A vision for the supervision and control systems based on synchrophasor technology
Outline

• The challenges for the system operators
• Where are we today
• Our Vision
• The iSAAC project and its road map
• Final thoughts
Colombia has interesting challenges derived from its particular energy system

- Highly dynamic energy market
- Multiplicity of participants
- Auction based Reliability Charge

- Large hydro capacity, but far from consumption centers
- Uncertainties deriving from wet and dry seasons (length and depth)

- Latest widespread rolling blackout was in 1992
- Total blackout on April 26, 2007
- Frequent terrorist attacks on transmission infrastructure
Requirements for the supervision systems of the future

Requirements and Challenges for the Future Supervision Systems

- ✓ Improve Situational Awareness
  - Use of all available PMU data
  - Improved State Estimation (Quality and Reliability)
  - Advanced Graphical Interface
  - Improved warning and alarming

- ✓ Improve the Reliability of the System
  - Supervision System more robust and reliable
  - Enabling advanced SIPS
  - Improved system restoration mechanisms

- ✓ Improve the Planning Processes
  - Improved system modelling parameters
  - Reduce uncertainties for congestion management

- ✓ Improve knowledge and skills
  - Training in PMU technology
  - Enhanced training tools
The need for a WAMS in Colombia
Total system blackout of 2007

The originating cause of the blackout was an human error with a significant involvement of a faulty solution of the state estimator. The behavior of the backup protections (Zones 3 and 51N) was also a factor.

The system took 11 seconds from the time of the first outage until the trip of the last generator. The sequence of events offered several opportunities to contain the advance of the cascade.
Extremely Low Frequency Oscillations – ELFO

- Almost faced another black-out in 2008, after experiencing one in 2007
- No PMUs installed in Colombia before 2008
- Provided the need to monitor system dynamics

Colombian power system

August 19th 2008

Duration: **90 minutes**

Mode Freq: 0.06 Hz

System Freq: 58.9–60.8 Hz

UFLS of approx 15% of the demand due to frequency excursion

Not a mistake, it was a 0.06 Hz mode
Current WAMS at the Colombian Power System and milestones

Milestones

• PMUs installed at 20 substations, some with more than one unit
• PMU installed in a cavern of a hydro plant for parameter validation
• Super PDC installed in our Headquarters in Medellin receiving all the PMU data
• The WAMS system provides SCADA backup
• In a Psymetrix a high availability platform
• Design of visualization using phasor data
• Our aim is not just increasing the number of PMUs, but to design analytic tools from phasor information (Baselining, indexes, alarms, parameter validation)
• Developed a vision for the supervision and control systems of the future
XM’s current WAMS prototype provides some tools for situational awareness at the control center.

Some tools are used for making decisions about oscillatory stability and others are used to get feedback from operators about its usability.
Oscillatory stability monitoring and analysis tool

General visualization of the oscillatory behavior

Oscillation characteristics analysis and alarming
Our challenge today is to monitor, control and protect the new energy infrastructure on a new market environment with more dynamic energy flows.

With an improved reliability promise!
The iSAAC project
XM proposes a push to integrate the new technologies for a new kind of supervision and control system

**Current SCADA/ EMS systems**

- Centralized data processing and decision making
- No time synchronization
- Radial / Serial communications
- Steady State (1-4 sec updating)

**iSAAC Vision 2025**

We are working on a collaborative strategy to make it happen …
The goal of the project is to design the architecture and the functional ecosystem for the future real time supervision and control systems.

Key Elements:
- Wide use of Phasor Measurement Technology
- Decentralized Functionality at Substations
- IP Communications / Data Bus Architecture
- Collaborative Protection and Control
- Advanced Situational Awareness

The Intelligent Supervision and Advance Control (iSAAC) System

Control Center

Advanced HMI
System Wide State Integration
Global Supervision and Control

T&D Companies
Generators

IP Communications
Network

Gateway/IDD

Data Bus SOA/CIM/C37.118/61850

Gateway/IDD at Substations
Station State Reconciliation (Steady state / dynamics)
Selected decentralized EMS functions
Decentralized system protection and control

Station Bus/61850

Gateway/IDD

Phasor Measurement (PMU)

Phasor Measurement (PMU)
Research and Development partners

Working groups
• EPRC
• NASPI

R&D groups
• Universidad Nacional (Colombia)
  Decentralized State Reconciliation
• Universidad Pontificia Bolivariana (Colombia)
  Advanced Situational Awareness
• Universidade Federal Santa Catarina (Brazil)
  Generation model validation using PMU
• Iowa State University (USA)
  Angle and Voltage Stability

In close cooperation with Quanta Technology and with support from USTDA we’re developing both the conceptual design and road-map.
**iSAAC Road Map and Lines of work**

**Phasor Measurement Technology**

- **2009 – 2012**
  - What is a PMU?
  - What the arrows mean?
  - WAMS prototype
  - WAN implemented in the corporate network
  - SIPS with PMU?

- **2013 – 2015**
  - Shared knowledge
  - Parallel operational prototype phase
  - TCP/IP channels independent from the corporate network
  - Alternative displays within the control room

- **2016 – 2018**
  - Technical competences in SPMS*
  - SCADA/EMS integration
  - IP based communications (Internetworking)
  - Control center decisions based upon Situational awareness
  - SIPS based on WAMS platform

**Decentralized Functionality at Substations**

**IP Communications / Data Bus Architecture**

**Collaborative Protection and Control**

**Advanced Situational Awareness**

*SPMS: Synchro-Phasor Measuring Systems*
We are moving forward ...

First prototype of a Gateway/IDD at the Sabanalarga 500/220kV station, implemented using OpenPDC and its adapters.