Development of A Comprehensive Software Suite for Stability Monitoring and Analysis Based on Synchrophasor Measurement (DOE-OE0000700)

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SOUTHERN COMPANY

BURNS McDONNELL

WASHINGTON STATE UNIVERSITY

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Project Overview

- **Project Plan**
  - Develop a suite of production level software applications (named Grid Stability Awareness System - GSAS) for power grid real-time monitoring and analysis of oscillation stability, voltage stability and transient stability.
  - Deploy the software suite to one of Southern Company's control centers by the end of the project
  - Develop training materials, training sessions, and operating guidelines to enhance power system real-time stability monitoring
- **Key project partners**
  - Burns & McDonnell – Grant Recipient, software development/deployment
    - Scott Feuerborn, Project Manager (PM)
    - Jian Ma, Principal Investigator (PI)
    - Richard Wendland, Development Manager
  - Southern Company - Software demonstration host
    - Clifton Black, Co-PI
  - Washington State University (WSU) - Technology (analytical engines) provider
    - Vaithianathan (Mani) Venkatasubramanian, Professor
  - Grid Protection Alliance (GPA) - Data layer product (openPDC) consultant

Project Approach and Lessons Learned

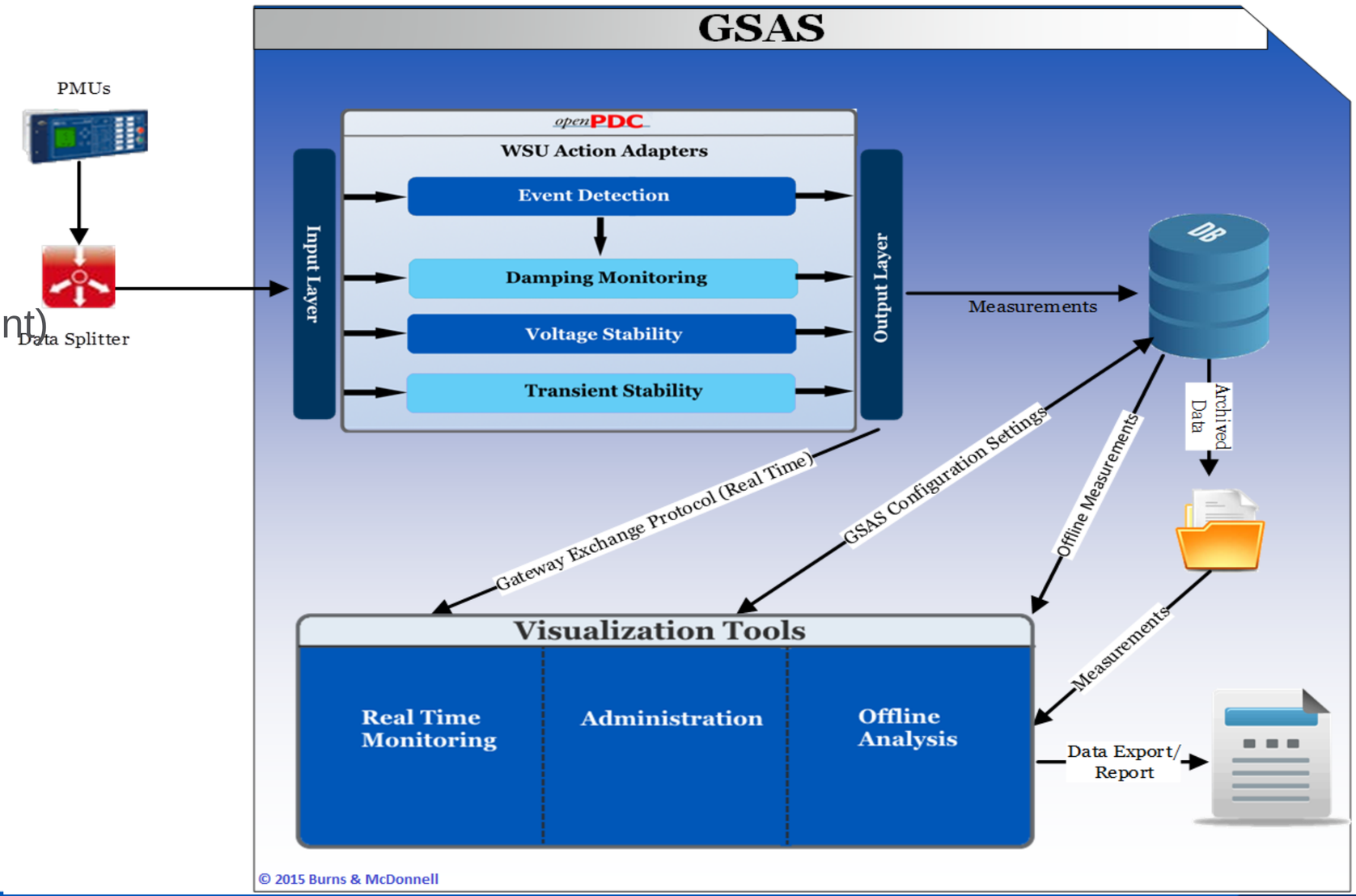
- Agile development approach
  - Iterative planning and feedback loop
  - Adapting to changing requirements throughout the process
  - Rapid delivery of business value
  - Reducing overall risk associated with software development
- Involves all key stakeholders (end users, technology providers, software development personnel) in whole cycle of development
- Identify requirements and prioritize features based on Southern Company personas' expectation
- Implement software prioritized features based on Southern Company personas' comments and feedback

Southern Company Personas

- **Control Room Operator** – *responsible for day-to-day system operations and monitoring*
  - Ability to view the stability state of the entire system in real-time
  - Alerts when monitored measurements exceed customizable thresholds
  - Ability to adjust thresholds to meet operating standards
  - Ability to compare stability calculation results from multiple locations to help determine appropriate action or potential point of failure
- **Electrical Engineer** – *responsible for analyzing events and providing support to Control Room Operator*
  - Ability to access archived data for a specific date and time for post-event analysis
  - Ability to analyze system responses as part of post-event analysis to determine and/or confirm proper corrective action
  - Ability to view the stability state of the entire system in historical view
  - Ability to drill-down into data from a single PMU
- **System Administrator** – *responsible for hardware and software maintenance*
  - Ability to set system configuration parameters in GSAS
  - Ability to set measurement thresholds for warnings and critical alarms

GSAS Architecture

- Operator-oriented for control center environment
  - Operator view
  - Engineering view
  - Administrator configuration
- Event and alarm (warning/critical alarms) driven
- Key modules:
  - Visualization/situational awareness
  - Event detection/alarming
  - Event data playback
  - Oscillation (damping and event) monitoring
  - Voltage stability monitoring
  - Transient stability monitoring
  - Angle difference monitoring

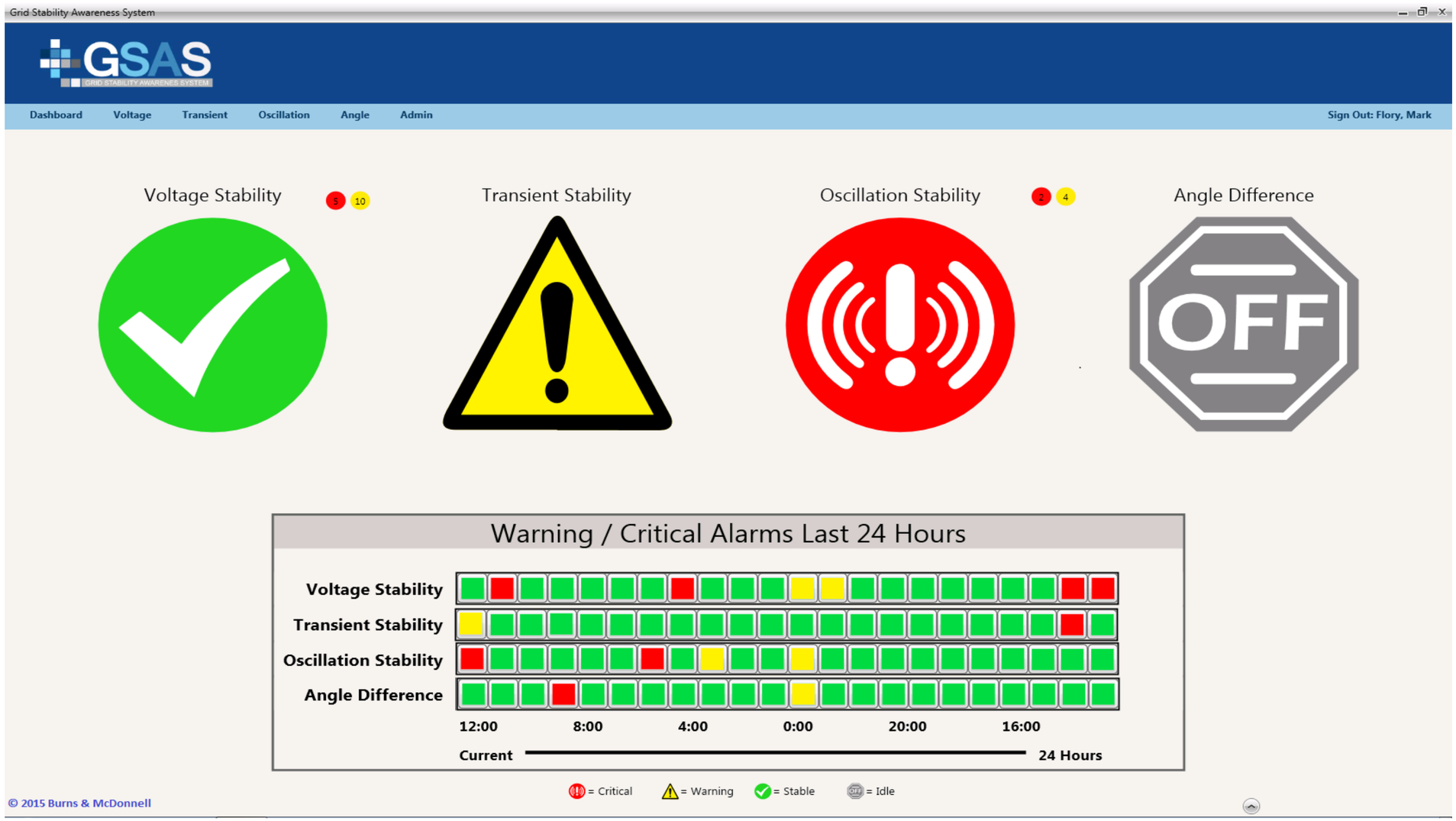


GSAS Key High-Level Features

- Monitor system stability status (WSU analytical engines/adapters)
  - Damping monitoring engine
  - Oscillation event detection engine
  - Voltage stability monitoring engine
  - Transient stability monitoring engine
- Display of a summary of system stability status (dashboard)
- Visualization of real-time data from a large number of PMUs
- Visualization of real-time stability analytical results from WSU calculation engines/adapters
- Geographical display of system stability issues
- Capability of post-event replay and analysis
- Automated event detection and triggering archival of specific event data
- Alarming and data archive when triggers meet user-defined criteria
- Multiple levels of alarming (normal, warning, & critical alarm) and configurable alarm thresholds
- Multiple types of alarms (threshold/limit violations, threshold/limit violations exceeding a time window, rate of change/sensitivity persisting exceeding a time window)
- Capability of alarm logs and acknowledgements
- Capability of alarm filtering, grouping, and report generation
- And more…

GSAS Dashboard Snapshot

- Display of a summary of system stability status (dashboard)
  - Real-time status of system stability
  - Historical (last 24 hours) status of system stability
  - User clickable event/alarm retrieval
  - Event/alarm log and acknowledgements



(Note: This snapshot is for demonstration purpose only. It does not reflect any real system stability status.)

Project Tasks

#	Tasks
Task 1	Project Management & Planning
Task 2	Define Software Suite Roadmap and Plans for Development, Deployment & Evaluation of Performance
Task 3	Develop and Refine Analytical Tools (Engines)
Task 4	Software Suite Development
Task 5	Software Suite Deployment
Task 6	Develop Training Materials and Operating Guidelines

Project Progress

- Progress (as of October, 2015)

Milestones	Status
Project Kick-off meeting at Southern Company	Complete
An on-site interview meeting at Southern Company	Complete
Software requirement specifications	Complete
Software suite roadmap and plans for development, deployment & evaluation of performance	Complete
Software visualization and GUI mockups	Complete
Software storyboards (operator, engineer, and administrator)	Complete
Develop and refine analytical engines (damping analysis engine, event detection engine, and voltage stability engine)	Complete
Develop and refine analytical engines (transient stability engine)	On Going
Software off-line performance evaluation	On Going
Implementation of visualization and GUI	On Going

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