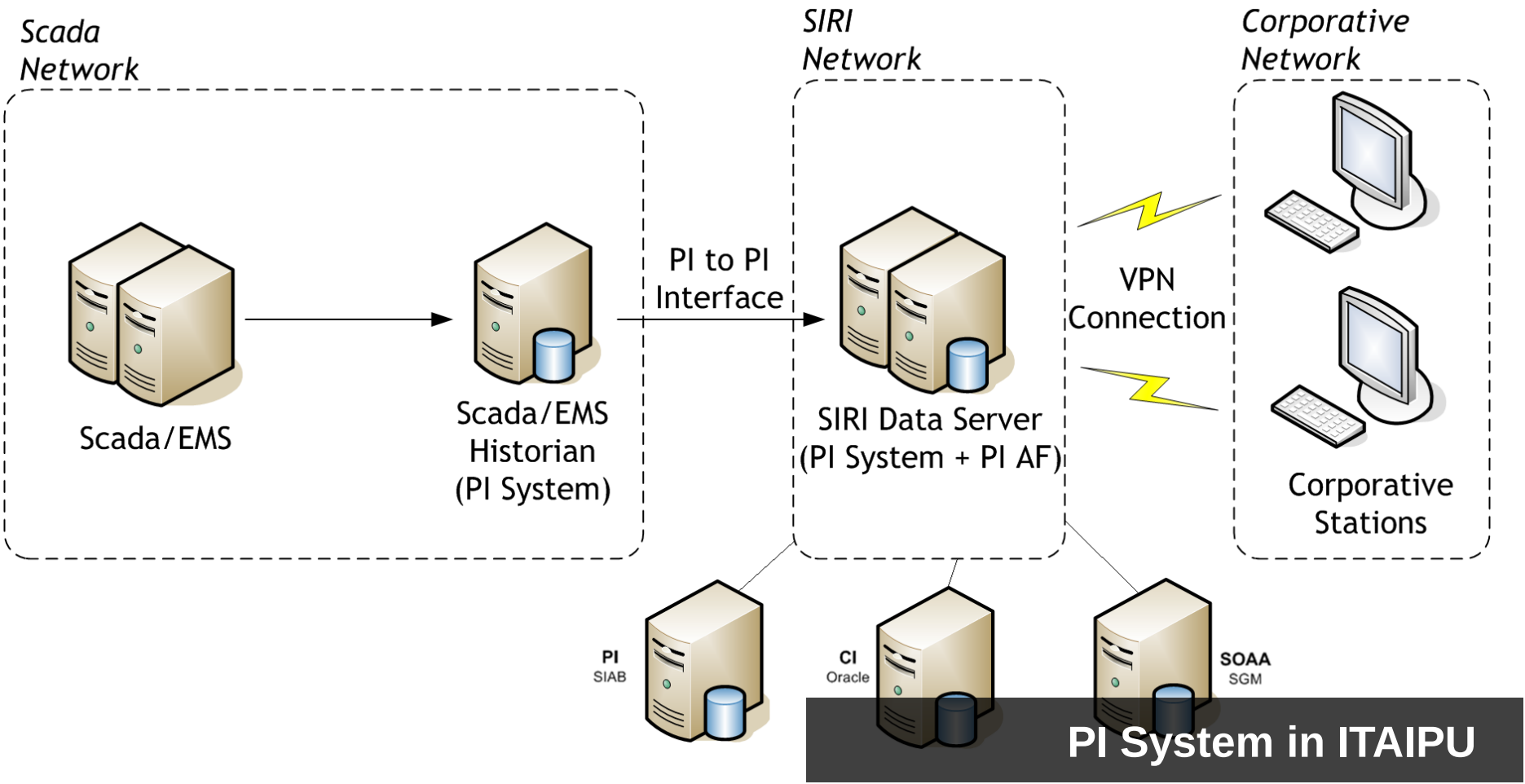
I – Left Connecting Dam

K – Rockfill Dam

L – Left Earthfill Dam

U – Power House

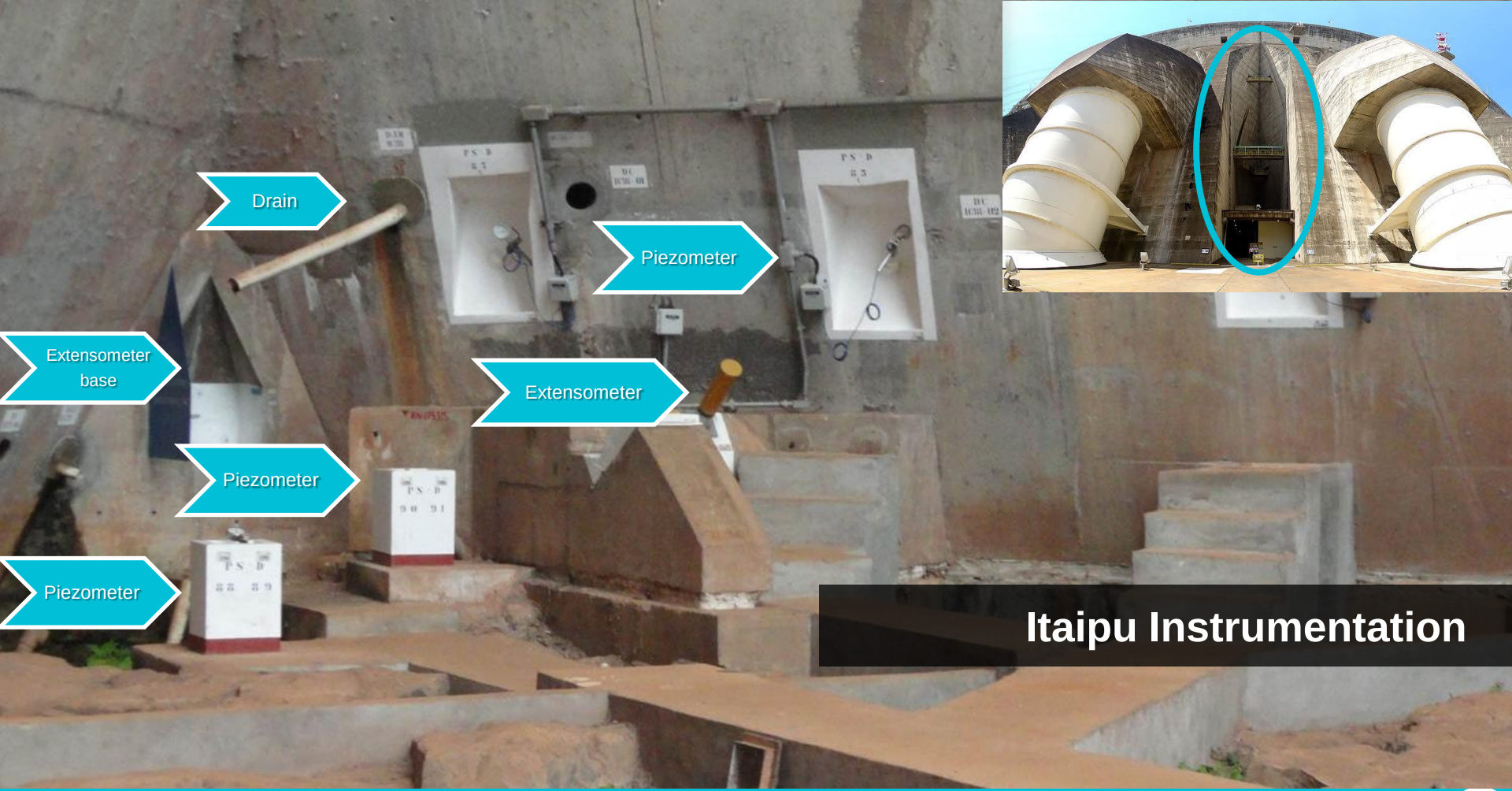
PI System on ITAIPU



PI System in ITAIPU

PI System on ITAIPU

- 70000 tags that store data related to diverse aspects of the dam
- 7000 tags that store instrumentation data of the civil structure of the ITAIPU power plant
- There are 19 types of instruments that monitor the civil structure

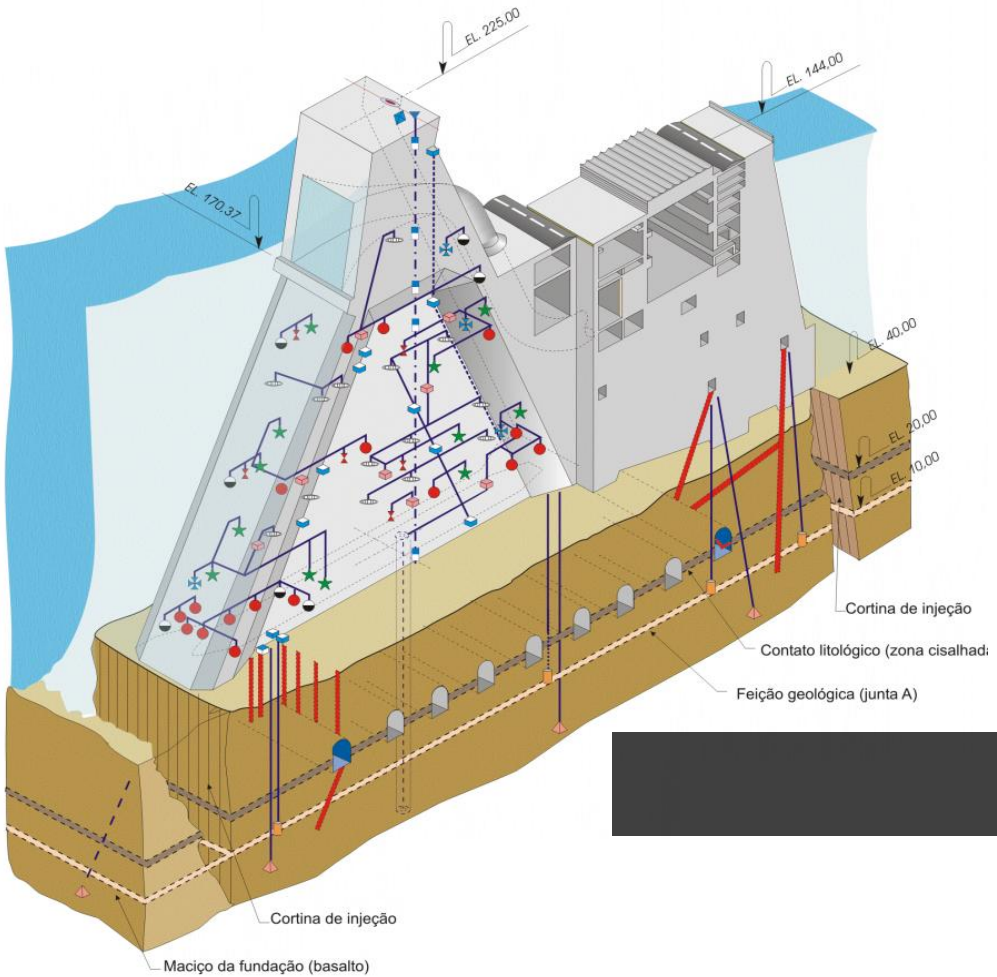


Itaipu Instrumentation

INSTRUMENTS TYPE																				
FOUNDATION							CONCRECT											GEODETIC		
PIEZÔMETRO	EXTENSOMETRO DE HASTE	TRIORTOGONAL	MEDIDOR DE VAZÃO	MEDIDOR DE ASSENTAMENTO	QUANT. INSTRUMENTOS	DRENOS	DEFORMÍMETRO	MEDIDOR DE JUNTA ELÉTRICO	TENÔMETRO	TENSÔMETRO P/ ARMADURA	BASE DE ALONGÂMETRO	PÊNDULO	COORDINOMETRO	PARES DE PINOS	TERMOMETRO	TRIORTOGONAL	DRENOS	ALVOS	MARCOS	TOTAL DE INSTRUMENTOS
661	136	22	51	9	879	4346	261	58	66	16	645	63	6	99	139	399	949	20	141	2792

Instruments

- Some dam blocks are called key-blocks
- Key-blocks are totally instrumented
- Defined by ITAIPU Binational Engineers according the block technical characteristics
  - High
  - Position
  - Type of foundation



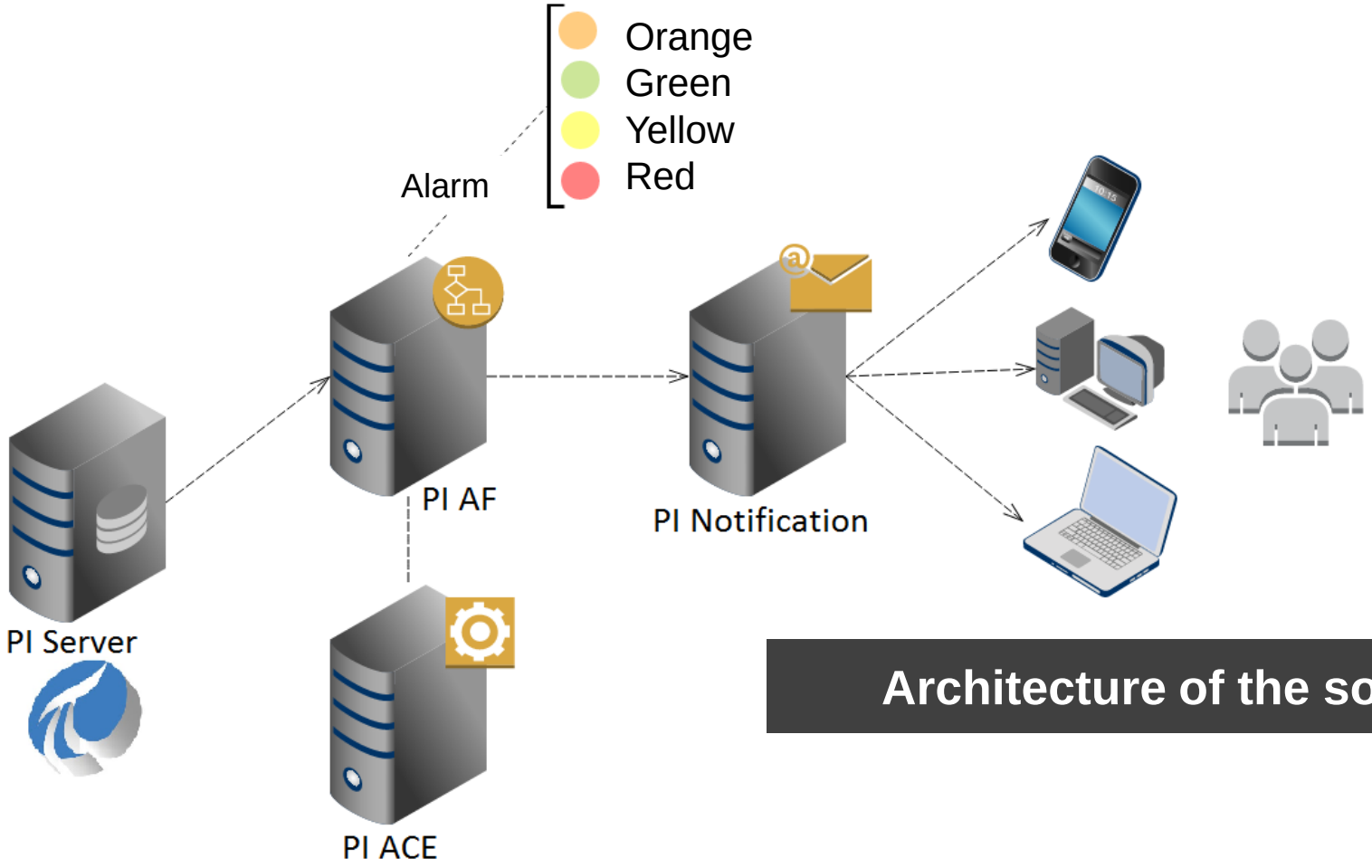
Key block

The solution:

Alarm System for Structural Monitoring of the ITAIPU Dam Employing the tools of the PI System

The solution

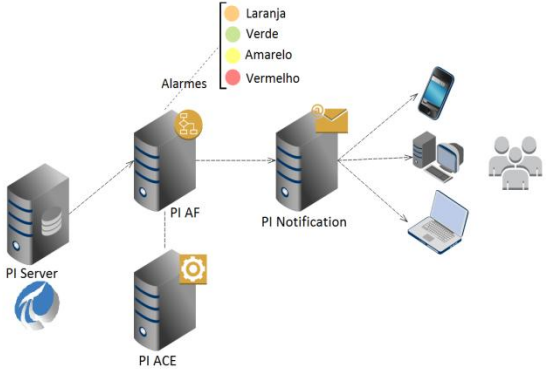
- Analyses the data from the readings;
- Executes processing of the information;
- Applies the Fault Tree technique;
- Generates an alert on the structural situation.



Architecture of the solution

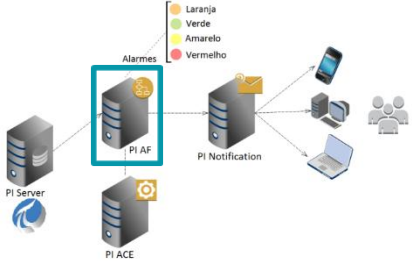
The Solution

- OSISoft products in use
  - PI Server 2012
  - PI System Management Tools
  - PI Asset Framework
  - PI Advanced Computing Engine
  - PI Notifications
  - PI SDK (PI AF SDK)
  - PI Performance Equation



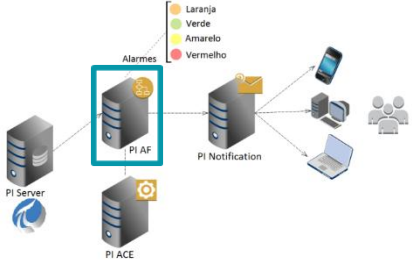
PI Asset Framework (PI AF)

PI Asset Framework



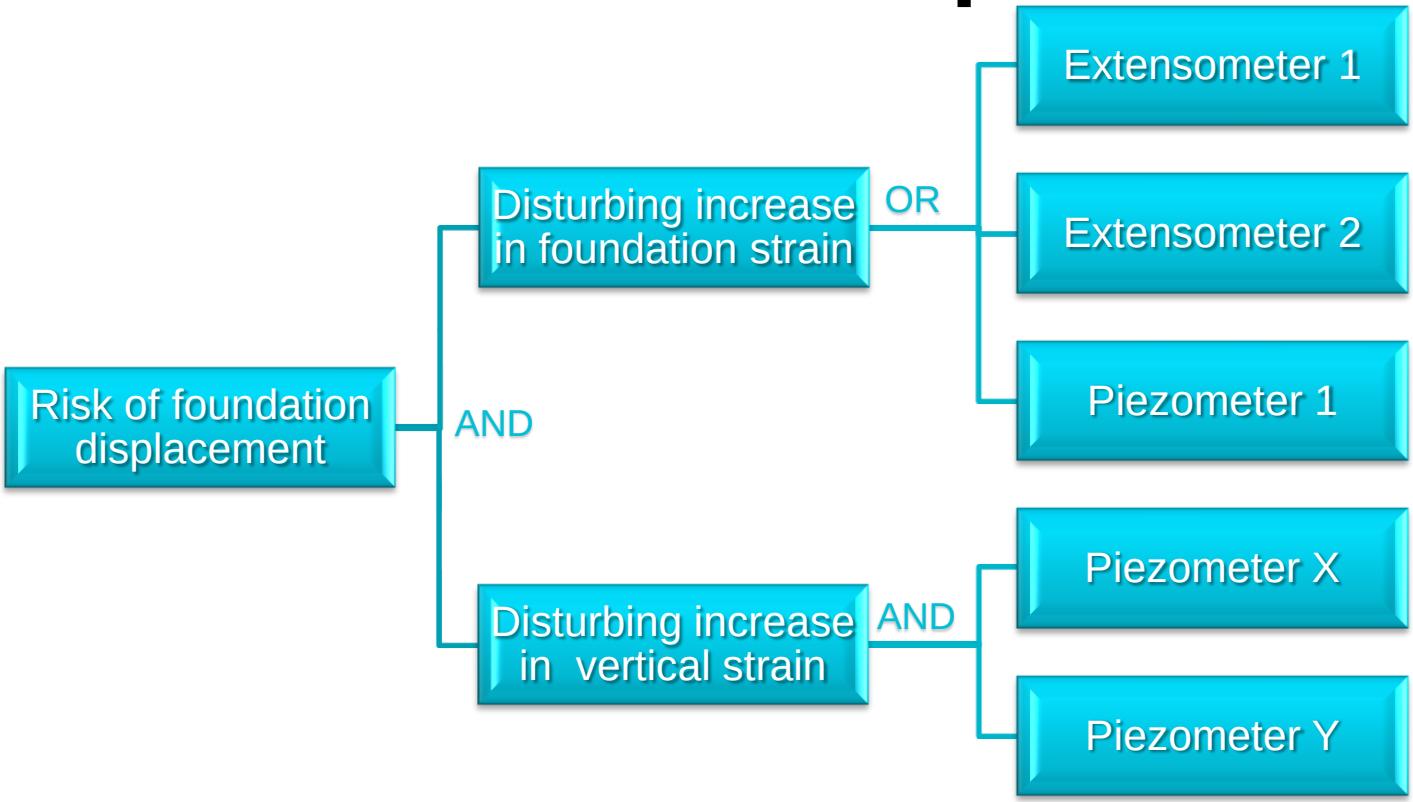
- Implementation of the analyses of the instrument readings is done in the PI Asset Framework, using the fault tree method
- Fault tree
  - 60’s, Bell Laboratories, created to evaluate the safety performance of a launch control method
  - Systematic analysis of possible faults and consequences
  - Corrective or preventive methods

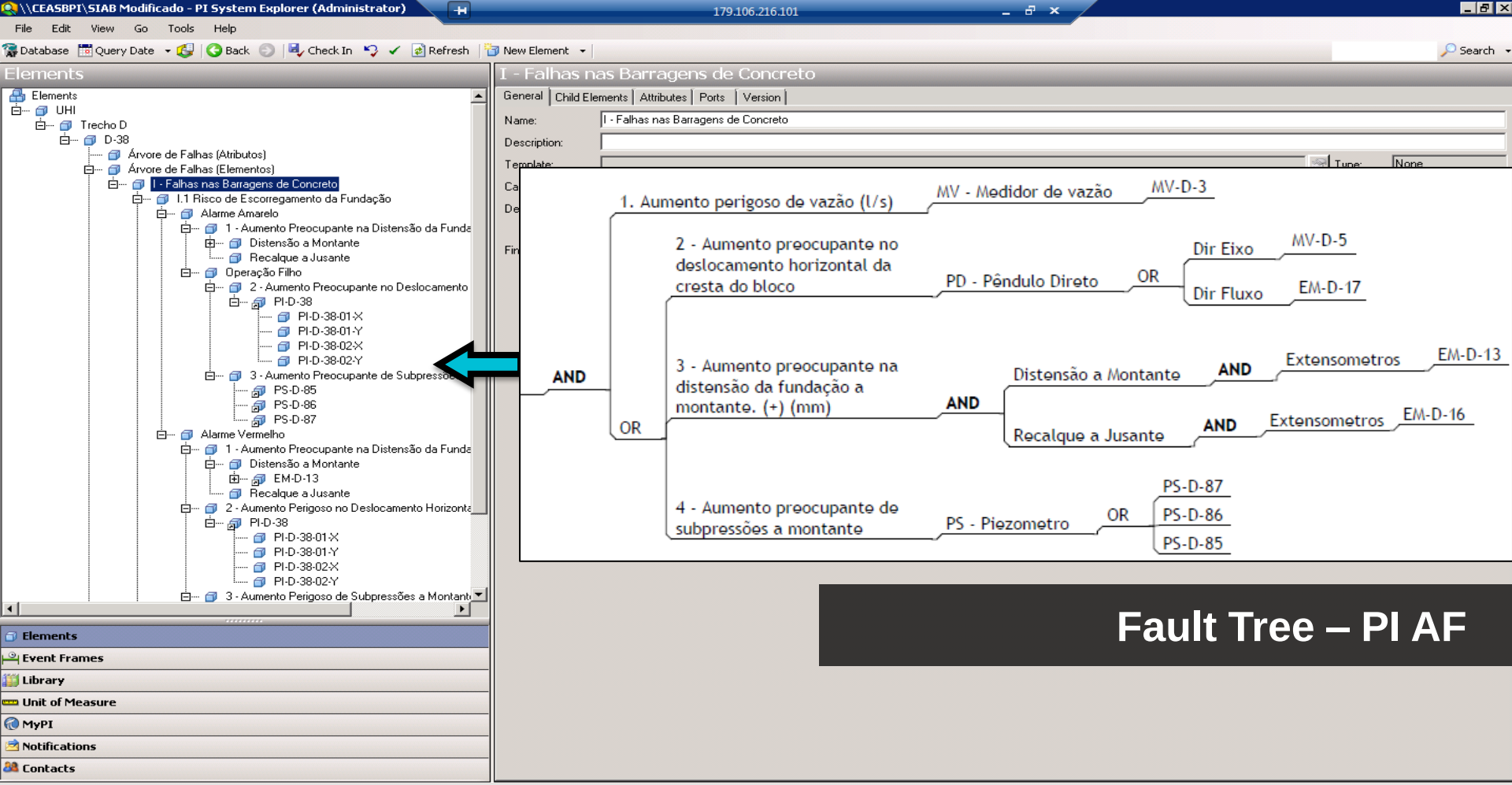
Fault Tree– PI AF



- Due to its hierarchical characteristic, we utilize the PI AF to represent the fault tree structure of the blocks
- It presents the present situation of the dam structure
- Levels of alarm conform to the degree of emergency
- Alarms defined by colours

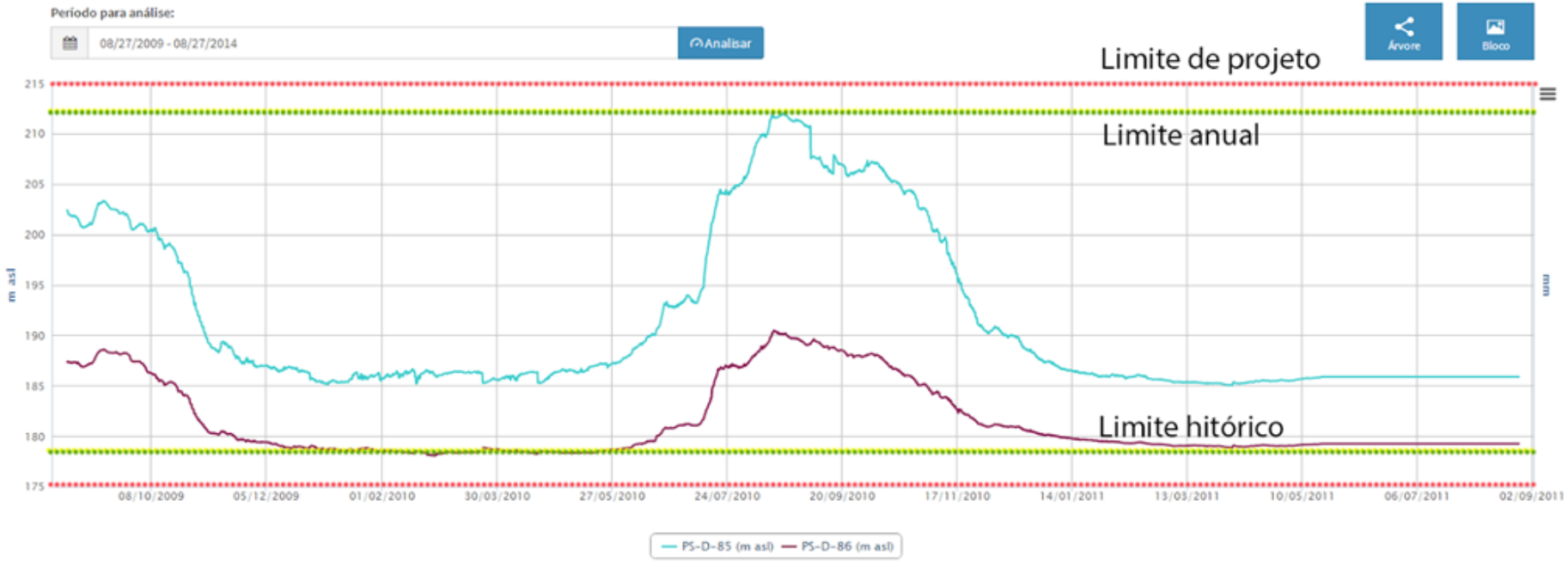
Fault Tree – Basic Example





Fault Tree – PI AF

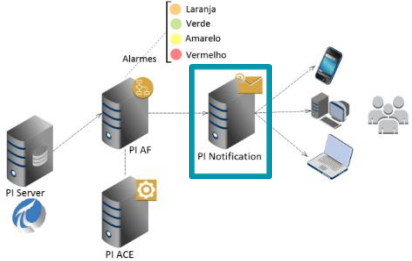
Notification – Alarm Level



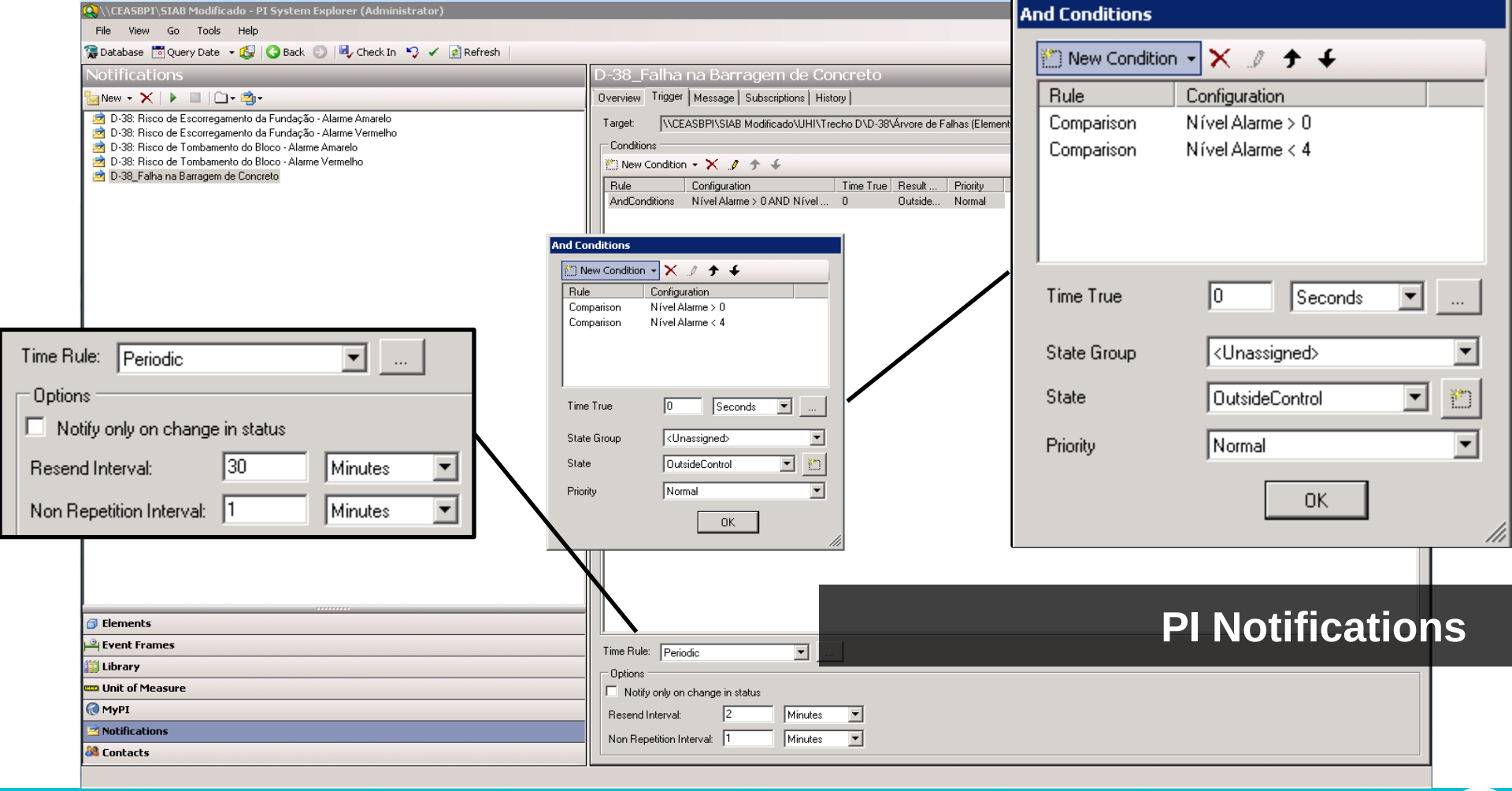
Normal | Manutenção | Limite anual | Limite histórico | Limite de projeto

PI Notifications

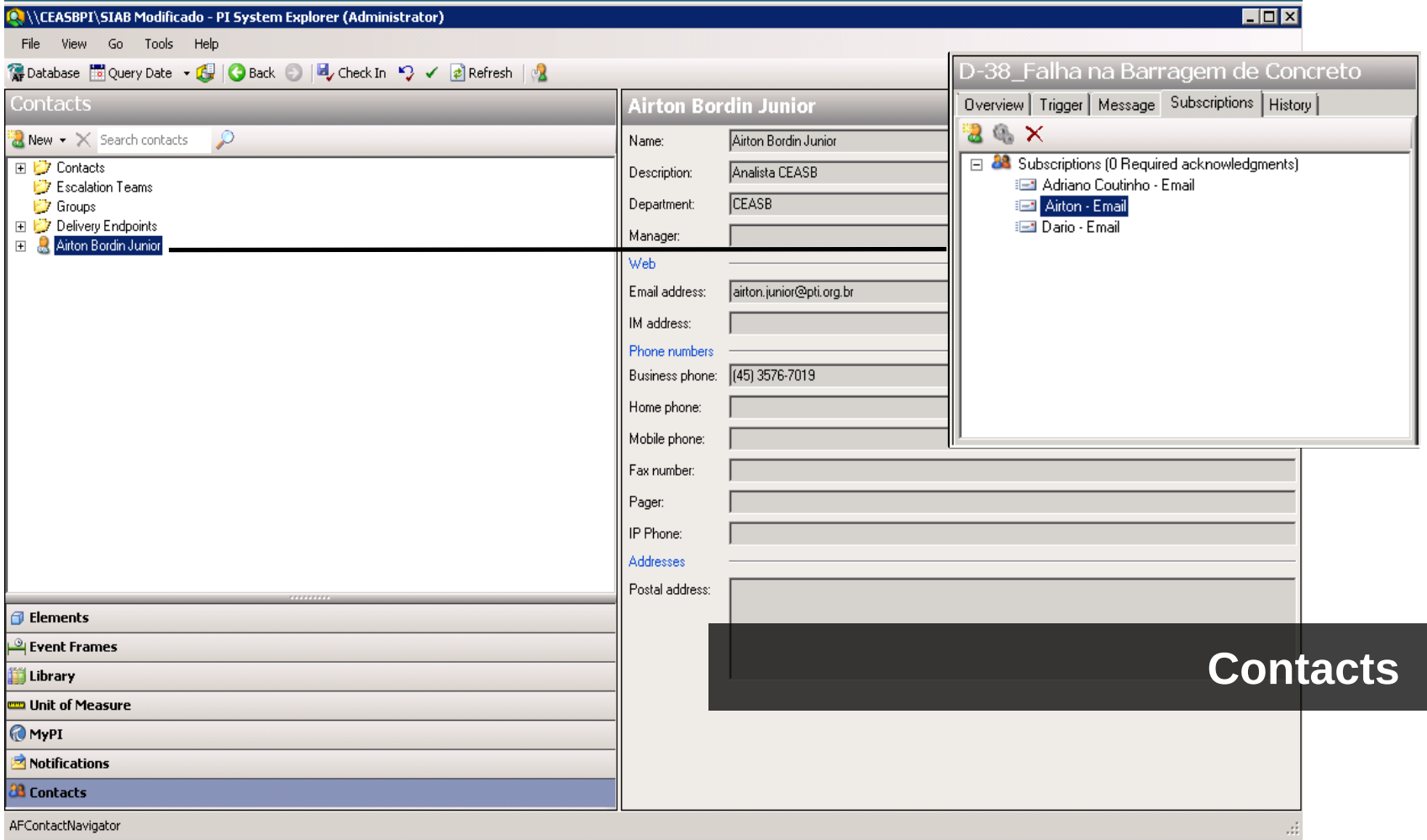
PI Notifications



- Define the FT elements that are to be analysed by the Notification (*target*)
- Define the conditions of conformity with the alarm type attribute (*conditions*)
- Configure those responsible who will receive the alert messages (*subscriptions*)
- Analysis of the *target* element executed every 30 minutes



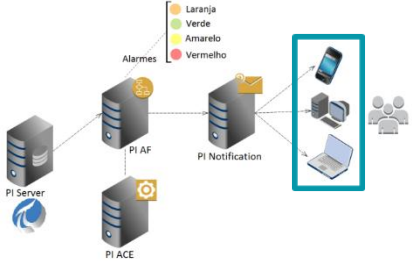
PI Notifications



Contacts

Message

Message



- The specialist user receives an email with information on the alarm to assist in taking a decision
- He also receives a link to access the module of visualization of the system for further information on the fault
  - Complete route of the fault
  - Historical graph of the tags related to the fault
  - Localization of the instrument in the dam

Data 15-08-2014 10:45
Prioridade Mais baixa

Informações sobre a falha:

Nome: D-38: Risco de Escorregamento da Fundação - Alarme Amarelo;

Horário: 15/08/2014 10:44:55 Hora oficial do Brasil (GMT-03:00:00);

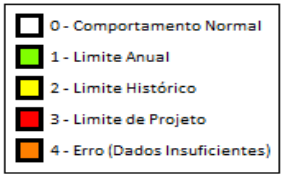
Nível de Alarme: 2 (Limite Histórico)

Para mais informações, acesse o link:

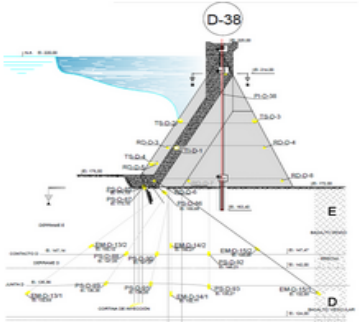
P&D System

alarm_map.png
block.png

Baixar todos os anexos

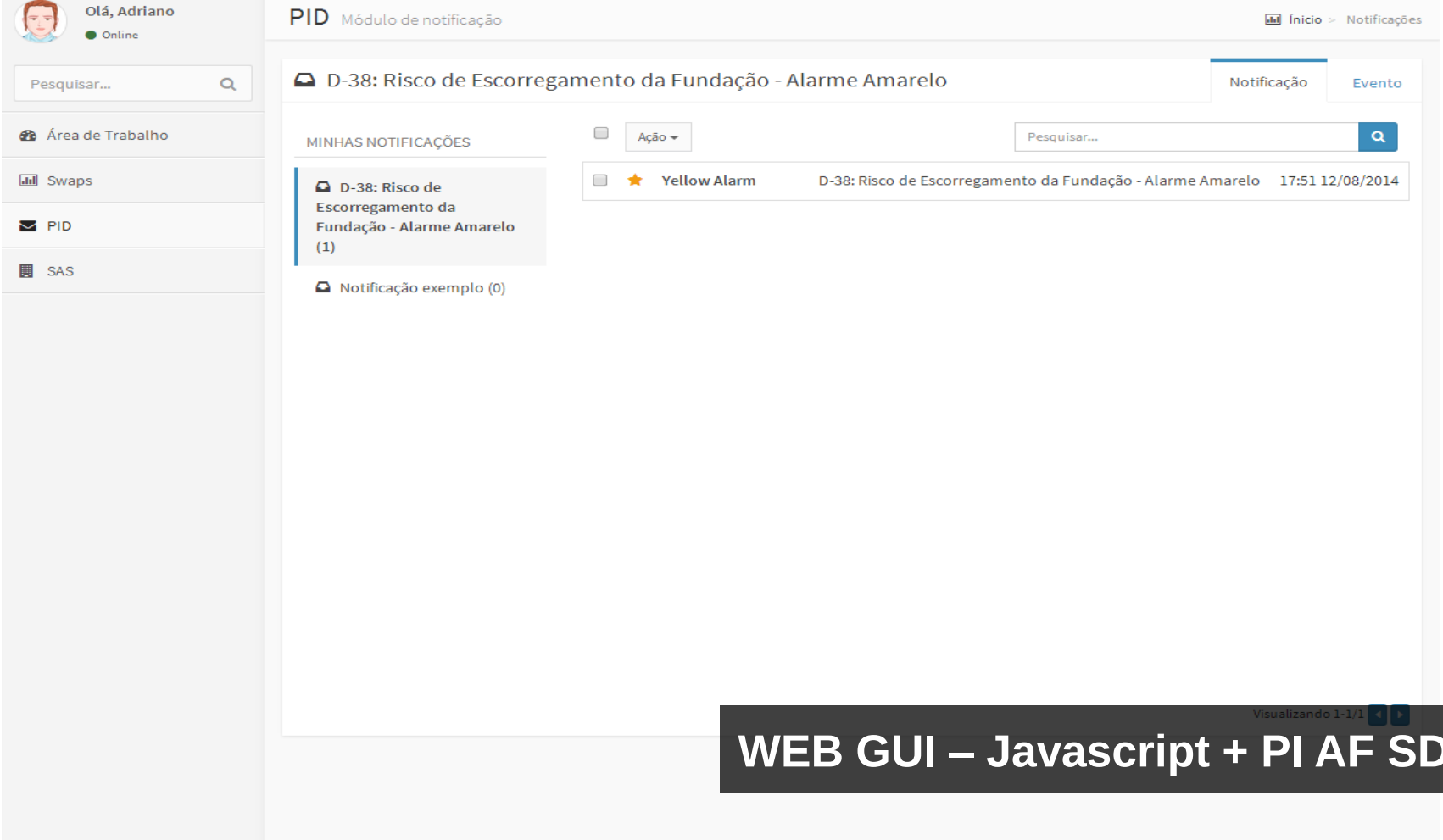


alarm_map.png
~4 KB Exibir Baixar

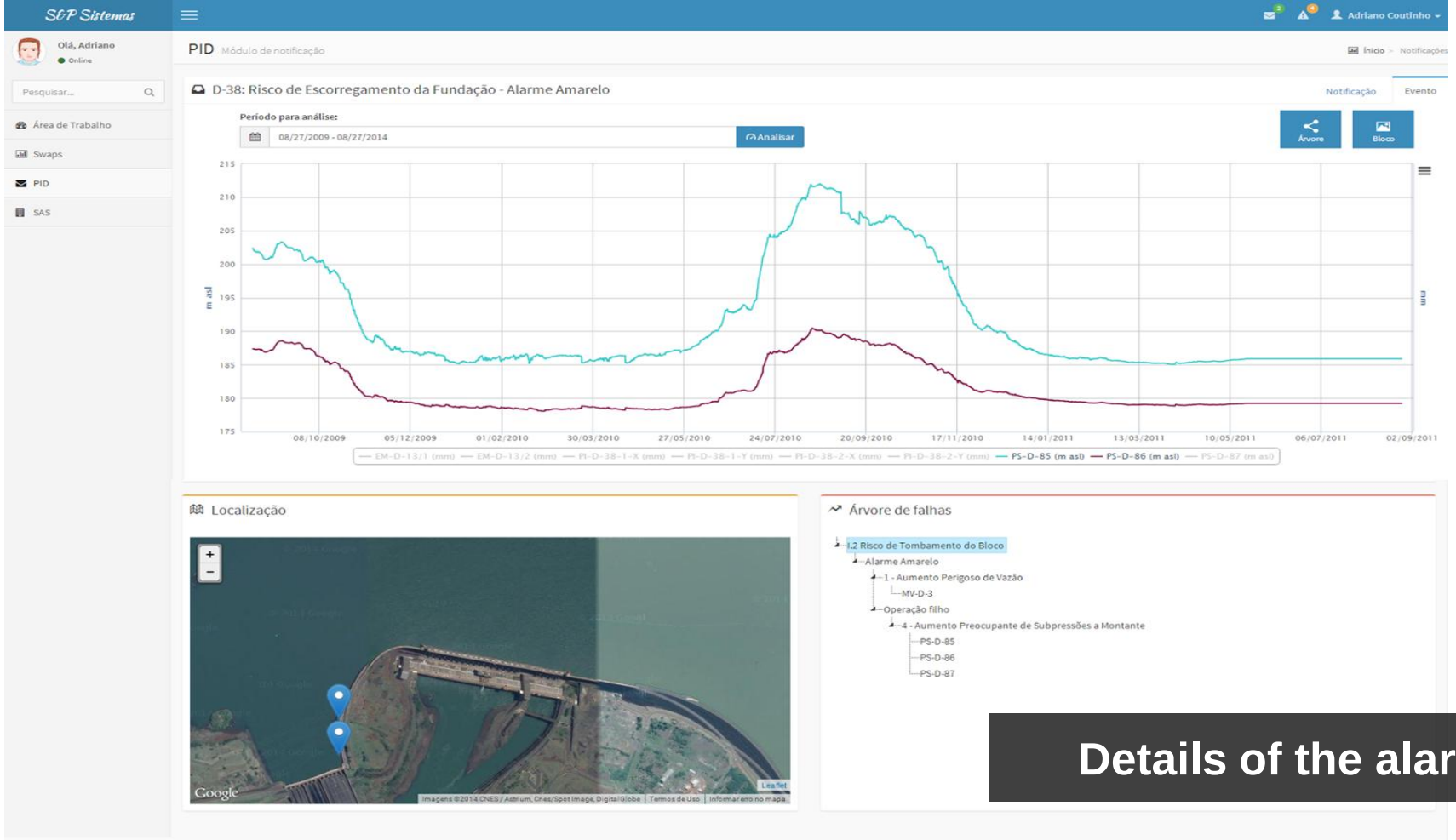


block.png
~132 KB Exibir Baixar

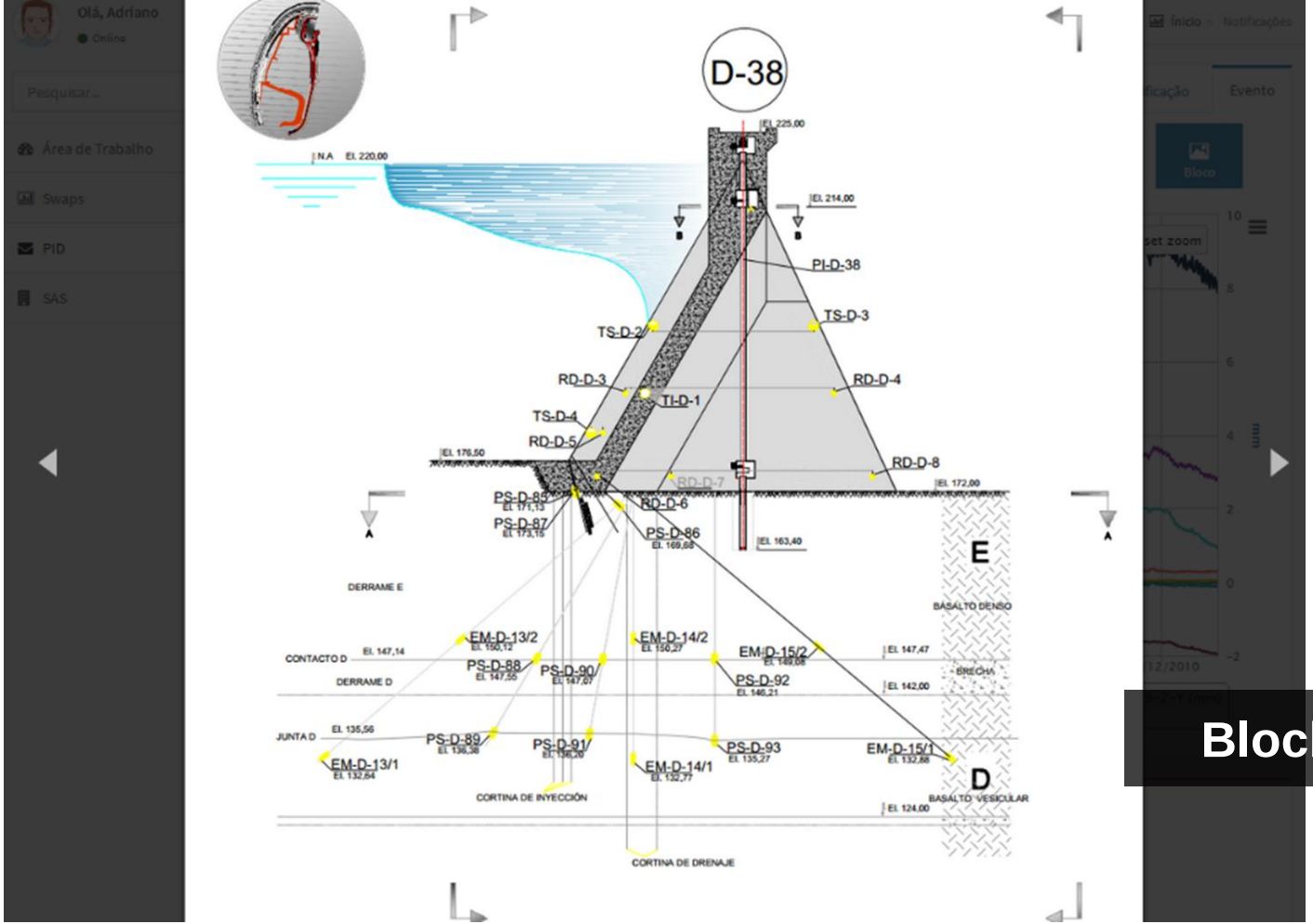
Email message example



WEB GUI – Javascript + PI AF SDK



Details of the alarm



Block Image

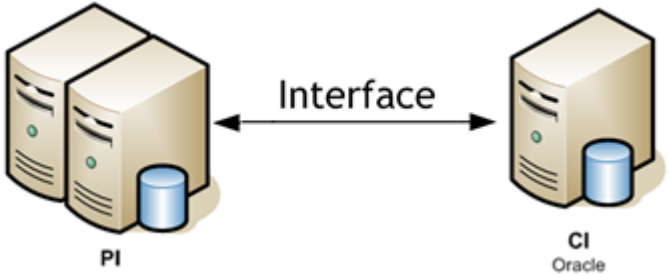
Responsive design - Mobile

Demo

Next steps

Next steps

- Oracle Database Integration (manual readings)

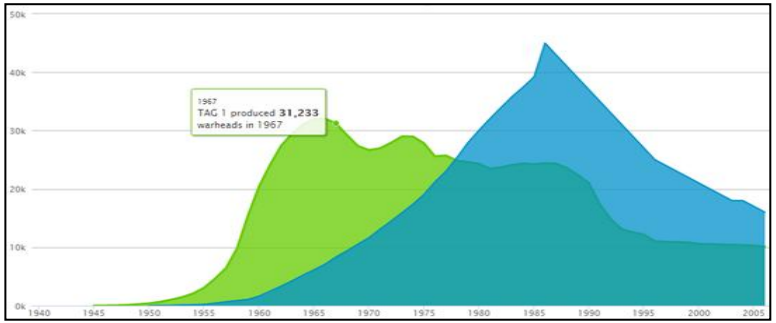


- Statistical analysis using PI ACE

Results

Results

- System executes the structural monitoring of the ITAIPU Binational dam
- Automatic alerts are sent to the specialists responsible for the auscultation area
- Response time to verify a possible problem is immediate
- The system permits detailed analysis of the anomaly and assists the specialist in reaching a decision
- Guarantees greater safety and more efficient monitoring of instrumentation of civil structure of the dam



Conclusion

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"The implementation turned our system more proactive instead of reactive"

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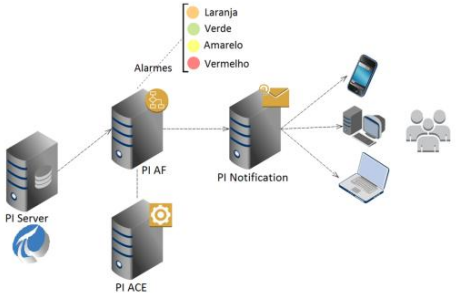
Business Challenge

- Monitoring the ITAIPU dam
- Generation of alarms
- Sending messages to those responsible

Solution



Results and Benefits

- Assists structural monitoring of the dam
- Facilitates reaching decisions
- Automatic alerts to those responsible
- Greater safety…

Credits

- ITAIPU Technological Park Staff
- ITAIPU Binational Staff
- Students
- Volunteers

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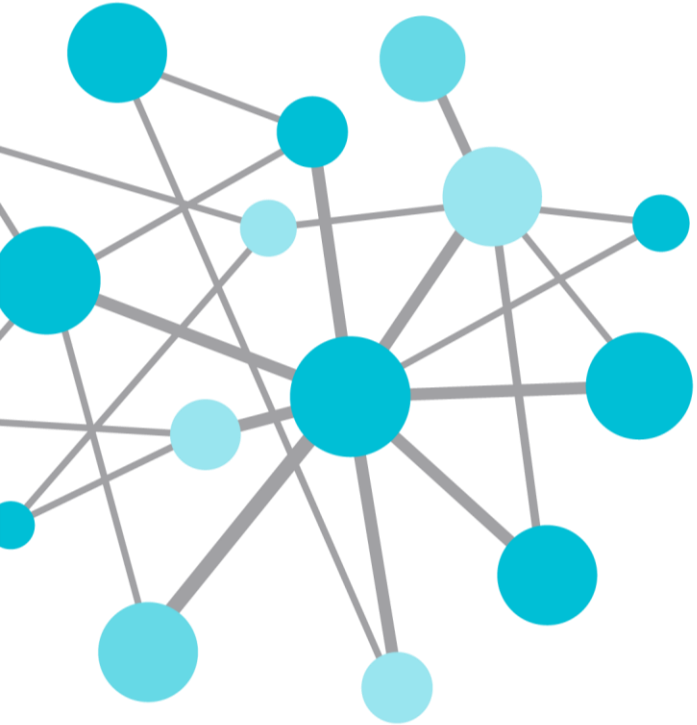
Questions

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

State your **name & company**



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