Synchrophasor Systems in Brazil

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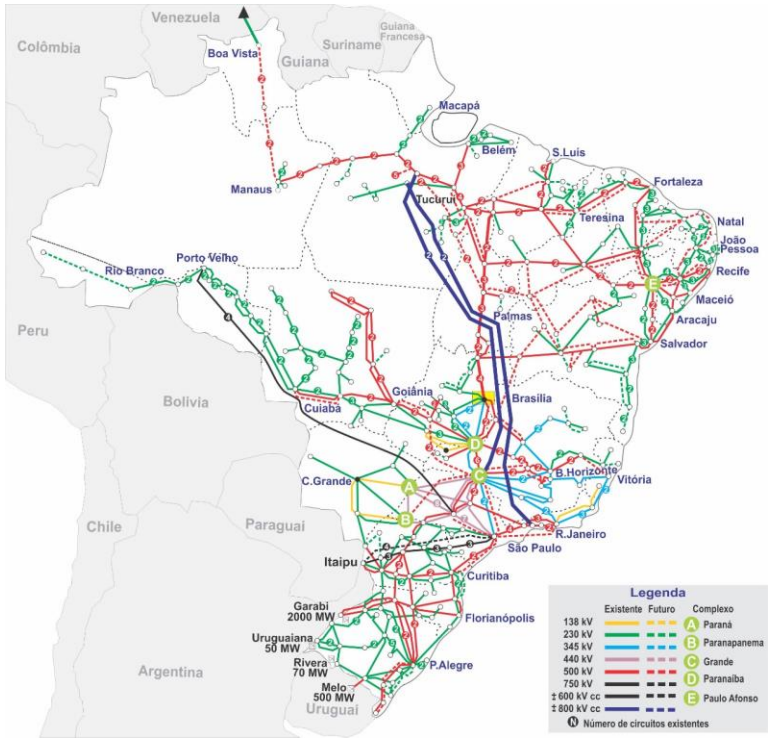
Brazilian Interconnected Power System (BIPS)



- Brazil is a continental country where the main sources are far from the main consumers.
- BIPS supplies more than 99% of the country's total load.
- Hydroelectric generation is dominant, with an increasing share of non-conventional renewable energies (wind, solar and biomass).
- Multiple ownership transmission system: 119 Transmission owners have more than 145,500 km of lines at 230 kV and above.
- ONS (Brazilian Independent System Operator) is responsible for the Regulatory Agency (ANEEL) for the development of a Synchronized Phase Measurement System (SPMS) for Brazil.

SPMS – Project Highlights

Year	Activity
2005	Technical Studies for PMU Location
2006 / 2007	Technical specification of the synchronized phasor measurement system (SPMS)
2008	Technical Studies for the Application of Phasor Measurements Technology for Real Time Decision Making
2009	PMU Certification Process
2011	MME/World Bank understandings for funding SPMS
2012	Telecommunication Technical Specification
2013	PDC Infrastructure Technical Specification
2015 / 2016	Bidding process conducted by the ONS team
2017	Contract awarded to winner of the bidding process

How ONS managed the issue of PMU interoperability

Starting point:

- The synchrophasors studies to use in the Brazilian Electrical System, mainly for recording dynamic performance during disturbances, begins in the 90s.
- In August 1998, ONS was created with the function of operating the National Interconnected Energy System.
- The great blackout that occurred on March 11, 1999, revived interest in PMU applications.
- Many Agents, each with the possibility to select a different PMU supplier, have given us an important constraint to implement the system.

ONS Strategy to conduct your SPMS:

- In 2009 developed tests to evaluate the performance of PMUs based on the IEEE C37.118-2005 standard (steady state and dynamic conditions) in order to verify the interoperability of PMU from different suppliers. (at that time, the standard had only steady state requirements).
- The tests were done at NIST-Gaithersburg-USA for 8 PMUs from different vendors and no one passed.
- ONS interrupted the project, suppliers made adjustments on their PMU and the standard has evolved to include all dynamics conditions tested at NIST in the new version IEEE C37.118-2011.
- Now days: All PMU need to present a Performance Tests based on C37.118-2011-2014 to be used by our SPMS.

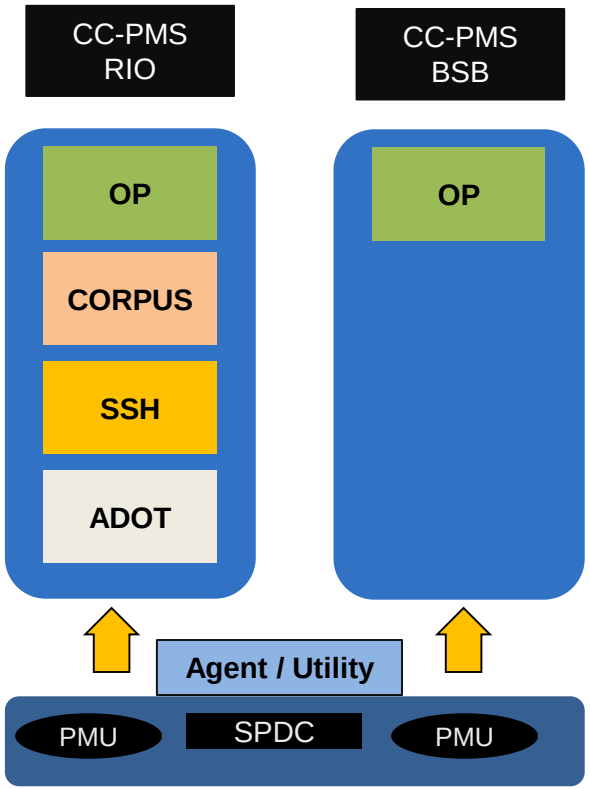
How are we going to manage the issue of interoperability of the new PMU standards?

The new STTP (Streaming Telemetry Transport Protocol - Proposed IEEE standard 2664) is coming ...

- We are talking about a protocol that is not based on frames, but on messages that allow 3 to 5 million points per second.
- How to manage the interoperability of different IED providers?

Participate in discussions on the new standard. A good standard closes several doors to different implementations.

Control Center Phasor Measurement System - Project Highlights



OP - Operation Production

CORPUS - Corporate User System

SSH - System Staging & Homologation

ADOT - Application Development & Operator Training

Function

Real Time

Alarm Management
Composite Alarms
CIM Based Configuration
ICCP
Oscillation Monitoring
F, V&I, Power Flow Monitoring
System Disturbance
Islanding & Restoration
Dynamic Stability Assessment

Offline

User Calculations
Spectral, Modal & Event Analysis
Interfaces (OSI PI) + Export
Reporting
Training Environment
Historical Event Storage

Scale & Performance

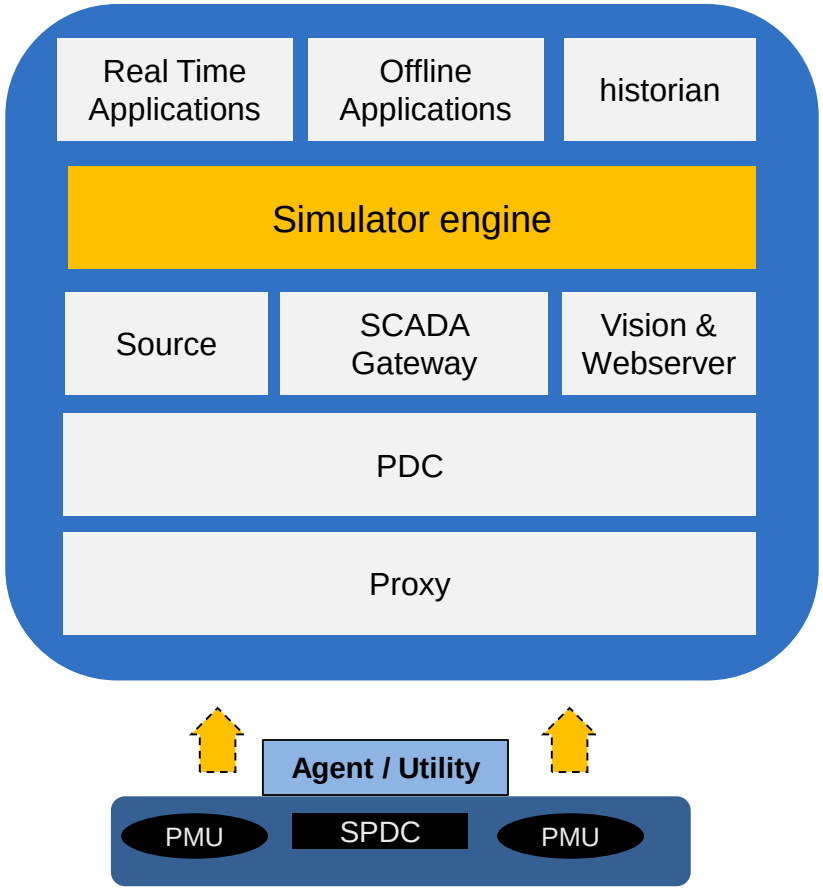
1000 PMUs
6000 phasors
10000 Digitals
} 60 fps

Availability 99.95 %

OP Concurrent Users 8 + 4

CORPUS Concurrent Users 40

ADOT Environment – some details



Especial characteristics:

- Simulator – generates current and voltage phasors based on fully electromechanical models. These phasors are sent to PDCs at a rate of 60 ftp using the IEEE C37.118-2014 protocol and then sent to be consumed by applications in real time and offline. The simulator allows you to do:
  - Start / stop the simulation
  - Changing generation & load
  - Open & close equipment's (LT / TR / SC / EC / RE / CA)
  - Separate/ & reconnect bus bars
  - Generate errors in loads and phasor measurements
- The dynamic models are the same as those used by the planning and engineering teams and benefit from the evolutions made in the database of dynamic models by these teams.
- Supported models: hydraulic generators, wind generators, thermal units, HVDC, different load models, protection schemes. All lines and transformers receive standard protection automatically (zone protection, bus protection, etc.).

A 2019 disturbance – Lets go to Simulator to compare responses

Real time Environment – What was observed by a PMU near the problem

Simple to use - get a pre fault base case from State Estimator, started a simulation with it and do the actions to generate the disturbance.

Simulator – What was observed by the same PMU

Thank You

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