NASPI 2013

Ecuador's experiences with synchrophasor technology

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CORPORACIÓN cenace
CENTRO NACIONAL DE CONTROL DE ENERGÍA

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ECUADOR - OVERVIEW

Location: South America

Extensión: 283,561 km^2

Capital: Quito

Population: 14,483,499 (2010)

Currency: USD $

Ecuador
Electrical System
Description

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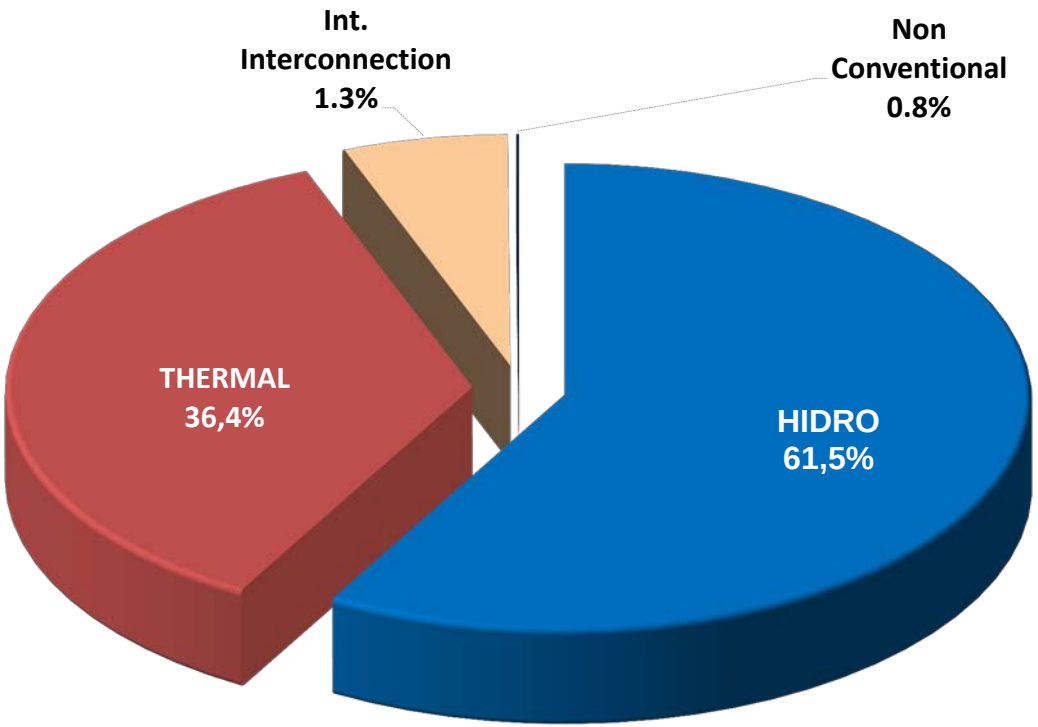
GENERATION PRODUCTION – 2012 (19.650 GWh)



TRANSMISSION SYSTEM 2012

Transformation Capacity

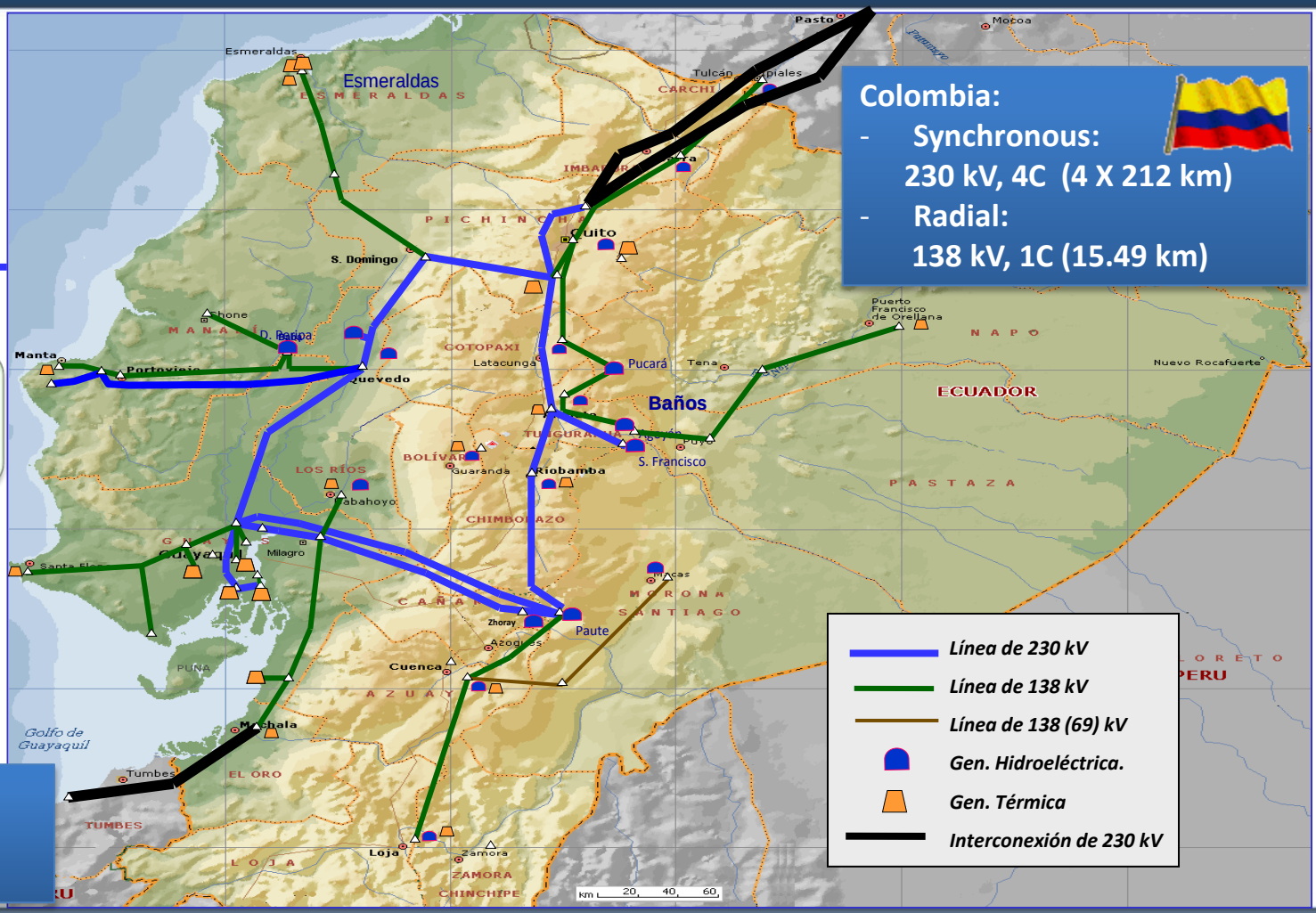
- 8521 MVA

Transmission Lines

- 230 kV : 1841km.
- 138 kV : 1718 km.

No. Substations

- 230 kV : 15
- 138 kV : 20



Perú:
Radial:
230 kV, 1C 107 km

CENACE

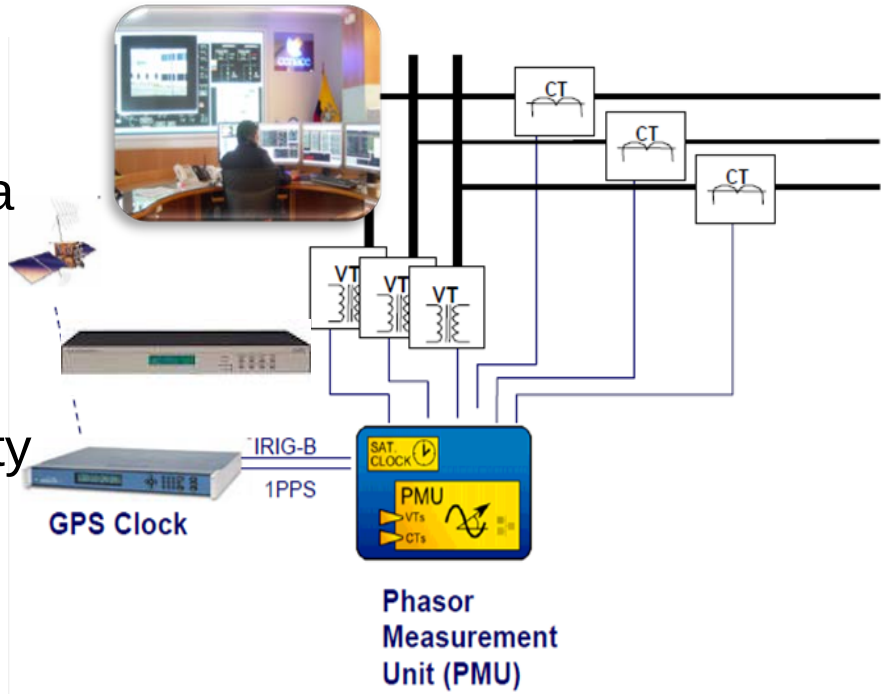
The CENACE Corporation (National Energy Control Center) is the ISO of Ecuadorian Power System . CENACE is responsible for the supervision and control of the G-T network of Ecuador.

Main functions are: Operations Planning, Economic Dispatch, Real Time Operation with an EMS system.

WAMS in Ecuador

Since 2010, CENACE, has been working with initiatives for implementing wide area monitoring applications.

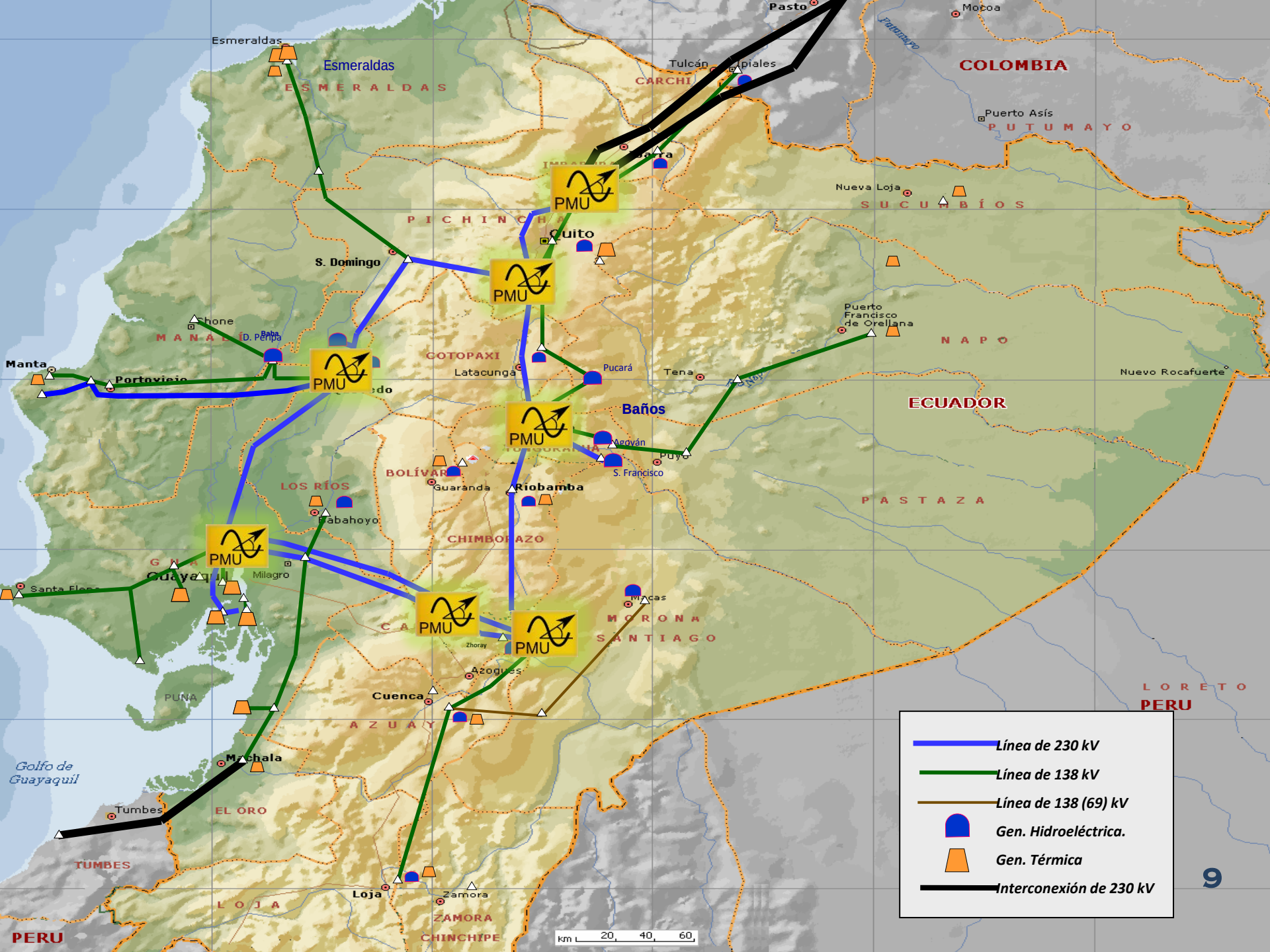
This consists mainly of: Phasor Measurement Units (PMUs), high-capacity communication systems through fiber optics and applications designed to process data sent by PMUs.



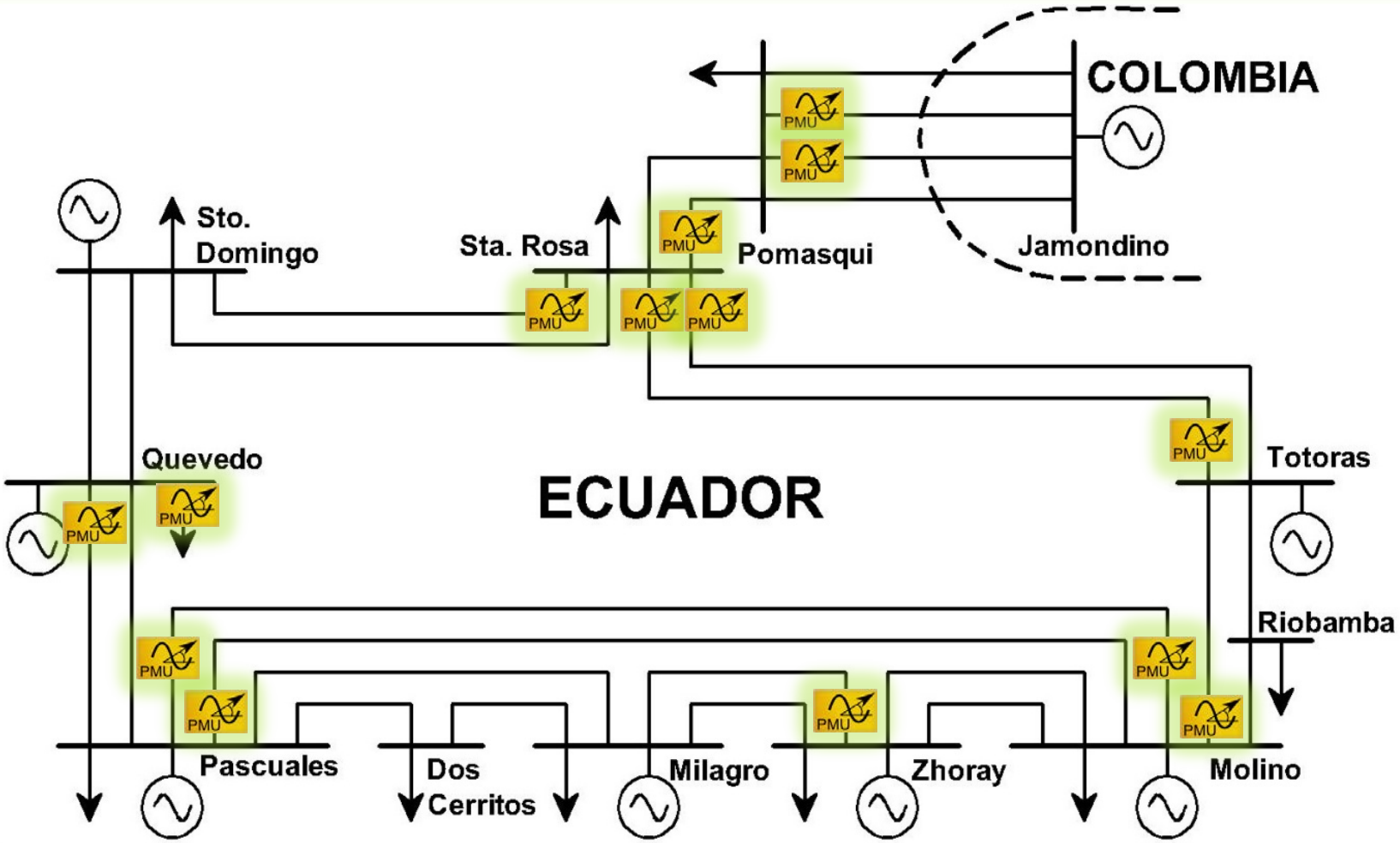
Phasor Measurement Unit

Model 1133A Power Sentinel™

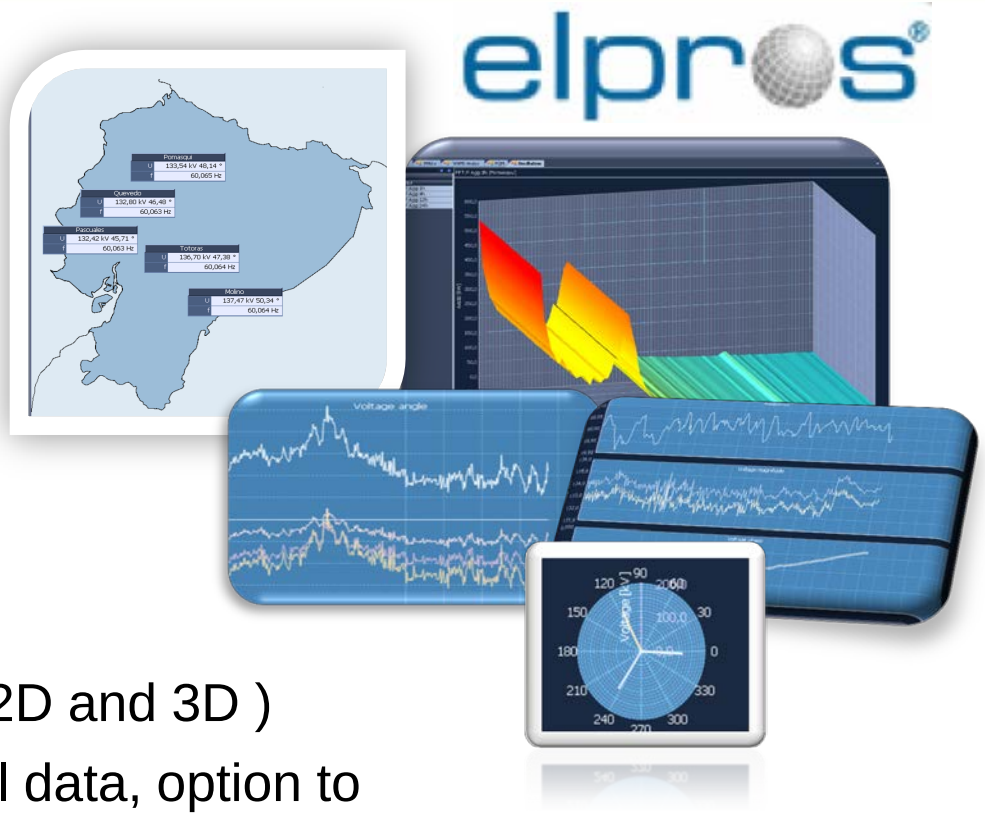
- Synchronized via GPS
- Protocol IEEE C37.118
- PMU measurements are taken at high speed (e.g., 60 observations per second)
- Accuracy: 0.025%
- Power Quality: Harmonics, Flicker, Interruptions
- Phasor Measurements for Stability & Flow Analysis


Esmeraldas
Esmeraldas
ESMERALDAS
Tulcán
Ipiales
CARCHI
Pasto
Mocoa
COLOMBIA
Puerto Asís
PUTUMAYO
Nueva Loja
SUCUMBÍOS
PICHINCHA
Quito
S. Domingo
PMU
PMU
PMU
PMU
PMU
PMU
Puerto Francisco de Orellana
NAPO
Nuevo Rocafuerte
ECUADOR
Manta
Portoviejo
Baba
D. Pedro
MANABÍ
COTOPAXI
Latacunga
Pucará
Tena
Baños
Agoyán
Puyo
S. Francisco
BOLÍVAR
Guaranda
Riobamba
LOS RÍOS
Babahoyo
PASTAZA
CHIMBORAZO
Milagro
Guayaquil
Santa Elena
Macas
MORONA SANTIAGO
Zhoray
Azogues
Cuenca
PUNA
AZUAY
LORETO
PERU
Machala
Golfo de Guayaquil
Tumbes
EL ORO
TUMBES
Loja
Zamora
LOJA
ZAMORA CHINCHIPE
PERU
km 20 40 60
Línea de 230 kV
Línea de 138 kV
Línea de 138 (69) kV
Gen. Hidroeléctrica.
Gen. Térmica
Interconexión de 230 kV
9

ECUADOR - WAM NETWORK



WAProtector, ELPROS



Web-based interface

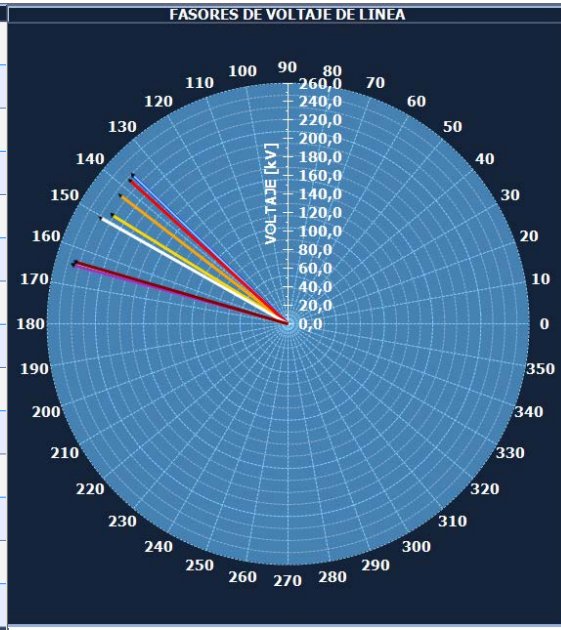
Main Features:

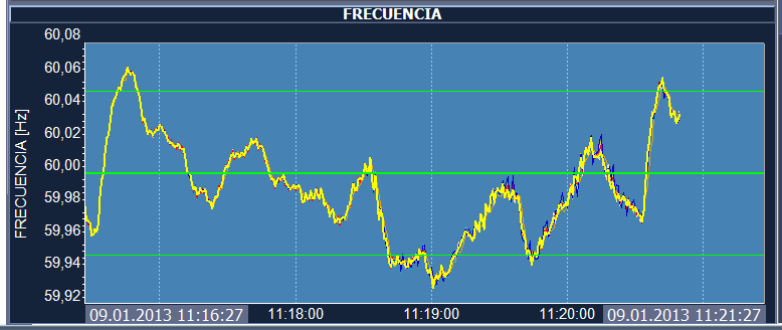
- Real-time monitoring (polar plots, 2D and 3D)
- Data archiving (access to historical data, option to export data for further analysis outside the system)

ECUADOR - WAM NETWORK

WAProtector

VOLTAJES DE LINEA (Vab)		
MOLINO--> PASC1		239,7 kV 164,60 °
MOLINO--> TOTO		240,5 kV 164,70 °
MOLINO--> AT1138kV		143,4 kV 166,65 °
POMASQUI--> JAMO2		232,14 kV 136,20 °
POMASQUI--> JAMO3		232,2 kV 136,17 °
PASCUALES--> MOLI1		223,0 kV 148,24 °
PASCUALES--> MOLI2		222,99 kV 148,26 °
QUEVEDO--> PASC1		228,02 kV 142,52 °
QUEVEDO--> ATT 138kV		138,9 kV 142,21 °
SANTA ROSA--> TOTO1		230,4 kV 137,75 °
TOTORAS--> SROS1		232,6 kV 150,50 °
SALITRAL 138kV--> ATR		134,7 kV 144,58 °
MILAGRO 138kV--> SIDE1		139,9 kV 151,85 °
ZHORAL--> MILA2		238,6 kV 163,75 °





WAProtector

- Time synchronized data in all analysis functions
- In real-time is performed:

  Stability detection functions:

  - ✓ Voltage stability detection in transmission corridors,
  - ✓ Low frequency oscillation detection,
  - ✓ Phase angle diference detection,
  - ✓ Thermal monitoring detection,
  - ✓ Over/under value detections,
  - ✓ Islanding detection,
  - ✓ Oscillation source detection.

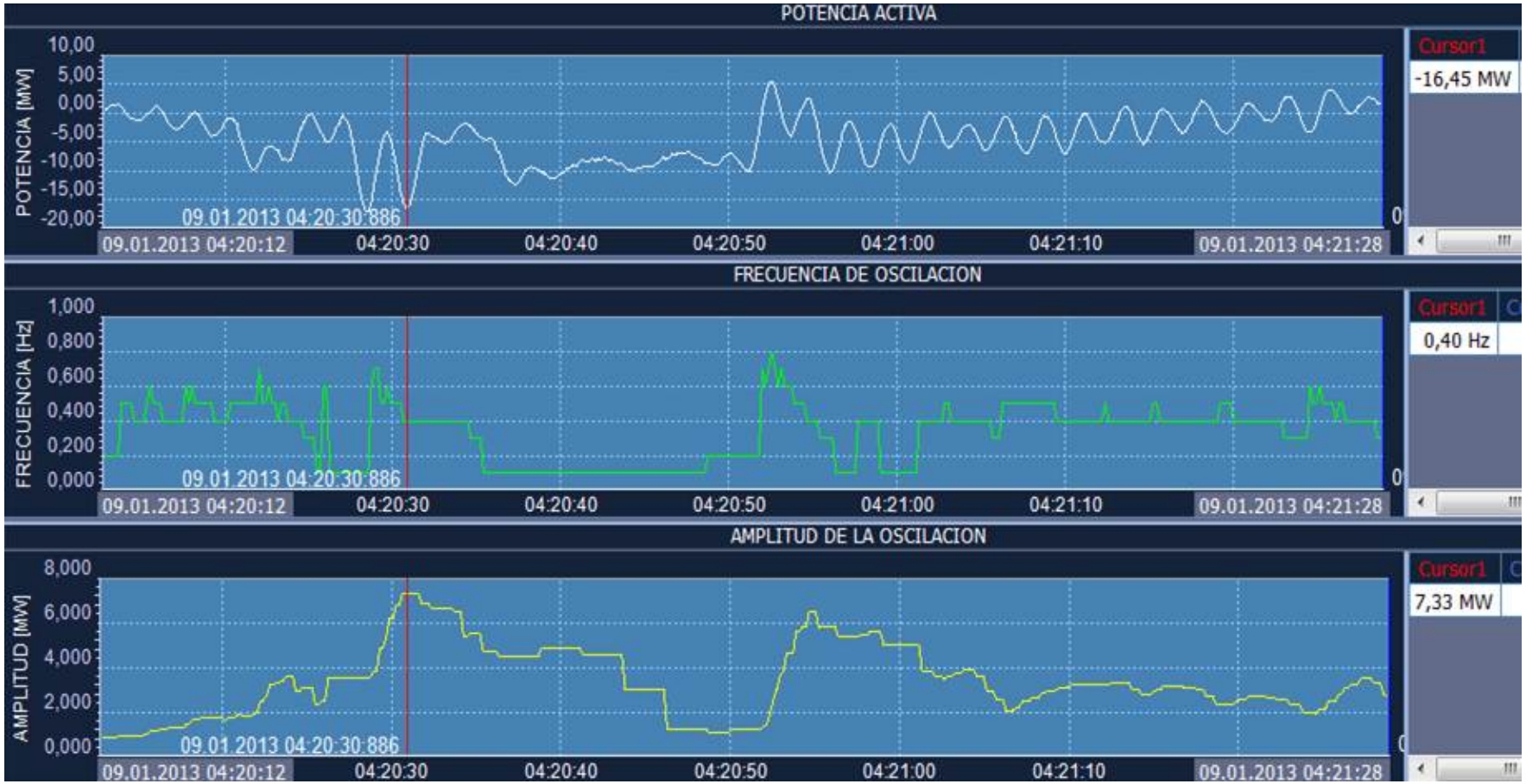



WAProtector

Low frequency oscillation detector

- Oscillation detections on: active power, frequency and angle difference.
- Problems when events in a power system cause big changes in power flows. This can cause undamped power oscillations.
- Low frequency oscillation function calculates:
  - ✓ Dominant frequency, magnitude and damping factor
  - ✓ Trigger status when the value is over the limits for the tolerant time

WAProtector

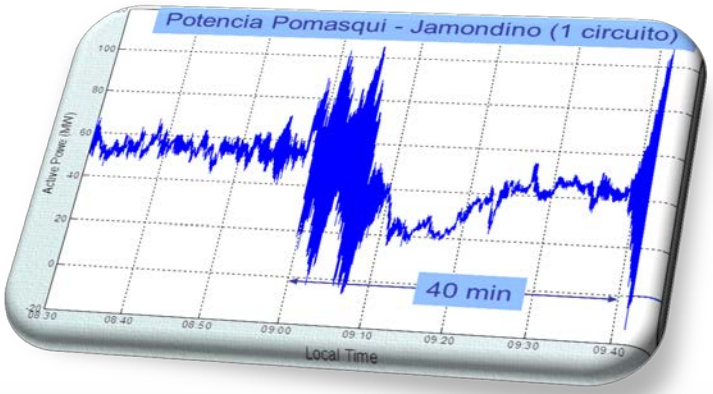


Fault Analysis

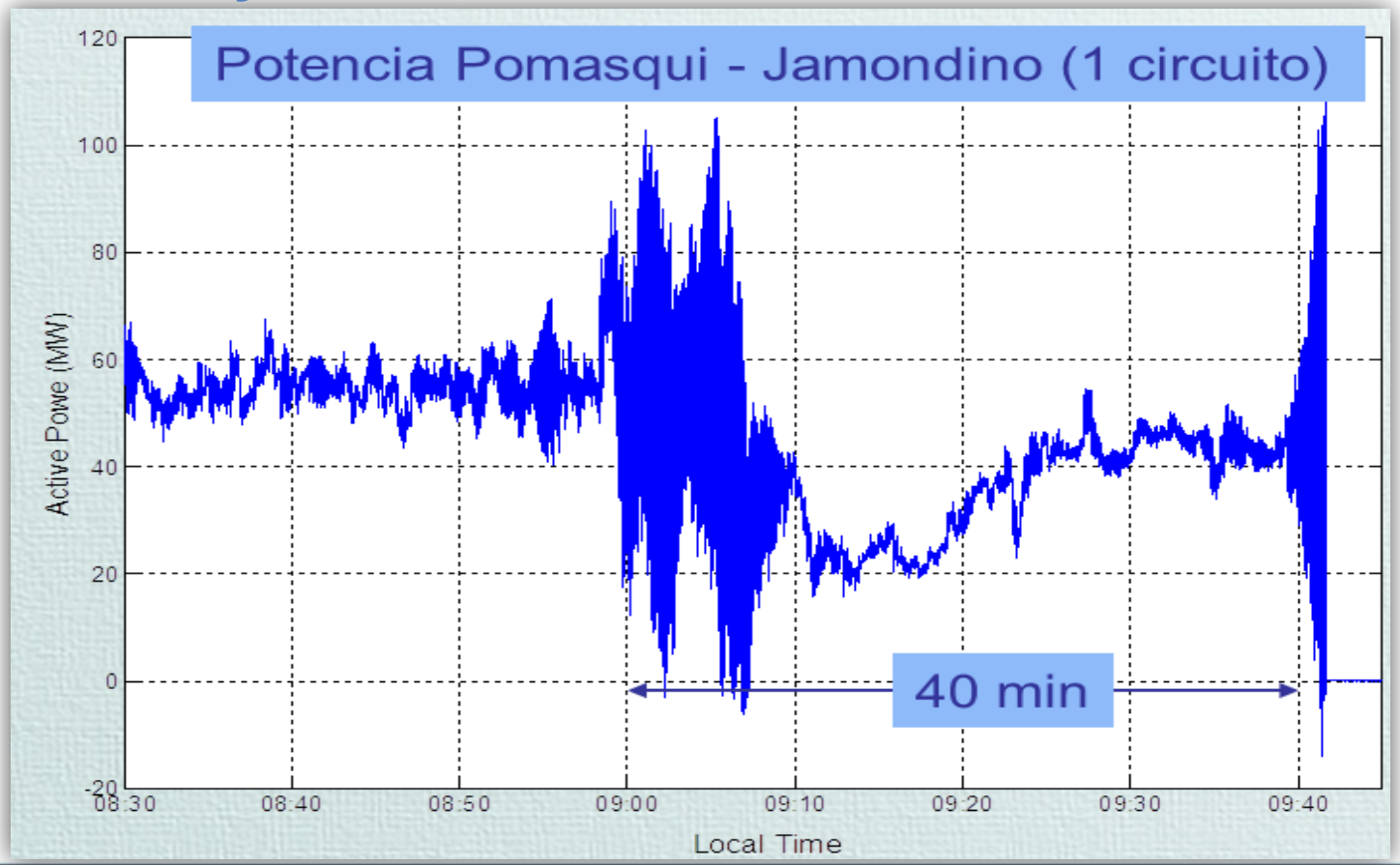
Fault analysis of the September 4, 2011.

In the corresponding fault report mentions that at 9:41:42 of September 4, 2011, opened the four circuits Colombia-Ecuador interconnection 230 kV, with a transfer of 249 MW and -138.4 MVAR in the sense Ecuador to Colombia.

The frequency recorded was 61.23 Hz



Fault Analysis



New Challenges

With PMU devices and new tools for real-time analysis. The electrical system presents new challenges, and hopes to answer the following questions in the near future:

- ¿What were the main contributions to instability?
- ¿What design changes in the control systems are required?
- ¿What operating procedures should be implemented to eliminate instability?

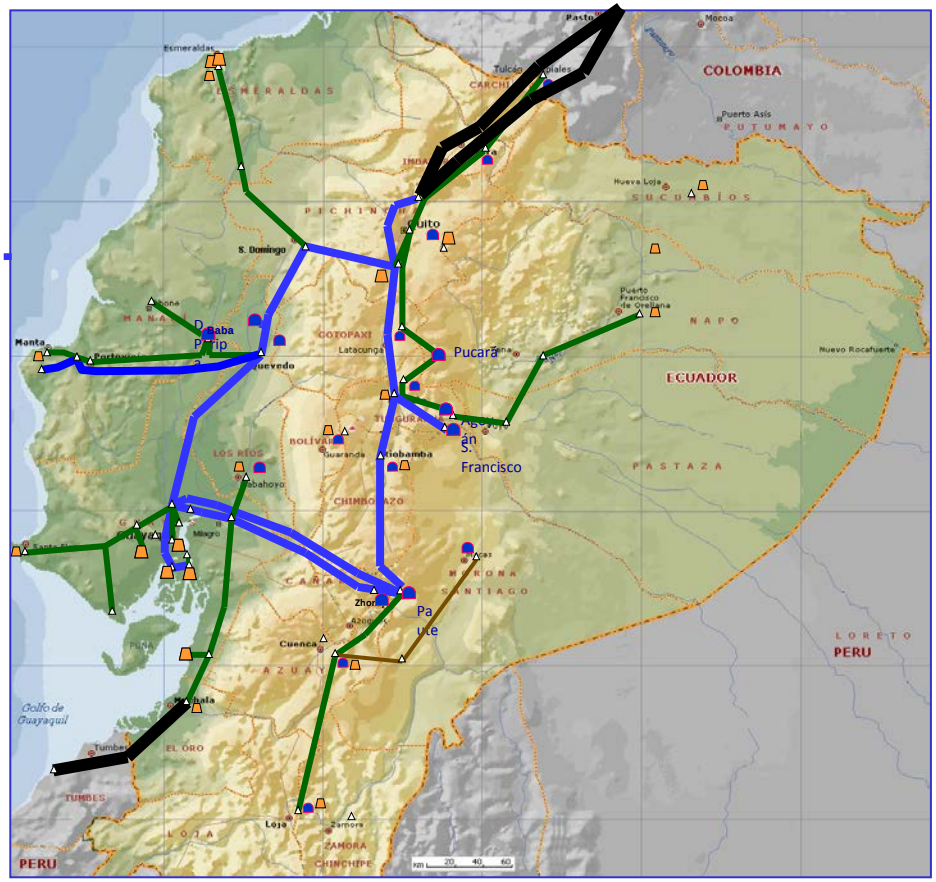


System Protection Scheme

The electrical system in a stressed state - with double contingencies in 230 kV ring - can cause a system collapse.

An Intelligent (computer based) system protection scheme (SPS) is being implemented to mitigate the n-2 contingencies

The SPS was designed with high flexibility and expandability.

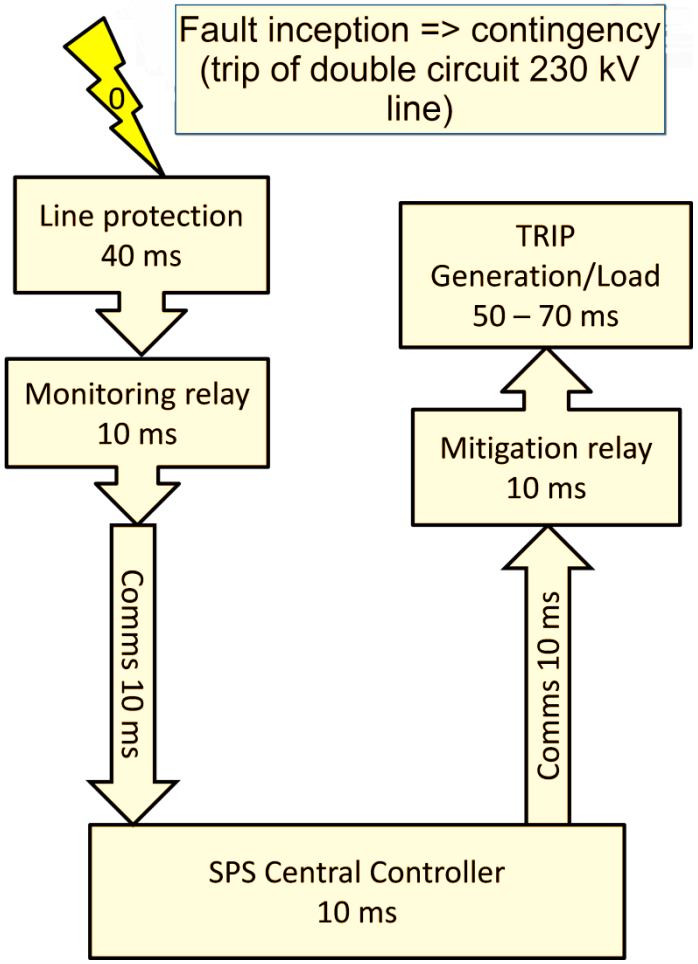


System Protection Scheme

The mitigation of any specific conditions is dependent on SPS controller programming and on placement of sensing/monitoring and tripping/mitigating IEDs at the locations identified in the studies.

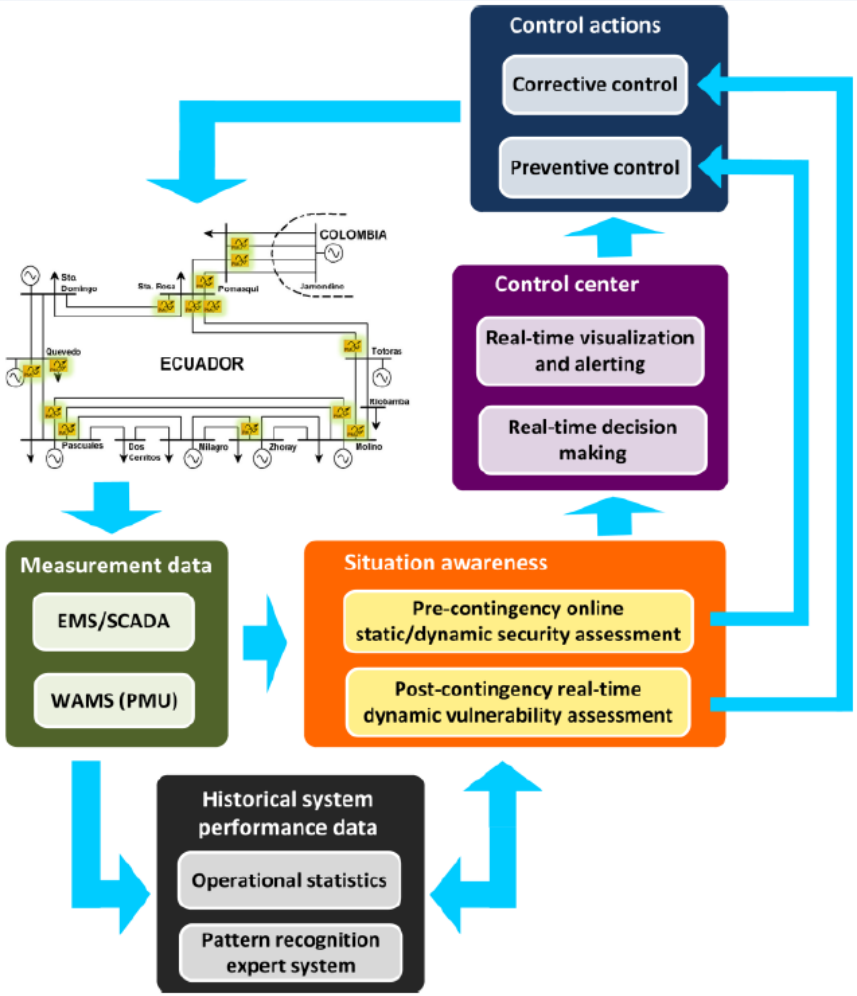
The stream of synchrophasor measurements PMU arrives every second

CENACE is in the bidding process for the implementation of the SPS. According to the work schedule, the SPS will be installed in late 2013 and fully operational in early 2014.



Future Developments

The CENACE actual challenge is to develop a highly integrated WAMC scheme that enables the closed loop comprising real time wide-area situational awareness and enhanced grid control and operations, integrated with actual EMS system.




Thank
you