



Using your PI System to Ensure Operational Data Quality and Cybersecurity

Presented by Patricia Rebelo
Michael Shalyt



APERIO 

Main brands worldwide



Renewables



Brazil



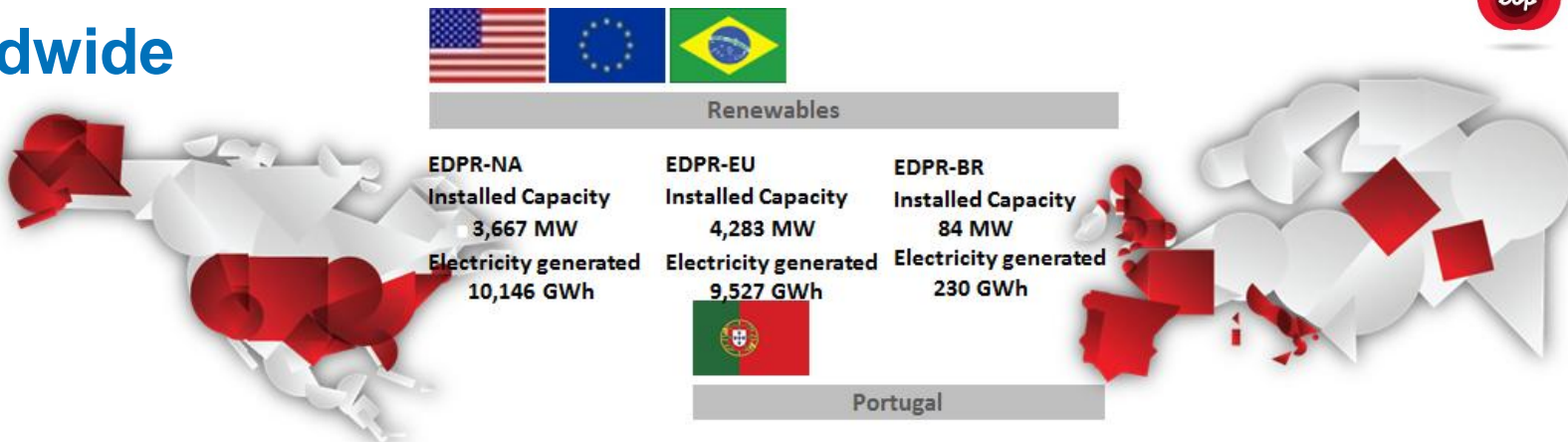
Portugal



Spain



EDP worldwide



Renewables

EDPR-NA

Installed Capacity
3,667 MW

Electricity generated
10,146 GWh

EDPR-EU

Installed Capacity
4,283 MW

Electricity generated
9,527 GWh

EDPR-BR

Installed Capacity
84 MW

Electricity generated
230 GWh



Portugal

Installed Capacity
8,911 MW

Electricity
22,723 GWh generated
43,858 GWh distributed
5,718 thousand Customers

Gas
6,938 GWh distributed
224 thousand Customers



Spain

Installed Capacity
3,853 MW

Electricity
9,961 GWh generated
9,147 GWh distributed
1,118 thousand Customers

Gas
51.535 GWh distributed
796 thousand Customers



Brazil

Installed Capacity
2,157 MW

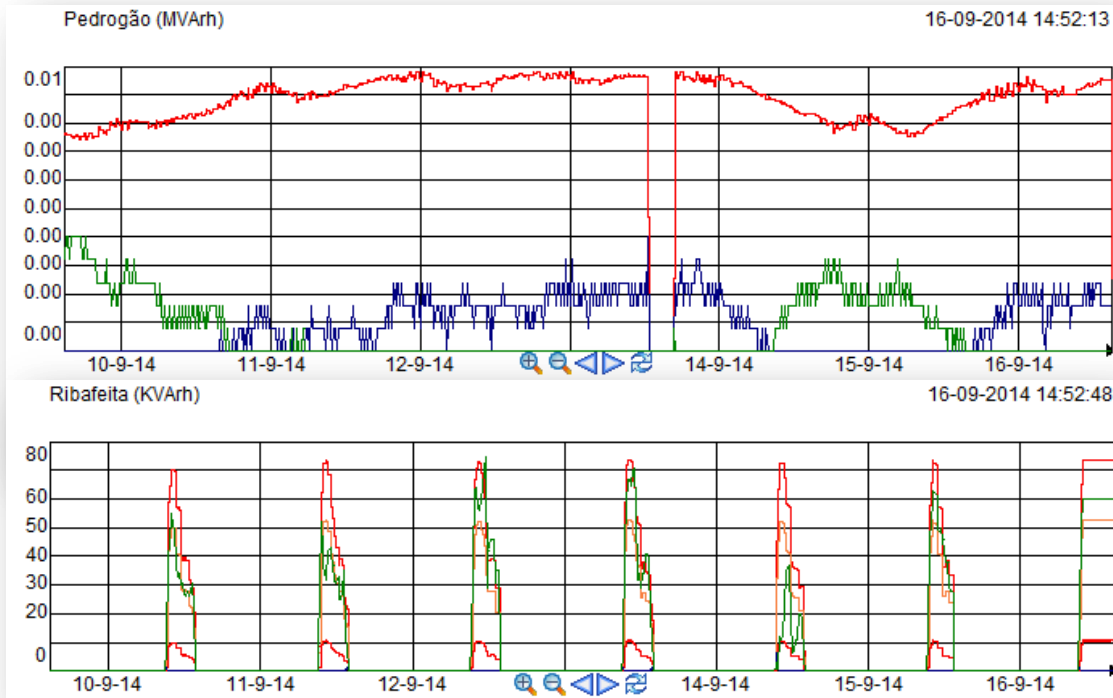
Electricity
8,360 GWh generated
25,880 GWh distributed
3,045 thousand Customers

* MW EBITDA

APPLICATIONS



Data Applications



- Process Monitoring (operational efficiency optimization, CBM etc.).
- Energy Metering (billing control, cost center visibility etc.).
- Performance evaluation and business impact (generation vs demand).

When Data Goes Wrong – EDP Lab Cyber Attack

```

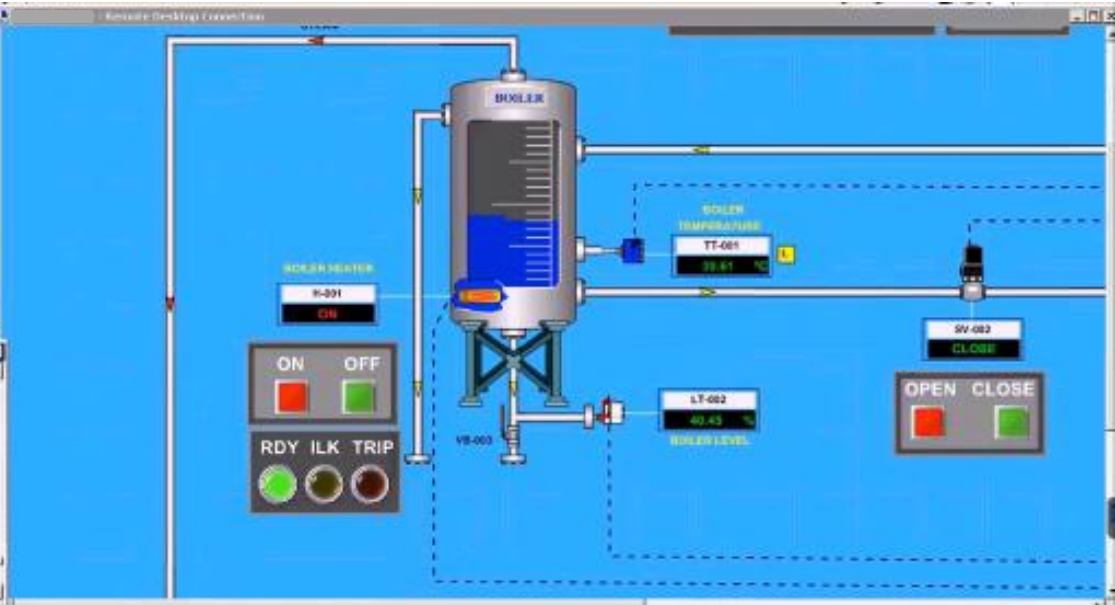
7461 1.0
7462 1.0
7463 1.0
7464 1.0
[ChannelAnalyzerConst.14]INFO [step:6545] last topic rows:
  slice  antcopy  cl
6541 2086677 2086777 0.664064 C 1.0
6542 2086678 2086778 0.682958 C 1.0
6543 2086679 2086779 0.693418 C 1.0
6544 2086680 2086780 0.697447 C 1.0
6545 2086681 2086781 0.691025 C 1.0
[ChannelAnalyzerConst.14]INFO [step:6545] last topic rows:
  slice  cl  classification  conf@acct  orgmax_cmtc  max_cmtc
6760 2086927 2086777 0 0.0 1283 0.251664
6761 2086928 2086778 0 0.0 1203 0.251056
6762 2086929 2086779 0 0.0 197 0.270468
6763 2086930 2086780 0 0.0 187 0.288938
6764 2086931 2086781 0 0.0 157 0.278232

```

```

$injector
injector> zsi_injector_stop_recording()
injector> zsi_injector_start_recording()
injector> heater_off_injector_enable()
injector> zsi_injector_start_recording()
injector> heater_off_injector_disable()
injector> zsi_injector_stop_recording()
injector> heater_off_injector
injector> heater_off_injector
injector> heater_off_injector

```



When Data Goes Wrong – EDP Lab Cyber Attack

The image displays a multi-panel interface for a cyber attack simulation on an industrial control system (ICS).

- Top Left:** A 'Change Display Range' dialog box is open, showing 'From: 1000000000' and 'To:'. Below it, a table lists event process data:

Event Process	Time	Value
7031	1.0	
7032	1.0	
7033	1.0	
7034	1.0	

Below the table, a log entry shows: [ChannelAnalyzerConst.14] [INFO] [step:6015] last topic cover: slice entropy c1

- Top Right:** A data plot window titled 'Plot 0' showing a green line on a grid. The x-axis is labeled 'Time' and the y-axis is labeled 'Value'. The plot shows a relatively flat line with minor fluctuations.
- Bottom Left:** A terminal window showing a series of commands and their outputs:

```

hmaster_off_injector_enable()
zri_injector_start_recording()
hmaster_off_injector_disable()
zri_injector_stop_recording()
hmaster_off_injector_enable()
zri_injector_start_playingCMD()

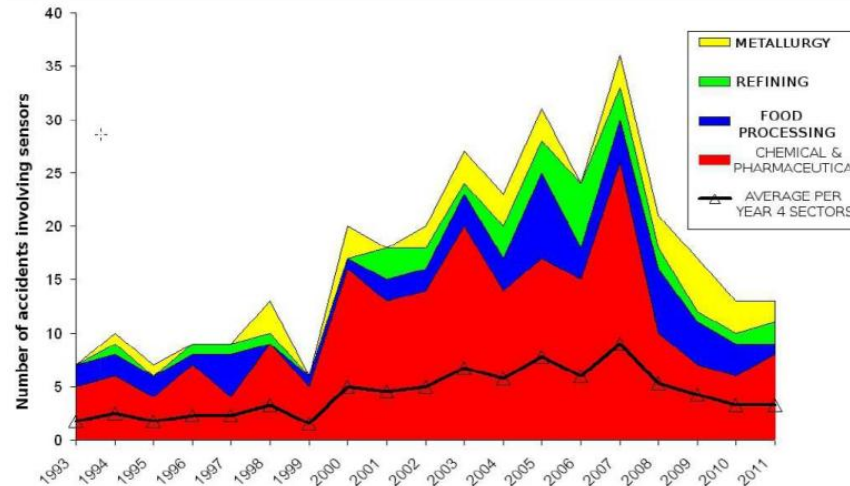
```

- Bottom Right:** A detailed process control diagram for a 'BULLER' system. It includes:
 - A central 'BULLER' tank with a level indicator.
 - 'HEAT EXCHANGER' (HE-001) with 'ON' and 'OFF' buttons.
 - 'TEMPERATURE' (TT-001) sensor showing 39.50 °C.
 - 'LEVEL' (LT-002) sensor showing 40.25 %.
 - 'VALVE' (VS-003) at the bottom of the tank.
 - 'CONTROL VALVE' (SV-002) with 'OPEN' and 'CLOSE' buttons.
 - 'RDY ILK TRIP' indicator lights (green, yellow, red).

Sensors are Critical

“The role of sensors has become increasingly important in providing for the safety of industrial sites and the quality of their production”

(From a 2013 report by the French Ministry for sustainable development)

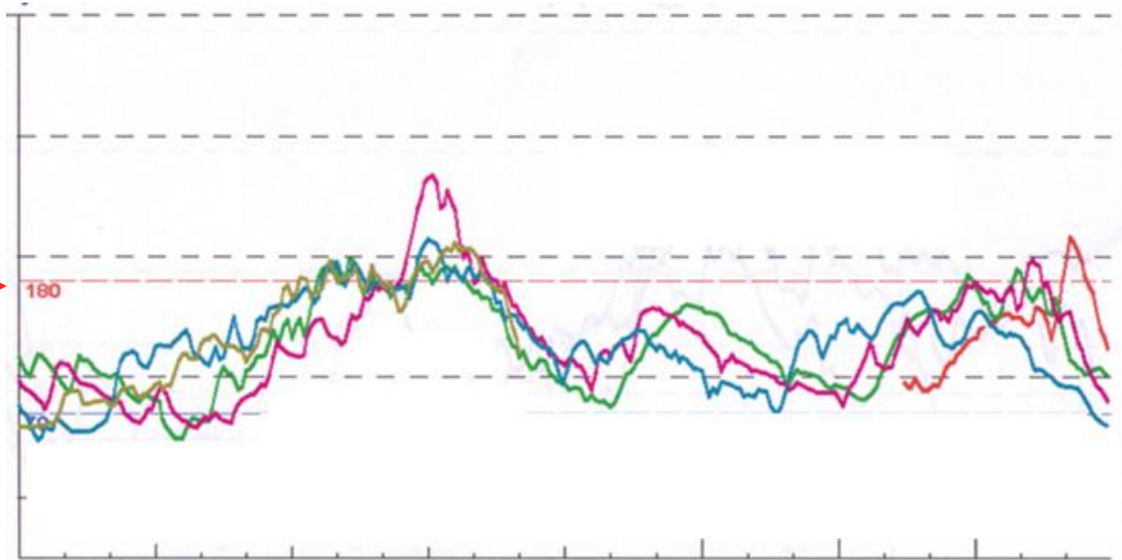


Annual number of accidents involving sensors for the most highly automated industrial sectors (ARIA base - 345 accidents)

Operational Data Fingerprinting

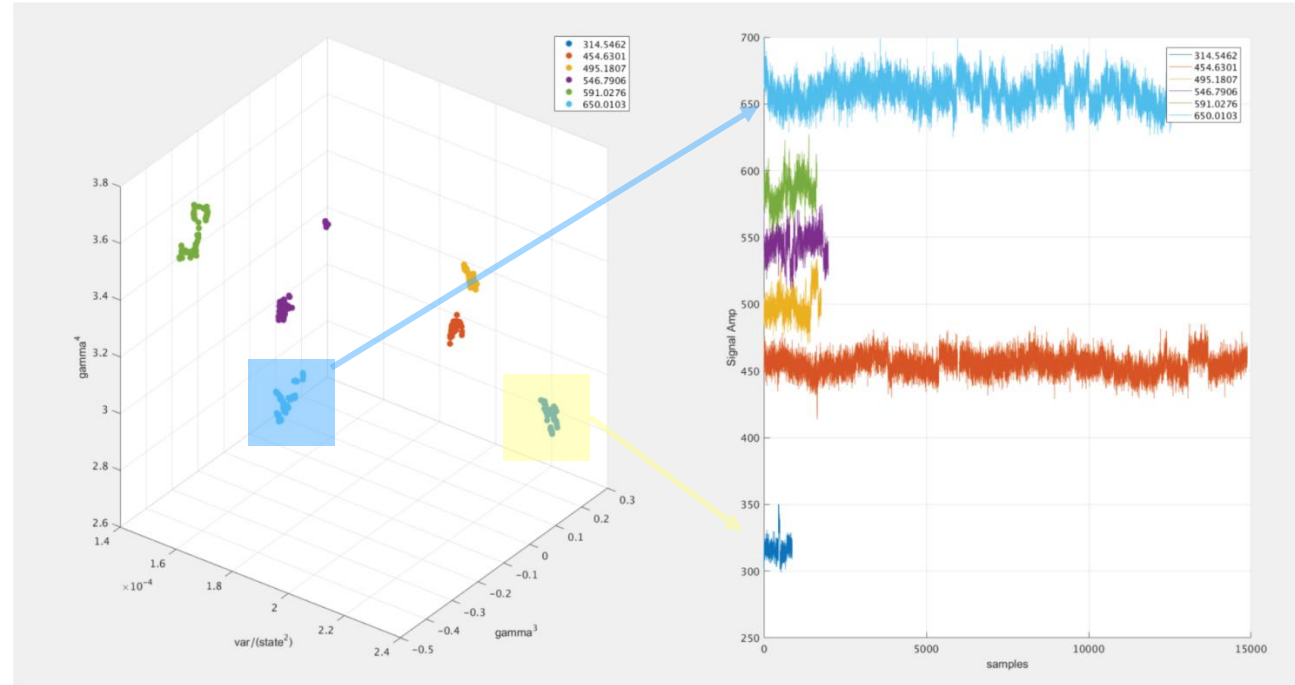


Wealth of Information

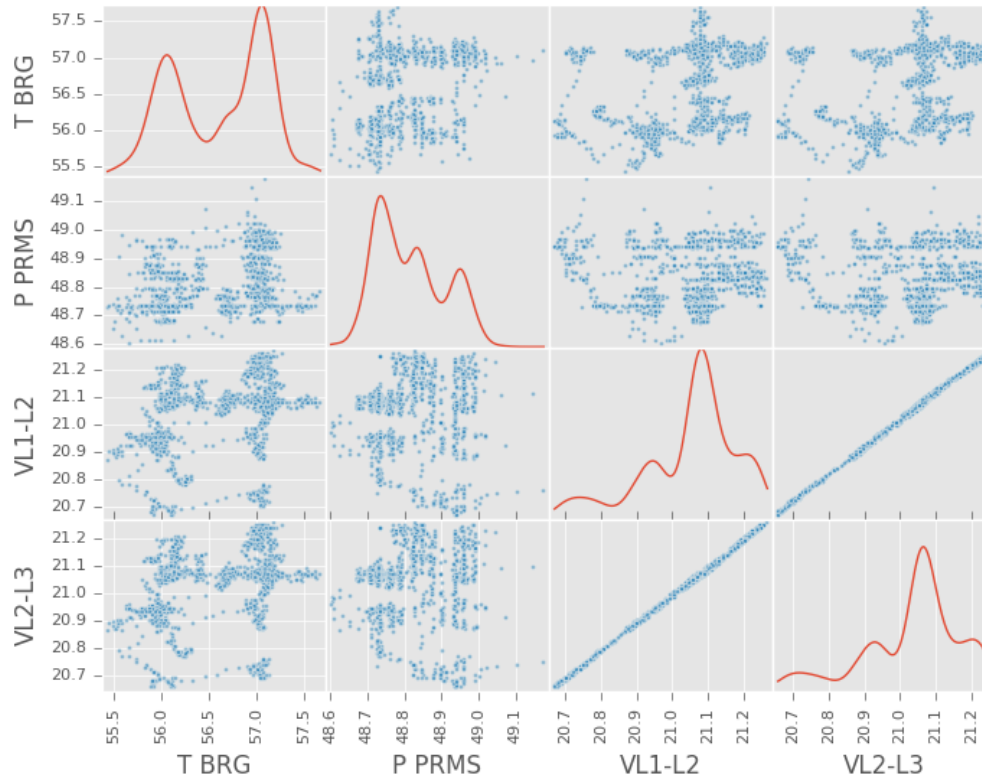


Signal Fingerprinting

- Extraction of **Fingerprints** from different system states
- Using advanced Signal Processing methods to extract interesting features, characterizing dynamical systems

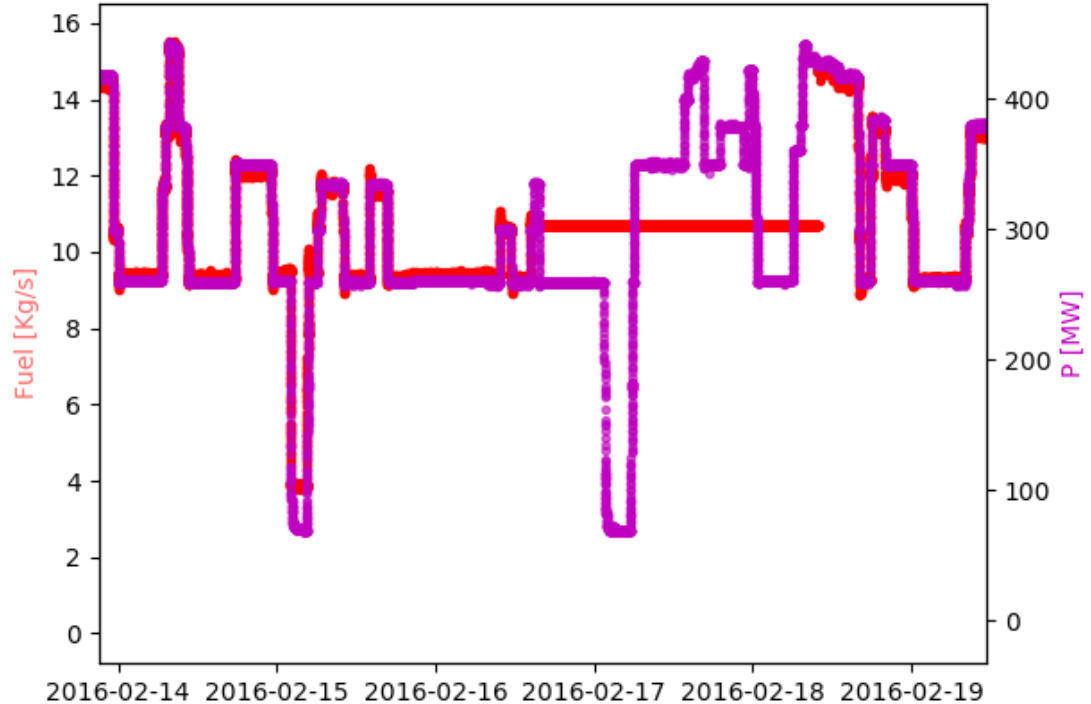


Correlations and Estimation



Data Quality Issues

As seen in the plot (red – fuel signal, purple – Turbine power output) both signal are highly correlated except for 3 days, in which the fuel signal was constant.

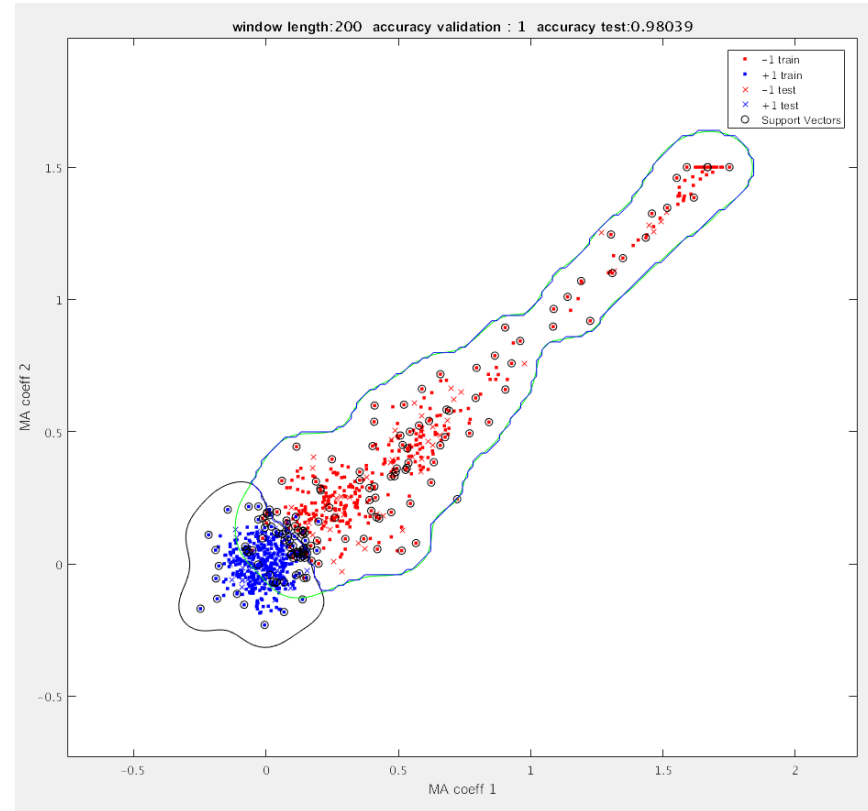


Synthetic Signals Detection

For Example:

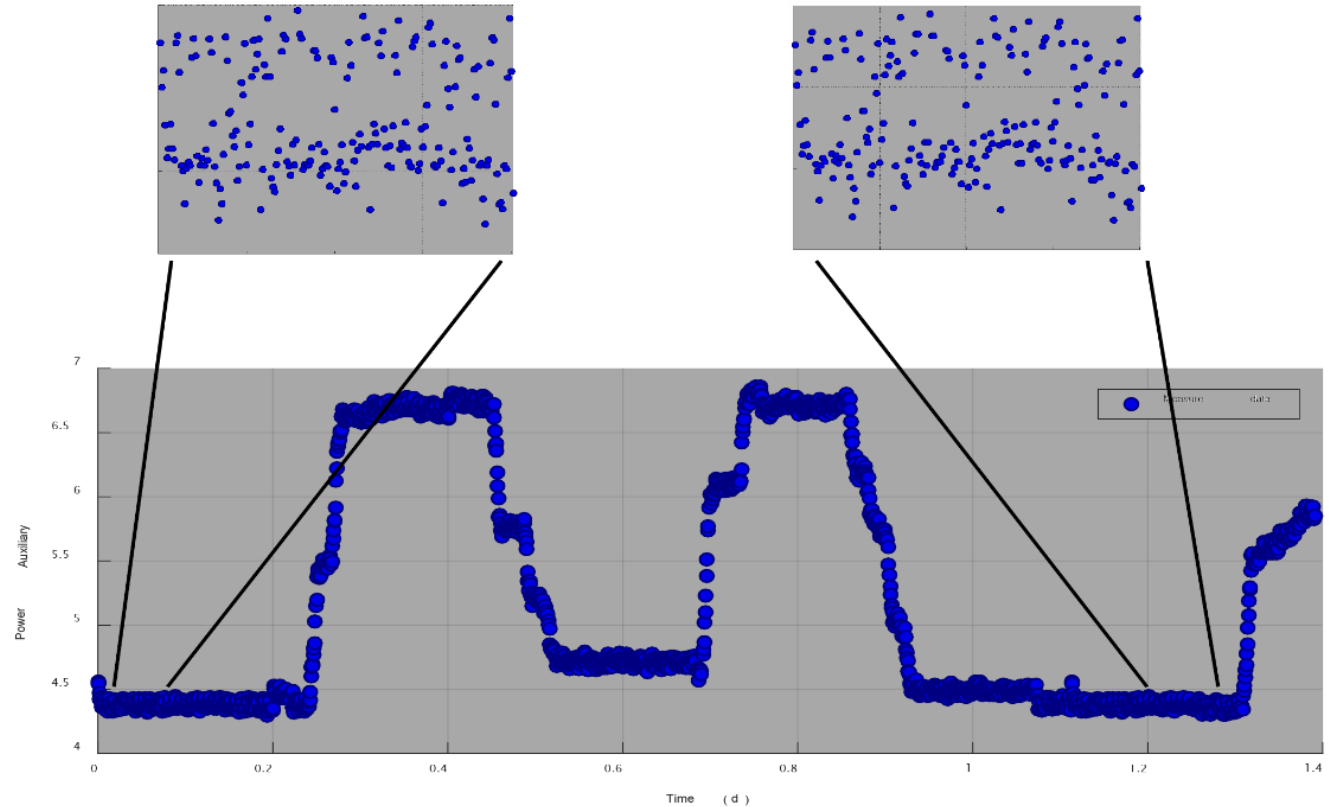
Autoregressive integrated
moving average

$$\left(1 - \sum_{i=1}^{p'} \alpha_i L^i\right) X_t = \left(1 + \sum_{i=1}^q \theta_i L^i\right) \varepsilon_t$$



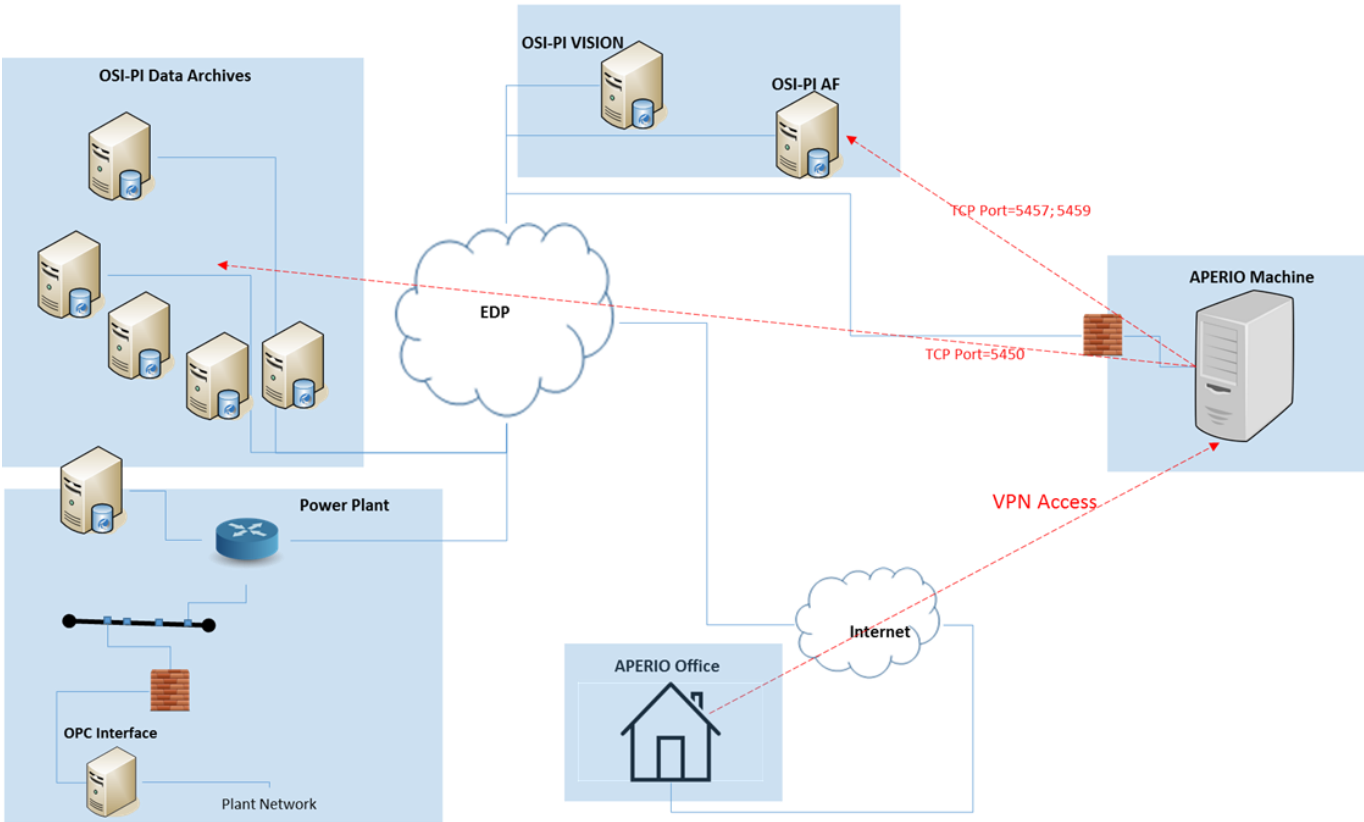
Replay Detection

We alert, when signal statistics is **unrealistically** similar to previous times – probably being **forged**



Deployment

Functional diagram for APERIO Systems



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EDP Produção



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APERIO Systems



Questions

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

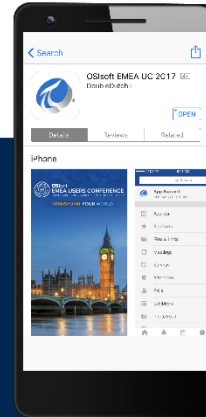


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Questions?

