NASPI - North American Synchrophasor Initiative
Task Team Virtual Meeting Series - July 2025

Control Room Solutions Task Team (CRSTT)

*open***WAMS**: Operations PMU Applications at ONS

Ricardo Lira, MSc
Senior Business Specialist for Power System Operation
ricardo.lira@ons.org.br

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Topics

1) Overview of the openWAMS project

2) Examples of Control-Room Dashboards

3) RT Applications Foundation development

About ONS
www.ons.org.br

We are the National Electric System Operator - ONS (Brazilian ISO)

The mission of ONS is to ensure the supply of electricity in the country, with quality and a balance between safety and the overall cost of operation.

The ONS is a private law legal entity, non-profit, under government's regulation and supervision. ONS does not own any generation, transmission, or distribution assets. The centralized management of the system operation guarantees operational security at the lowest possible cost.

PMU infrastructure is owned and maintained by the TSOs guided by ONS standards.

COSR-NE
(Recife)

COSR-NCO
(Brasília)

CNOS

COSR-S
(Florianópolis)

COSR-SE
(Rio de Janeiro)
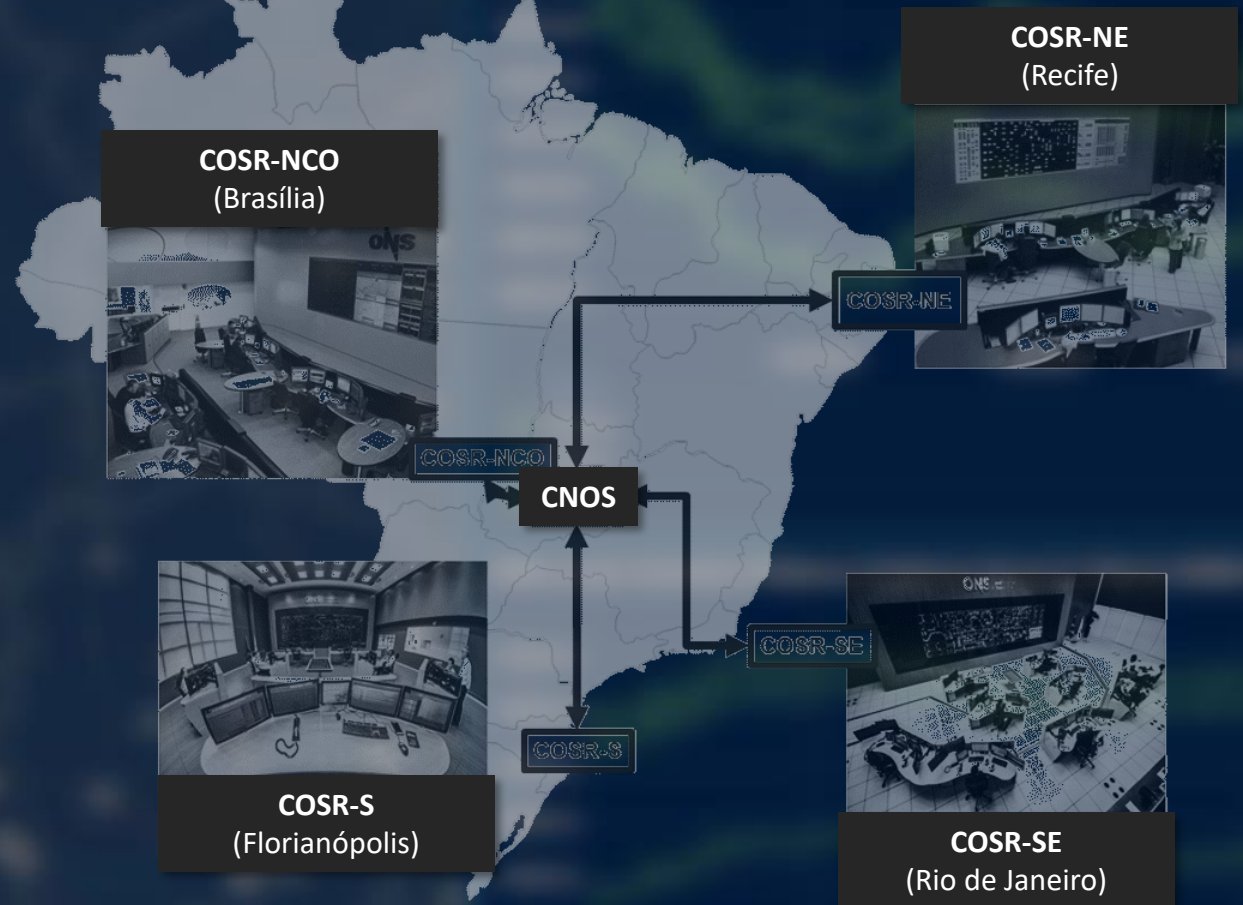
What is *open**WAMS***?

OVERVIEW

openWAMS is an open-based platform designed by ONS for real-time monitoring and disturbance analysis based on synchrophasors (PMU) measurements:

- Empowers decision-making for control room operators and ONS engineers.
- Provides detailed analysis for the engineering team
- Custom-built solution tailored to ONS's needs at reduced costs
- Supports integration with existing systems to ensure grid stability and development of new applications

AVAILABLE APPLICATIONS

Control-Room/Real-Time:
- – Geo-Localized Navigation
- – Real-Time & Historical Trend Graphs
- – Short-Circuit Visualisation
- – Electric Island Synchronization
- – PMU Data Quality Reporting
- – Wallboard Support Panels

Off-line Analysis (stand-alone application)
- – Historian Trending
- – openPLOT (in development)

PLANNED APPLICATIONS 2025/2027 (BACKLOG)

- Oscillatory Stability Detection and Tracking
- Disturbance Detection and Characterization
- Fast Islanding Clusters Detection
- Events Notification System

Control-Room **Engineering Analysis**
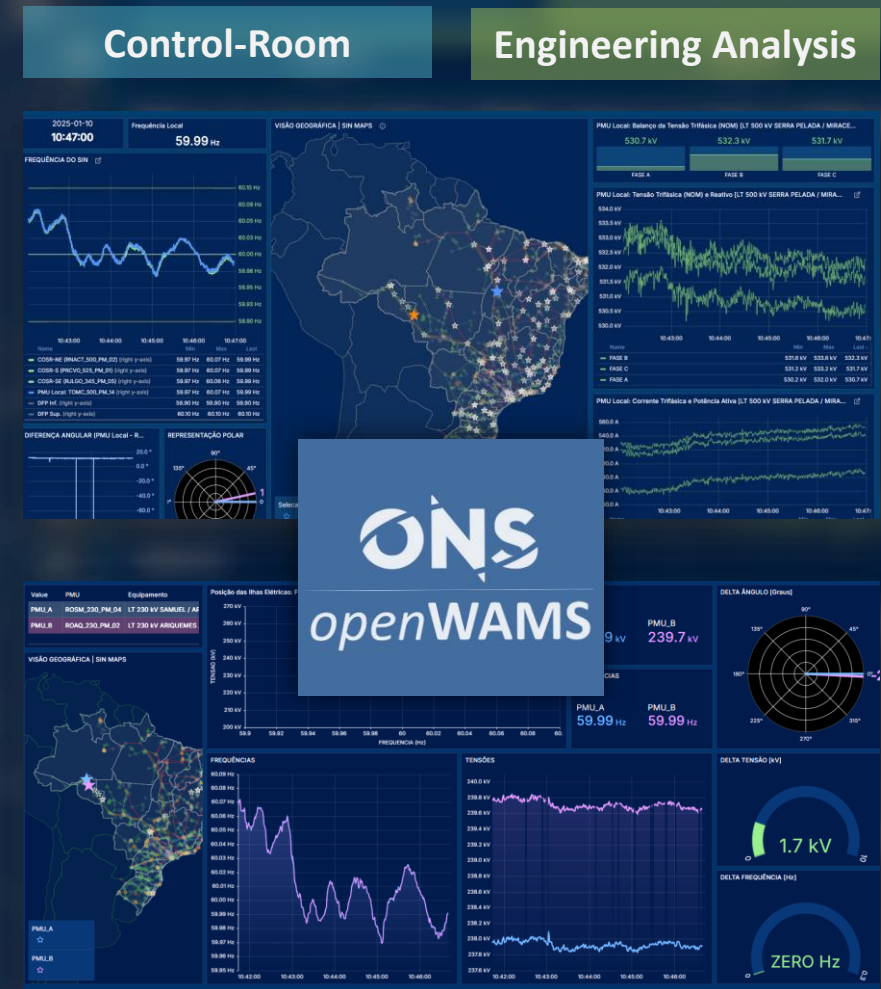
SCADA x WAMS Feat.	SCADA	Phasor Measurement
Resolution	Low	60-120x Higher
Real-Time Detection	Limited	Immediate Disturbance Alerts
Post-Event Analysis	Minimal	In-depth Investigations
Integration Capabilit.	Restricted	Smart Grids & Renewables

Synchrophasors at ONS

Studies Phase
2005-2010

Tendering Phase
2011-2017

CC-PMS (GE)
2018-2024

openWAMS (GPA)
2024-...

2005
Technical studies of the technology

2009
PMU vendor's certification process

2012
Telecom technical especification

2015
Bidding Process Analysis from ONS Team

2019
Production operation of the CC-PMS

2024/may
openWAMS (Phase One) enters in production

2006/2008
Technical specification for the future production system

2011
MME/BIRD Funding Research

2013
PDC Infra Technical Specification

2017
GE Grid Solutions Bidding Process Winner

2023 /out
Management decision opting in a alternative solution based on open-source platform.

2025
New site (Brasília) in production

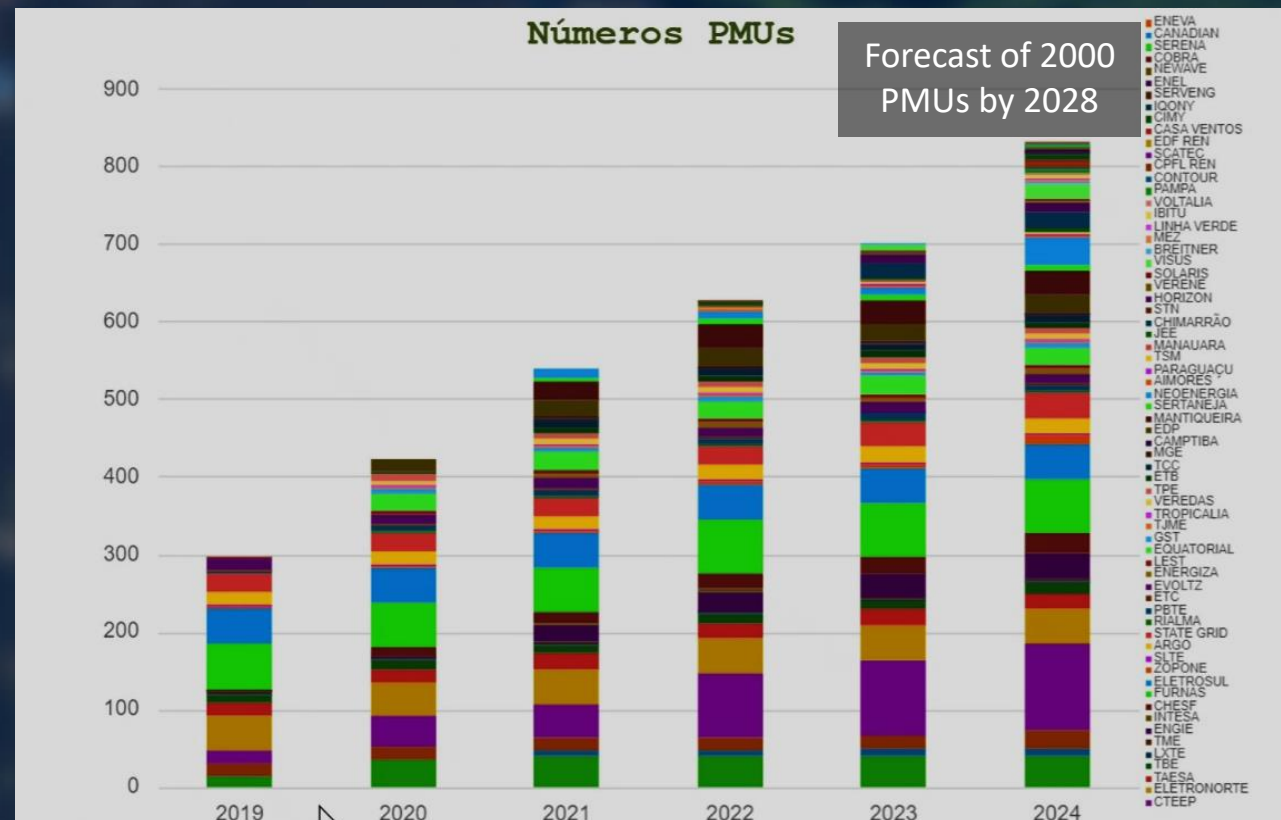**2025**
Definitive hardware arrival en installation

2025/2026: Advanced applications, alarms and more

Our PMU Network Scale

3 phase Voltage and Current Phasors
60 frames per second
+ Harmonics (analogs) for selected PMUs

Actual coverage (~800 PMUs)

Forecast of 2000 PMUs by 2028

Architecture Overview

- **Redundant critical** production systems:
  - **OP-RIO** (Rio de Janeiro)
  - **OP-BSB** (Brasília): PROD

- **Scalability**: Up to 1500 PMUs @ 60 FPS, 3-phase V/I

- **Comprehensive Support Environments:**
  - **DEV:** Development environment
  - **SIM:** Simulation environment for system validation and training (Future)
  - **LAB:** For testing, exploratory learning, and Grafana editor training

- **Grafana visualization UI**: comprehensive dahsboards portfolio for control room, post-operation activities, and system maintenance.

- **Advanced applications** Real-time, Analyst and maintenance applications.
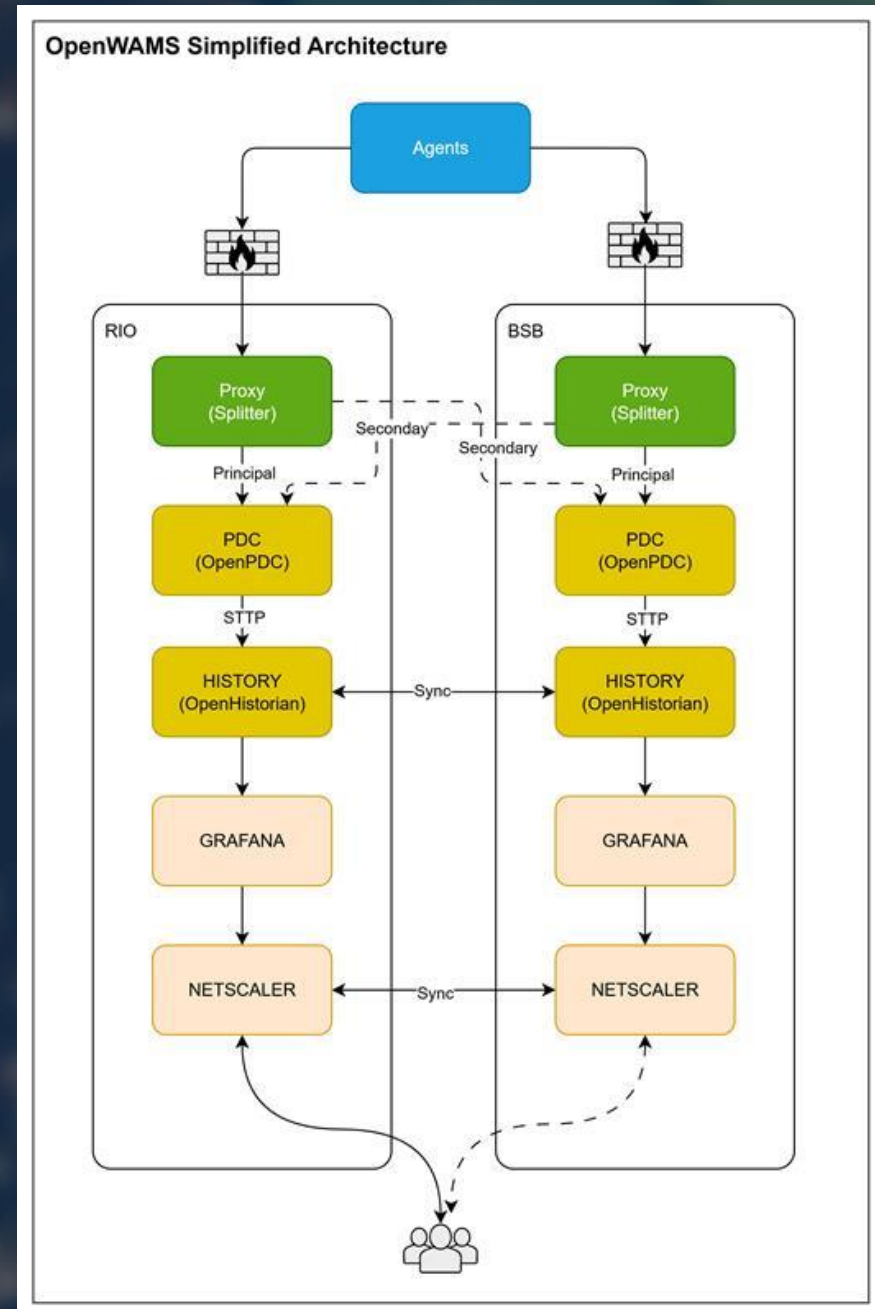
*open*WAMS: Advanced User Interface

GRAFANA DASHBOARDS

Grafana enables modern, flexible and highly customizable platform for dashboard creation. Real-Time/Historic combined.

openWAMS uses an independent Grafana server enabling more flexible and customized deployment. GPA openHistorian connected via openHistorian Data Source plugin.

Grafana community provides several plugins for advanced panels creation, enabling continuous UX enhancement.

ONS' users provided excellent feedback (friendly navigation, easy to access data and modern design).

CUSTOM MADE DASHBOARDS

End-User (Control-Room & Engineering):
- Geographical/Navigation View
- Real-Time/Historic Trending
- Short-Circuit Analysis
- Islanding and Resynchronisation
- Energy Quality/ Harmonics Monitoring

***Governance Team** responsible for quality and creation*

Administration & Maintenance:
- PMU Data Quality Report
- System Health Status
- Users Monitoring
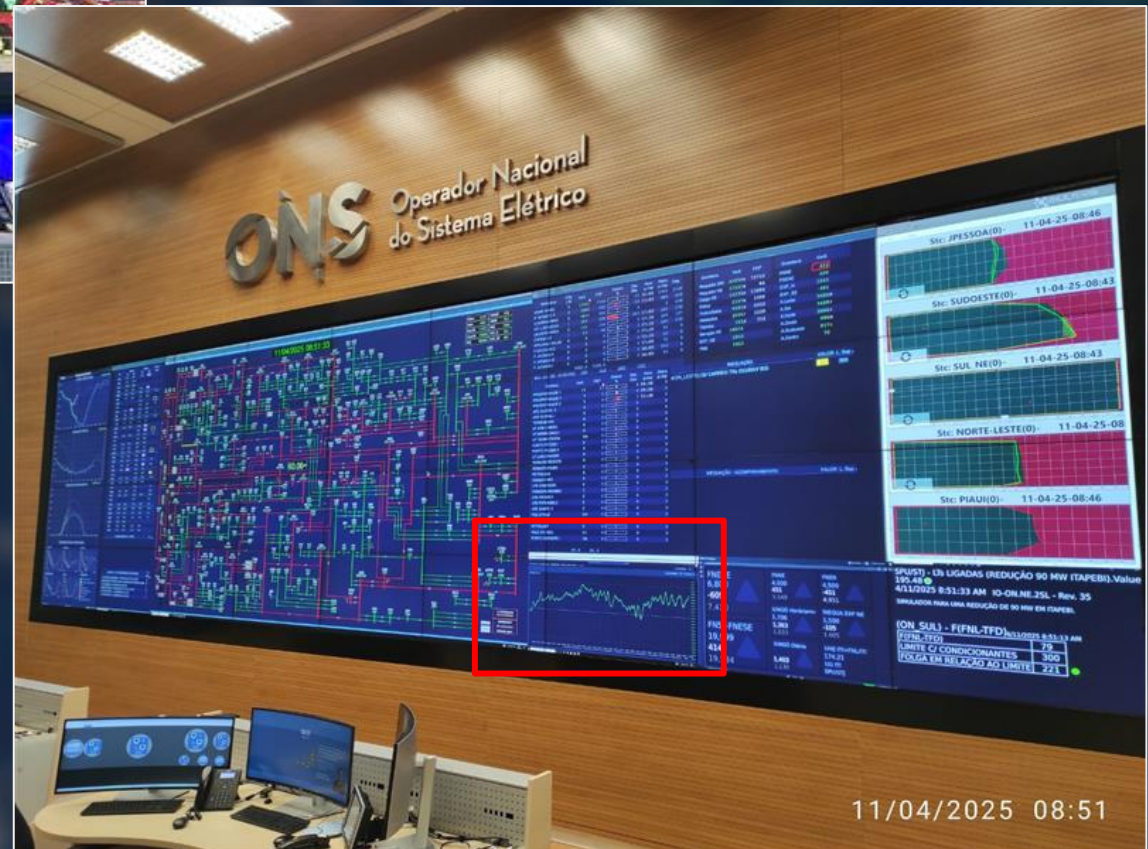- Dashboard Usage Monitoring
- PMU Configuration View

Geographical/Navigation View

Real-Time/Historic Trending

Islanding and Resynchronisation
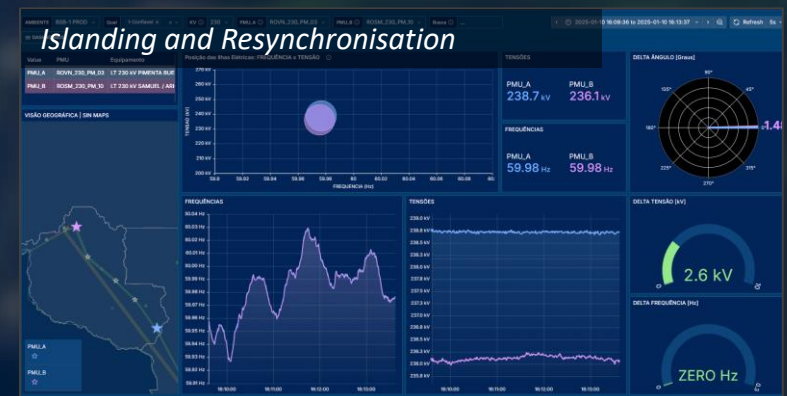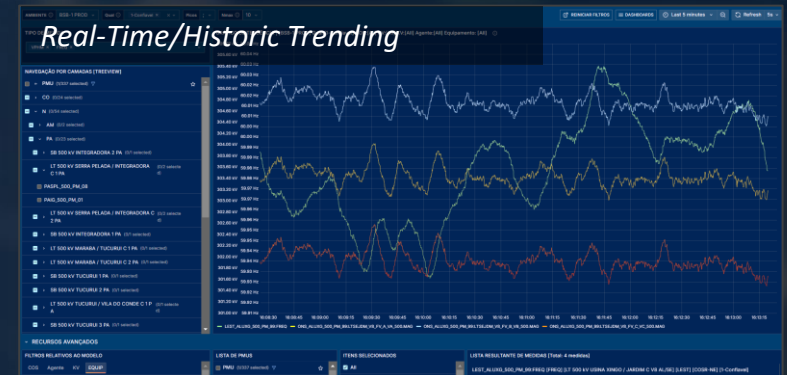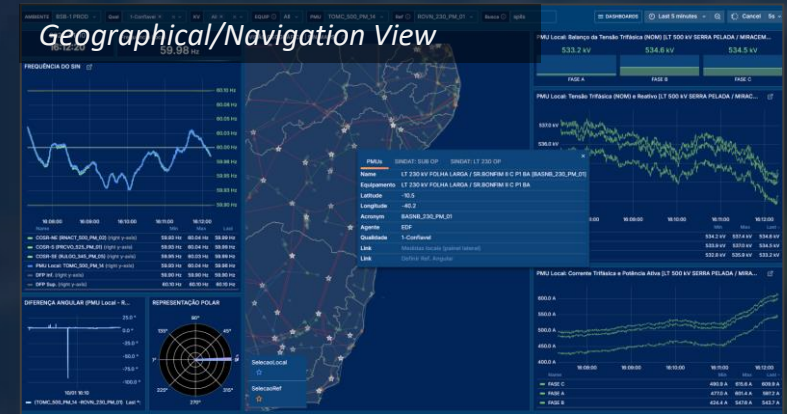
Wallboard Dashboards: Control-Rooms

Brasília

Recife

OP1 - Geographical Navigation

REGINA
Real-Time Grid Inteligent Notification Alarm

REGINA - Real-Time Grid Intelligent Notification Alarm

○ Últimos 10 Minutos ● Selecionar Intervalo   Data Inicial: 14/02/2025 12:00   Data Final: 14/02/2025 13:00   Aplicar   Descrição: DESLIGOU/LIGOU ▾

COS: Todos ▾   Área: Todas ▾   Tipo: Todos ▾   Nome: Filtrar por Nome   Estação: Filtrar por Estação   Tensão: Todas ▾

DATA	HORA	DESCRIÇÃO	NOME	COS	ÁREA	TIPO	ESTAÇÃO	TENSÃO
14/02/2025	12:59:41	SCUHSR_13P8_UG3 UG3 13.8 47 UHE SAO ROQUE LIGOU	UG 47P3 MW UH...	S	2SC	Unidade Ge...	SCU...	13.8
14/02/2025	12:58:50	MGSTIT_345_LTMGJCAB_1 LT 345 ITUTINGA / JECEABA C1 DESLIGOU LADO JECEA...	LT 345 kV ITUTIN...	SE	5MG	Linha de Tr...	MGS...	345.0
14/02/2025	12:58:48	MGITO2_345_LTMGJCAB_2 LT 345 ITABIRITO 2 / JECEABA C2 DESLIGOU	LT 345 kV ITABIRI...	SE	5MG	Linha de Tr...	MGIT...	345.0
14/02/2025	12:58:46	MGITO2_345_LTMGJCAB_2 LT 345 ITABIRITO 2 / JECEABA C2 DESLIGOU LADO JEC...	LT 345 kV ITABIRI...	SE	5MG	Linha de Tr...	MGIT...	345.0
14/02/2025	12:57:36	MGSTIT_345_LTMGJCAB_1 LT 345 ITUTINGA						
14/02/2025	12:55:34	SCBLU_230_BC2 BC2 230 125 BLUMENAU LI						
14/02/2025	12:54:22	MGITO2_345_LTMGJCAB_2 LT 345 ITABIRITO						
14/02/2025	12:53:13	MGITO2_345_LTMGJCAB_2 LT 345 ITABIRITO						
14/02/2025	12:53:10	MGSTIT_345_LTMGJCAB_1 LT 345 ITUTINGA						
14/02/2025	12:52:53	MSAQU_138_LTMSCGI_2 LT 138 AQUIDAUAN						
14/02/2025	12:52:06	MGSSUS_16P5_UG3 UG3 16.5 285 SAO SIM						
14/02/2025	12:51:56	SPTAQ_13P8_UG5 UG5 13.8 105 TAQUARUÇ						
14/02/2025	12:50:57	MGSSSE_500_LTMGSSUS_3 LT 500 SAO SIM						
14/02/2025	12:50:17	MGITO2_345_LTMGJCAB_2 LT 345 ITABIRITO						

PMUS PRÓXIMAS ELETRICAMENTE

EQUIPAMENTO	NOME PMU	SELECIONAR
MGITO2_345_LTMGJCAB_2	MGJCAB_345_PM_02	☐
MGSTBB_345_LTMGITO2_1	MGSTBB_345_PM_01	☐
MGSDU2_345_LTMGLPD2_1	MGSDU2_345_PM_01	☐
MGSAR_345_BAA	MGSAR_345_PM_01	☐
MGSAR_345_BAB	MGSAR_345_PM_02	☐

Fechar

VISÃO GEOGRÁFICA | SIN MAPS ⓘ

REGINA is a synchrophasor-based system within the ONS alarm setup. It enables users to select an event from the SCADA alarm list (such as a transmission line disconnection), automatically locates the nearest PMUs to the event, and offers an analysis interface for examining the event.

OP2a - Trending (Tree View)
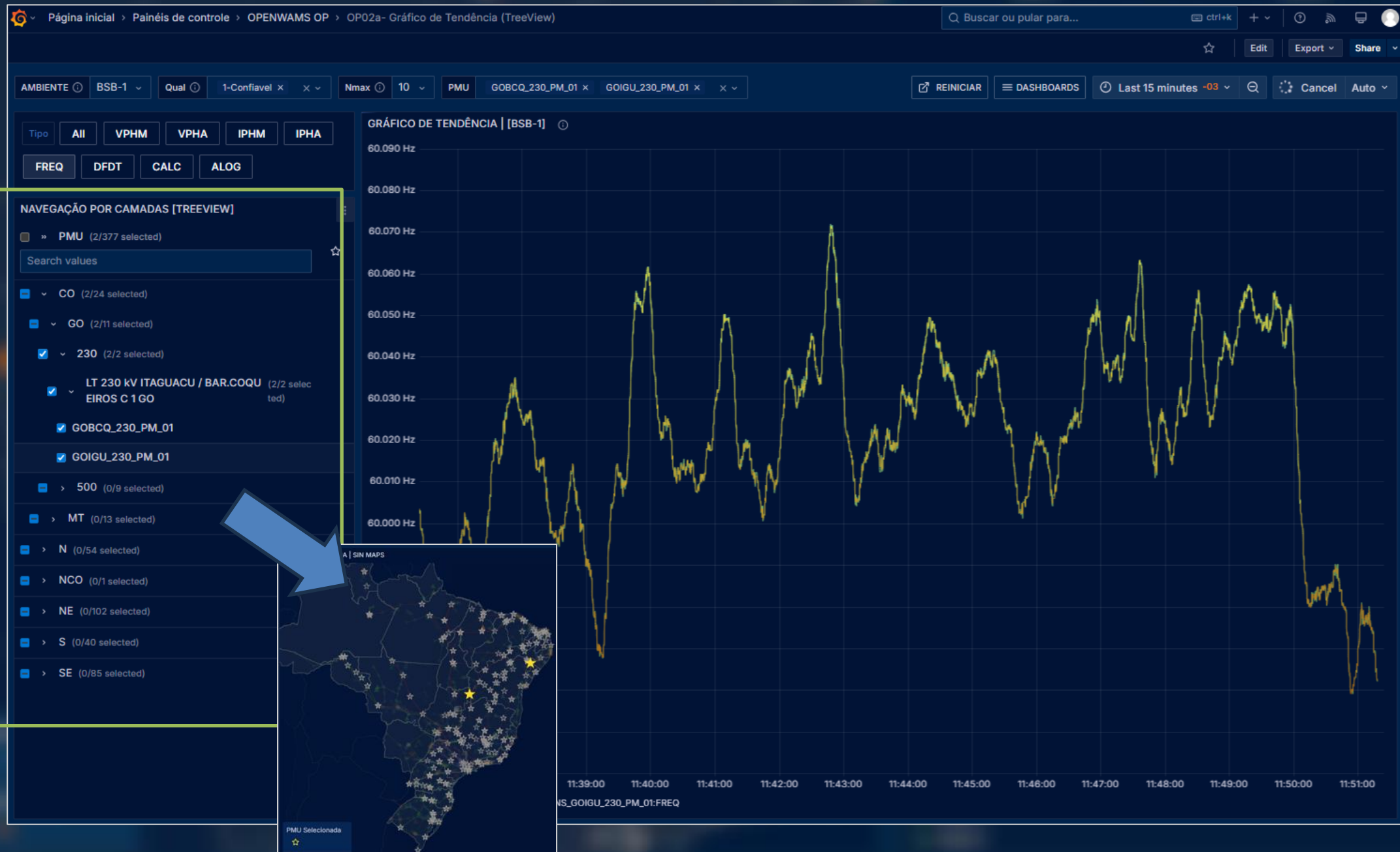
OP2b - Trending (Advanced Filters)

OP4 - Islanding Resynchronization

Foundation for Real-Time Applications
Innovation / Prototype / Easy-to-Deploy

OPEN PLATFORM ARCHITECTURE
- Facilitates easy deployment of new real-time control room applications
- Built on the STTP protocol for seamless real-time data streaming

DATA INTEGRATION & DISTRIBUTION
- Retrieves real-time streams from the main historian system
- Distributes data across independent application modules via a common data bus

ORCHESTRATION & ANALYTICS
The orchestrator:
- Converts STTP streams into discrete data packages and provide the metadata
- Performs basic analytics and injects results into the data bus

Actionable Business Insights
- Applications generate real-time analytics for improved situational awareness.
- Results are stored in a relational database for:
  (i) Visualization in Grafana
  (ii) Triggering of alarms for proactive decision-making

Grafana UI +Alerting

Grafana Alerting responsible to send notification to the users (email, Teams etc)

MS SQL database

Results are stored in the database for UI dashboards presentation

RT APP 1	*RT APP 2*	*...*	*RT APP n*

Real-time applications independent modules. To handle big data processing, the code are built on multi-instances schemes (parallel procesing architecture).

RabbitMQ DATA BUS: *Shared Measurements, Metadata and Basic Analytics*

STTP Orchestrator

Responsable to connect to openHistorian via STTP and to organize the information in discrete message blocks, dropping them into the data bus. Multi-processing architecture built.

GPA *open***Historian**

Reliable source of real-time PMU streams (raw measurements).
Can be used for on-demand historic data retreival also (off-line applications)

ONS code to be adapted into openHistorian

Real-Time Disturbance Detection

- **openWAMS DIST:** Automatic detection, localization, and characterization of disturbances in the National Interconnected System (SIN), based on nationwide PMU coverage.

- **Method:** Uses rapid variations in PMU measurements (current, voltage, and frequency), analyzed by specialized anomaly detection algorithms. Other methods are still under research.

- **Architecture:** Modular and scalable structure based on a data bus, with the use of parallel processing. We are evaluating the effective development strategy designed at the beginning of the project.

- **Testing phase (prototype):** Results processed in real time, already being evaluated by selected control room users.

- **Backlog:** oscillation detection, MS Teams alarms, intelligent alarm grouping, epicenter determination, event characterization (severity and fault type).

Case: RJ 28/05 at 18:10:46

Event that occurred on May 28 at 6:00 PM in the Rio de Janeiro region, during which the lights could be seen flickering in the ONS building.

DIST promptly flagged the event 5 seconds after the disturbance was observed through the flickering lights in the ONS building, Rio.

Epicentro conforme dados fasoriais

Probable cause: three-phase short circuit(RJTRIO Icc = 700A)

Voltage drop

Obrigado!

Q&A